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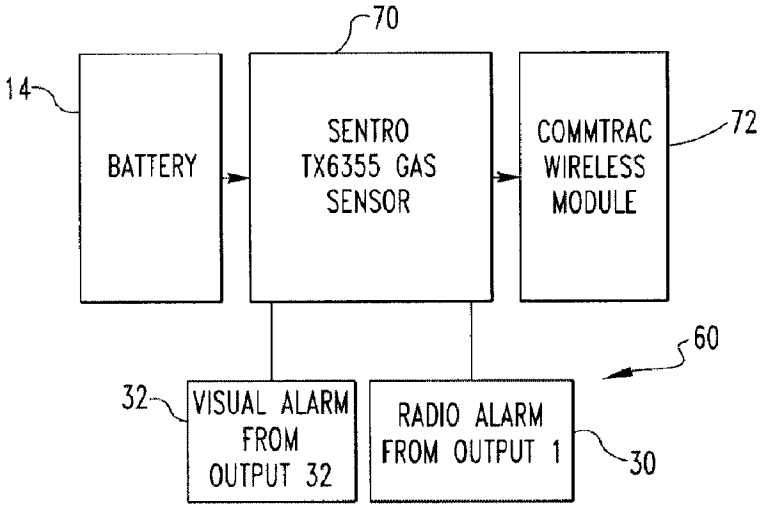

(57) **Abrégé/Abstract:**
A monitor for gases and a mine includes a housing. The monitor includes a battery disposed in the housing. The monitor includes a gas sensor portion powered by the battery. The monitor includes an alarm portion disposed in the housing which emits a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold. The monitor includes a wireless communication portion disposed in the housing which sends a wireless signal from the housing that the gas sensor portion has sensed a gas. The monitor includes a processor disposed in the housing. Alternatively, the monitor includes a terminal portion that has two states, an output configuration state, and an input configuration state. A method for monitoring gases in a mine. A system for monitoring gases underground. A system for monitoring gases on an oil or gas rig.

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ABSTRACT

A monitor for gases and a mine includes a housing. The monitor includes a battery disposed in the housing. The monitor includes a gas sensor portion powered by the battery. The monitor includes an alarm portion disposed in the housing which emits a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold. The monitor includes a wireless communication portion disposed in the housing which sends a wireless signal from the housing that the gas sensor portion has sensed a gas. The monitor includes a processor disposed in the housing. Alternatively, the monitor includes a terminal portion that has two states, an output configuration state, and an input configuration state. A method for monitoring gases in a mine. A system for monitoring gases underground. A system for monitoring gases on an oil or gas rig.

GAS MONITOR, SYSTEM AND METHOD

FIELD OF THE INVENTION

[0001] The present invention is related to monitoring of gas where the value of the gas is transmitted wirelessly. (As used herein, references to the "present invention" or "invention" relate to exemplary embodiments and not necessarily to every embodiment encompassed by the appended claims.) More specifically, the present invention is related to monitoring of gas in an underground environment or an oil or gas rig with an apparatus where the value of the gas is transmitted wirelessly from the apparatus and an alarm is activated at the apparatus when the value of the gas is above a predetermined value, or an input signal from an input of the apparatus is transmitted wirelessly from the apparatus.

BACKGROUND OF THE INVENTION

[0002] This section is intended to introduce the reader to various aspects of the art that may be related to various aspects of the present invention. The following discussion is intended to provide information to facilitate a better understanding of the present invention. Accordingly, it should be understood that statements in the following discussion are to be read in this light, and not as admissions of prior art.

[0003] Atmospheric Monitoring Systems, herein after referred to as AMS, and their requirements are thoroughly described in The Mine Safety Health Administration's 30 CFR § 75.351.

[0004] Historically, AMS consisted of gas monitors connected over a hardwired network all communicating to a central area as described in the above requirement in section (b)(1). As the mine expanded and additional monitors were needed, lengths of cable were added to facilitate communications and power to new monitoring locations. As technology progressed, wireless and battery powered solutions became available. Extensive lengths of cable providing data and power were no longer needed. Mines now have the option of running a hardwired system or a hybrid of both hardwired with wireless. This becomes especially effective when the mine monitoring requirement consists of both permanent and temporary monitoring needs. Areas along the beltways are typically unchanging and are best suited for

hardwired monitoring where developing areas of the mine are better suited for a wireless/battery powered solution. Aside from the existing hardwired network, a wireless communication network is still needed to transmit data from the wireless monitors to the designated central area. This could be served with a device that acts as an access point for the wireless monitor data to enter the existing hardwired network or an entirely separate true wireless network such as Strata Products Worldwide, LLC's CommTrac™ system.

[0005] As taken from section (c)(2) of the above requirement, an AMS must have the ability to "Automatically provide visual and audible signals at the designated surface location when the carbon monoxide concentration or methane concentration at any sensor reaches the alert level as specified in § 75.351(i). These signals must be of sufficient magnitude to be seen or heard by the AMS operator."

[0006] The detail of importance in this section is the mention of "methane". Traditional AMS hardwired systems offer methane monitoring but only in the 0-5% by volume range using catalytic bead technology. Methane concentrations above 5% will cause catalytic technology to be permanently damaged. In the event of a disaster and mine ventilation is lost, methane levels can easily exceed 5% concentration. Existing technology cannot provide atmospheric information that is critical during rescue efforts. No wireless or hardwired option exists to fulfill this need. Furthermore, the available wireless gas monitoring devices only offer carbon monoxide as a detectable gas and only in the 100 PPM maximum range.

[0007] As taken from section (c)(4) of the above requirement, an AMS must have the ability to "Automatically provide visual and audible signals at all affected working sections and at all affected areas where mechanized mining equipment is being installed or removed when the carbon monoxide, smoke, or methane concentration at any sensor reaches the alarm level as specified in § 75.351(i). These signals must be of sufficient magnitude to be seen or heard by miners working at these locations. Methane signals must be distinguishable from other signals."

[0008] Traditional AMS hardwired systems offer this ability through a hybrid monitor/alarming unit although no wireless options for this requirement exist currently. Mines are often forced to run a separate control network if using a wireless monitoring solution to satisfy the section alarming requirement.

[0009] Similar to mines, oil and gas rigs need to monitor the atmosphere for dangerous levels of various gases without the need of cables and wiring cluttering the rig. In places such as oil and gas rigs, there is also the risk of dangerous gases and the need to monitor the atmosphere for these dangerous gases. Typically, gas monitors were connected by cabling and wiring throughout the rig has been used to monitor dangerous gases on a rig. The presence of all of these cables and wires distributed throughout a rig creates the problem of properly organizing and positioning the cables and wires so they do not interfere with the operation of the rig nor can be damaged so that connection is lost with the monitor during operation. If connection is lost with a monitor, then the monitor as well as the entire length of the cable or wire that connects the monitor to a remote station for monitoring must be examined to correct the loss of communication with the monitor. Such cabling and wiring could extend quite a long distance and be located in difficult positions to examine and can become a significant issue to correct.

[0010] In addition, in a mine, it is important to be able to track and communicate with a miner in ideally the most unobtrusive way possible. Besides the mine environment being a dangerous place in and of itself, the more equipment a miner carries, the more difficult it is for the miner to perform his functions and move through the mine. What is desired is a simple way to alert a miner of a dangerous or emergency condition, as well as for the miner to inform a remote station of the miner's condition and the miner's location.

[0011] To further provide for the safety of a miner, the miner is required to carry a light, such as a cap lamp that the miner wears on his head, as well as is required to be tracked in the mine, and also be protected from contact with machinery so as not to be injured by the machinery by accidentally contacting the machinery during operation. The latter protection is afforded with the use of a proximity device carried by a miner and proximity sensors positioned on machinery which, when determining that a proximity device carried by a miner is within a predetermined location of the proximity sensor, the machine is turned off so the miner is not injured. As the light is already required to be carried by a miner, and the proximity device is commonly carried by a miner, it would be desirable to combine tracking with these functions since they are already present on the miner.

[0012] To provide communication to and from the miner to inform the miner of important information or to track the miner or to enable the miner to communicate with the

remote station, communication networks are critical throughout the mine. Since the mine is a very difficult environment for communication networks, redundancy, as well as data networks that ideally work best to transmit data, and voice networks that ideally work best to transmit voice bidirectionally, in which also can transmit data, and work in combination are desired.

BRIEF SUMMARY OF THE INVENTION

[0013] The present invention pertains to a monitor for gases and a mine. The monitor comprises a housing. The monitor comprises a battery disposed in the housing. The monitor comprises a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine. The monitor comprises an alarm portion disposed in the housing, powered by the battery and in electrical communication with the battery which emits a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold. The monitor comprises a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing that the gas sensor portion has sensed of either the first or second gas. The monitor comprises a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, alarm portion, sensor portion and battery.

[0014] The present invention pertains to a method for monitoring gases in a mine. The method comprises the steps of detecting with a gas sensor portion a first gas and at least a second gas different from the first gas in the mine, the gas sensor portion powered by a battery and in electrical communication with the battery, the gas sensor portion and the battery disposed in the housing. There is the step of emitting with an alarm portion powered by the battery, disposed in the housing and in electrical communication with the battery a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold. There is the step of sending with a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion a wireless signal from the housing that the gas sensor portion has sensed either the first or second gas.

[0015] The present invention pertains to a monitor for gases in a mine. The monitor comprises a housing. The monitor comprises a battery disposed in the housing. The monitor comprises a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine. The monitor comprises a terminal portion that has two states, an output configuration state in which an output signal is sent from the processor to a first device, and an input configuration state in which an input signal is received from a second device. The monitor comprises a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing that the gas sensor portion has sensed of either the first or second gas. The monitor comprises a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, alarm portion, sensor portion and battery.

[0016] The present invention pertains to a monitor for gases and a mine. The monitor comprises a housing. The monitor comprises a battery disposed in the housing. The monitor comprises a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine. The monitor comprises a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing that the gas sensor portion has sensed of either the first or second gas. The monitor comprises at least one input for connection to a remote device which provides a status signal regarding the remote device which is transmitted by the wireless communication portion from the detector. The monitor comprises a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, the input, sensor portion and battery.

[0017] The present invention is related to a system for monitoring gases underground. The system comprises a monitor which detects a gas located in a tunnel underground and determines a gas value of the gas. The monitor has an audio alarm and a visual alarm which is activated what the detected gas is above a predetermined value, and a transceiver which transmits the gas value. The system comprises a wireless telecommunications network on

which the gas value is transmitted from the apparatus. The system comprises a remote station which receives the gas value from the network.

[0018] The present invention pertains to a system for monitoring gases on an oil or gas rig. The system comprises a monitor which detects a gas at the rig and determines a gas value of the gas. The monitor having an audio alarm and a visual alarm, which is activated when the detected gas is above a predetermined value, and a transceiver which transmits the gas value. The system comprises a wireless telecommunications network on which the gas value is transmitted from the monitor. The system comprises a remote station which receives the gas value from the network.

[0019] The present invention pertains to a remote station which receives gas values of gas monitors from a wireless network. The remote station comprises a receiver which receives the gas values wirelessly from the network. The remote station comprises a processor in communication with the receiver which receives the gas values from the receiver. The remote station comprises a display in communication with the processor on which the processor displays an alarm indication when the gas value is above a predetermined level.

[0020] The present invention pertains to a communication system. The system comprises a data network on which solely data is sent. The system comprises a wireless network on which voice and data is sent bi-directionally. The system comprises a plurality of nodes distributed and apart from each other that form the data network and the wireless network. Each node has a data portion which receives and sends data on the data network, a wireless portion which receives and sends voice signals on the wireless network, and a power supply portion in electrical communication with the data portion and the wireless portion which powers the data portion and the wireless portion.

[0021] The present invention pertains to a communication node of a data network and a wireless network. The node comprises a data portion which receives data wirelessly on the data network. The node comprises a wireless portion which receives and sends voice signals on the wireless network. The node comprises a power supply portion in electrical communication with the data portion and the wireless portion which powers the data portion and the wireless portion. The node comprises a data converter in communication with the data portion and the wireless

portion which converts the data from the data network into a transmission signal that is transmitted on the wireless network.

[0022] The present invention pertains to a method for communicating in a mine. The method comprises the steps of receiving data wirelessly at a data portion of a first node of a plurality of nodes 206 from a data network on which solely data is sent. The plurality of nodes distributed and apart from each other and form the data network and a wireless network. There is the step of converting with a data converter in communication with the data portion the data from the data network into a transmission signal that is transmitted on the wireless network. The wireless network transmitting and receiving voice and data bi-directionally. There is the step of transmitting the transmission signal from the first node on the wireless network with a wireless portion of the first node. There is the step of powering the data portion and the wireless portion with a power supply portion in electrical communication with the data portion and the wireless portion.

[0023] The present invention pertains to a miner communicator in a communications network. The communicator comprises a housing. The communicator comprises a processor disposed in the housing. The communicator comprises a transceiver disposed in the housing and in communication with the processor and the network to send to and receive from the network only data but not including text. The communicator comprises an input disposed on the housing and in communication with the processor which provides a trigger signal to the processor. The communicator comprises an alarm in contact with the housing and in communication with the processor that is activated by the processor when an alarm signal is received by the transceiver. The communicator comprises a position portion disposed in the housing and in communication with the processor which determines a location of the communicator and provides a location to the processor, the processor provides the location and an ID of the communicator to the transceiver which transmits the ID and location to the network to a communication node, ideally the closest node, and then to the remote station.

[0024] The present invention pertains to a method for communicating with a miner in a mine. The method comprises the steps of sending an alarm signal wirelessly through a wireless communication network to a miner communicator carried by a miner in the mine. The communicator is only able to receive data but not voice. There is the step of receiving the alarm

signal by the communicator. There is the step of activating an alarm of the communicator by a processor of the communicator in response to the communicator receiving the alarm signal. There is the step of activating a button of the communicator to cause the transmitter to transmit from the communicator to the network an indicator signal regarding the miner's status, and with the indicator signal is an id of the communicator and position of the communicator the communicator not having a display or a keyboard.

[0025] The present invention pertains to a miner apparatus of a wireless network. The apparatus comprises a housing which is carried by the miner. The apparatus comprises a tracking portion disposed in the housing which determines the miner's location and transmits the location wirelessly to the network. The apparatus comprises a battery disposed in the housing and connected to the tracking portion which powers the tracking portion. The apparatus comprises a cap lamp electrically connected to the battery which is powered by the battery to provide light, the cap lamp worn by the miner.

[0026] The present invention pertains to a miner apparatus of a wireless network. The apparatus comprises a housing which is carried by the miner. The apparatus comprises a tracking portion disposed in the housing which determines the miner's location and transmits the location wirelessly to the network. The apparatus comprises a battery disposed in the housing and connected to the tracking portion which powers the tracking portion. The apparatus comprises a proximity device electrically connected to the battery and disposed in the housing which is powered by the battery to provide a detectable presence to a proximity detector when the miner gets too close to the proximity detector, the proximity device worn by the miner.

[0027] The present invention pertains to a miner apparatus of a wireless network. The apparatus comprises a housing which is carried by the miner. The apparatus comprises a tracking portion disposed in the housing which determines the miner's location and transmits the location wirelessly to the network. The apparatus comprises a battery disposed in the housing and connected to the tracking portion which powers the tracking portion. The apparatus comprises a proximity device electrically connected to the battery and disposed in the housing which is powered by the battery to provide a detectable presence to a proximity detector when the miner gets too close to the proximity detector, the proximity device worn by the miner. The

apparatus comprises a cap lamp electrically connected to the battery which is powered by the battery to provide light. The cap lamp is worn by the miner.

[0028] The present invention pertains to a method for a miner to move through a mine. The method comprises the steps of powering a light of a cap lamp on the miner's head with a battery in a housing carried by the miner. There is the step of sending location information from the housing so the miner can be tracked as the miner moves through the mine. There is the step of stopping a machine with a proximity sensor connected to the machine, because the proximity sensor has sensed a proximity device in the housing has come within a predetermined distance to the proximity device.

[0029] The present invention pertains to a proximity detector attached to a machine. The detector for detecting a miner's presence comprises a generator which produces a magnetic field. The detector comprises a processor. The detector comprises a transceiver for sending a message produced by the processor having information about the generator's health and an ID of a PAD of a miner that has triggered a warning or hazard that has effectively stopped operation of the machine.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0030] In the accompanying drawings, the preferred embodiment of the invention and preferred methods of practicing the invention are illustrated in which:

[0031] Figures 1A, 1AA, 1B and 2A-2E are engineering schematic diagrams of the wireless communications portion, the alarm portion and the battery of the present invention.

[0032] Figure 3 is a block diagram of the present invention.

[0033] Figure 4 is a block diagram of the wireless communications portion, the alarm portion and the battery of the present invention.

[0034] Figure 5 is an operations diagram of the present invention.

[0035] Figure 6 is a representation of the output configuration of the claimed invention.

[0036] Figure 7 is a representation of the input configuration of the claimed invention.

[0037] Figure 8 is a representation of the terminal connectivity regarding input mode of the claimed invention.

[0038] Figure 9 is a representation of the terminal connectivity regarding output mode of the claimed invention.

[0039] Figure 10 is a representation of the terminal.

[0040] Figure 11 shows the apparatus having a housing with a first shell and a second shell.

[0041] Figure 12 shows the apparatus having a first port and a second port for inputs or outputs.

[0042] Figure 13 is a block diagram regarding the system of the present invention.

[0043] Figure 14A is a schematic representation of a communication system of the present invention.

[0044] Figures 14B and 14C are block diagrams of a shared power supply of a node.

[0045] Figure 15 is a block diagram of a miner communicator.

[0046] Figure 16 is a block diagram of a remote station which receives gas values of gas monitors.

[0047] Figure 17 is a perspective view of a housing of the remote station.

[0048] Figure 18 is a block diagram of a miner apparatus with a cap lamp and tracking.

[0049] Figure 19 is a block diagram of a miner apparatus with a proximity device and tracking.

[0050] Figure 20 is a block diagram of a miner apparatus with a cap lamp, proximity device and tracking.

[0051] Figure 21 is a representation of a system for a miner.

[0052] Figures 22 and 23 are circuit diagrams of the miner communicator of the present invention.

[0053] Figure 24 shows an overhead view of the circuit board having the circuitry described in figures 22 and 23.

[0054] Figures 25 – 28 are circuit diagrams of the miner apparatus of the present invention.

[0055] Figure 29 is an exploded view of the miner apparatus.

[0056] Figure 30 shows the terminals of the miner apparatus.

DETAILED DESCRIPTION OF THE INVENTION

[0057] Referring now to the drawings wherein like reference numerals refer to similar or identical parts throughout the several views, and more specifically to figures 1A-5, 11, 12 and 13 thereof, there is shown a monitor 10 for gases in a mine. The monitor 10 comprises a housing 12. The monitor 10 comprises a battery 14 disposed in the housing 12. The monitor 10 comprises a gas sensor portion 16 powered by the battery 14 and in electrical communication with the battery 14 which detects a first gas and at least a second gas different from the first gas in the mine. The monitor 10 comprises an alarm portion 18 disposed in the housing 12, powered by the battery 14 and in electrical communication with the battery 14 which emits a visual alert and an audible alert when the gas sensor portion 16 senses that either the first or second gas is above a predetermined threshold. The monitor 10 comprises a wireless communication portion 20 disposed in the housing 12, powered by the battery 14 and in electrical communication with the battery 14 and the sensor portion, which sends a wireless signal from the housing 12 that the gas sensor portion 16 has sensed of either the first or second gas. The monitor 10 comprises a processor 22 disposed in the housing 12, powered by the battery 14 and in electrical communication with the wireless communication portion 20, alarm portion 18, sensor portion and battery 14.

[0058] The housing 12 may be one single shell or a combination of shells that are effectively engaged together, as shown in figures 11 and 12. For instance, audio and visual (AV) alarms of the alarm portion 18 may be in a separate or second shell 26 from the processor 22 and the wireless communication portion 20 which is in a first shell 24 separate from the second shell 26, with the AV alarms electrically connected by wires which extend through MSHA approved glands 28 and the first and second shells 24, 26 may be held together with screws or rivets. The gas monitoring portion may be in a separate shell from the processor 22 and wireless communication portion 20 and be in electrical communication through wires passing through a gland(s) 28. Figure 11 shows the apparatus having a housing 12 with a first shell 24 and a second shell 26. The second shell 26 has the AV alarms. Figure 12 shows the apparatus having a first port 34 and a second port 36 with glands 28 for inputs 54 or outputs 56. Figure 12 also shows an embodiment of the apparatus with the capability of monitoring and detecting four different gases, for instance here Nitric Oxide, Methane, Oxygen and Carbon

Monoxide, as shown in a display 38 of the housing 12. Here, there are four openings 40, one for each gas being sensed, in fluid communication for the respective gas module monitoring and detecting the respective gas.

[0059] The gas sensor portion 16 may include a full range by volume between zero and 100% methane sensor 42 and the wireless communication portion 20 transmits wirelessly from the housing 12 a methane value of methane in the mine sensed by the sensor portion. The gas sensor portion 16 may include a carbon monoxide sensor 44 and a H2S sensor 46 and the wireless communication portion 20 transmits wirelessly from the housing 12 a carbon monoxide value of carbon in the mine sensed by the sensor portion and an H2S value of H2S in the mine sensed by the sensor portion. The processor 22 may receive a gas value signal from the gas sensing portion and converts the gas value signal into a converted signal form of the gas value which can be sent wirelessly by the communication portion 20 from the housing 12.

[0060] The communication portion 20 may include a transceiver 48 in communication with the processor 22, as shown in figures 1A, 1AA and 2A-2E. The communication portion 20 may include an amplifier 50 with an internal antenna 52 in communication with the transceiver 48, as shown in figures 1A and 1AA. The processor 22 may provide the converted signal of the gas value to the transceiver 48 which then transmits the converted signal form of the gas value wirelessly through the amplifier 50 and the internal antenna 52 from the housing 12. The processor 22 may receive an alarm signal from the gas sensor portion 16 and activates the visual alarm 32 and the audible alarm based on the alarm signal.

[0061] The present invention pertains to a monitor 10 for gases and a mine, as shown in figure 13. The monitor 10 comprises a housing 12. The monitor 10 comprises a battery 14 disposed in the housing 12. The monitor 10 comprises a gas sensor portion 16 powered by the battery 14 and in electrical communication with the battery 14 which detects a first gas and at least a second gas different from the first gas in the mine. The monitor 10 comprises a wireless communication portion 20 disposed in the housing 12, powered by the battery 14 and in electrical communication with the battery 14 and the sensor portion, which sends a wireless signal from the housing 12 that the gas sensor portion 16 has sensed of either the first or second gas. The monitor 10 comprises at least one input 54 for connection to a remote device which provides a status signal regarding the remote device which is transmitted by the wireless

communication portion 20 from the detector. The monitor 10 comprises a processor 22 disposed in the housing 12, powered by the battery 14 and in electrical communication with the wireless communication portion 20, the input 54, sensor portion and battery 14.

[0062] The present invention pertains to a method for monitoring gases in a mine. The method comprises the steps of detecting with a gas sensor portion 16 a first gas and at least a second gas different from the first gas in the mine, the gas sensor portion 16 powered by a battery 14 and in electrical communication with the battery 14, the gas sensor portion 16 and the battery 14 disposed in the housing 12. There is the step of emitting with an alarm portion 18 powered by the battery 14, disposed in the housing 12 and in electrical communication with the battery 14 a visual alert and an audible alert when the gas sensor portion 16 senses that either the first or second gas is above a predetermined threshold. There is the step of sending with a wireless communication portion 20 disposed in the housing 12, powered by the battery 14 and in electrical communication with the battery 14 and the sensor portion a wireless signal from the housing 12 that the gas sensor portion 16 has sensed either the first or second gas.

[0063] The present invention pertains to a monitor 10 for gases in a mine, as shown in figure 13. The monitor 10 comprises a housing 12. The monitor 10 comprises a battery 14 disposed in the housing 12. The monitor 10 comprises a gas sensor portion 16 powered by the battery 14 and in electrical communication with the battery 14 which detects a first gas and at least a second gas different from the first gas in the mine. The monitor 10 comprises a terminal portion 58 that has two states, an output configuration state in which an output signal is sent from the processor 22 to a first device 60, such as the audio alarm 30, as shown in figure 4, and an input 54 configuration state in which an input 54 signal is received from a second device 62, such as a field switch, as shown in figure 7. The monitor 10 comprises a wireless communication portion 20 disposed in the housing 12, powered by the battery 14 and in electrical communication with the battery 14 and the sensor portion, which sends a wireless signal from the housing 12 that the gas sensor portion 16 has sensed of either the first or second gas. The monitor 10 comprises a processor 22 disposed in the housing 12, powered by the battery 14 and in electrical communication with the wireless communication portion 20, alarm portion 18, sensor portion and battery 14.

[0064] The present invention is related to a system 64 for monitoring gases underground, as shown in figure 13. The system 64 comprises a monitor 10 which detects a gas located in a tunnel underground and determines a gas value of the gas. The monitor 10 has an audio alarm 30 and a visual alarm 32 which is activated what the detected gas is above a predetermined value, and a transmitter which transmits the gas value. The system 64 comprises a wireless telecommunications network 66 on which the gas value is transceiver 48 from the monitor. The system 64 comprises a remote station 68 which receives the gas value from the network 66. The transceiver may receive a signal from the network to change a set point for an alarm condition for the gas to be determined by the monitor.

[0065] In the operation of the invention, and with reference to figure 13, the system 64 is a battery 14 powered CommTrac™ enabled gas monitor 10 to fulfill the MSHA requirements identified above and offer a truly unique solution. To meet the requirement of section (c)(2), a visual and audible alarm has been integrated into a Trolex Sentro gas detector 70 equipped with a battery 14 pack and CommTrac™ Interface module 72 (CIM), as shown in figures 3 and 4. The alert points will allow for a completely wireless gas monitor 10 that has the ability to alert personnel in the working zones in accordance with section (c)(2). The gas concentration alert and alarm points as mentioned in sections (i)(2) and (i)(3) will trigger the integrated monitor 10 audible and visual alarms via two unique output options. The first output 74 will trigger the visual alarm 32 when an alert level is reached. Different color visual alarms 32 will be available for different gases. The second output 76 will trigger the audible alarm when an alarm level is reached. If the monitor 10 is not being configured as a section alarm, the outputs 56 can be used as remote output to control connected devices. Aside from just methane and carbon monoxide, carbon dioxide, hydrogen sulfide, nitrogen dioxide, chlorine, oxygen, nitric oxide, and hydrogen will also be available for detection. Methane will be detectable over the entire volume range using an infrared technology based sensor as opposed to the current catalytic technology. Aside from full range capabilities, infrared technology is not affected by high concentrations. Carbon monoxide will be available in 1000 PPM maximum range. Hydrogen discriminate carbon monoxide detection will also be supported along with nitrogen dioxide filtered carbon monoxide detection capabilities. Open wireless protocols such as 802.11 will also be a supported means of communication aside from the CommTrac™ mesh infrastructure.

Ultimately, the wireless battery 14 powered gas monitor 10 can offer a complete and single system solution to the MSHA AMS requirement. The features outline above are truly unique and the first of their kind. The CommTrac™ network 66 already exists and is available from Strata Products Worldwide, LLC, Sandy Springs, Georgia.

[0066] In regard to figure 5, there is shown a theory of operation of the present invention. First, the monitor 10 is turned on and powered up. Then, the necessary software and functionality is written into the static registers of the monitor 10 for operation. From that point, stable operation of the monitor 10 proceeds from an idle state. From the idle state, the processor 22 requests of the gas sensor portion 16 a status report every five seconds. The gas sensor portion 16, if there is no warnings or alarms identified, reports back to the processor 22 that there are no warnings or alarms. If there is a warning state or alarm state or calibration state that occurs, the processor 22 takes the information that it has received from the gas sensor portion 16 and prepares this information to be sent through the transceiver 48 and out the antenna 52 to the CommTrac™ network 66 and ultimately to the central monitoring station. In addition, if the processor 22 does not receive a response from the gas sensor portion 16 within the interval timer period after the request for sensor status has been issued, then the processor 22 also transmits through the CommTrac™ network 66 a signal that communication has been lost with the gas sensor portion extending. When the central monitoring station receives the signal that communication has been lost with the gas sensor portion 16, steps are then taken to investigate and review the gas sensor portion 16 to correct the problem that is causing the failure of the gas sensor portion 16 to respond to the processor 22.

[0067] In regard to figure 3, there is shown a block diagram of the monitor 10. The CommTrac™ transceiver 48 is in electrical connection over a UART connection to the antenna 52. The CommTrac™ transceiver 48 is also in communication with the battery 14 power supply through which power from the mine power supply is available. There is feedback protection connected to the external port connectors connected to the mine power supply. The battery 14 power supply is also connected at 3.3 V to the output 56 ports to provide power to them. There are two input 54 ports and two output 56 ports. There is also a video alarm 32 and an audio alarm 30. There is input/output protection connected to the battery 14 power supply, the CommTrac™ transceiver 48 and the input and output ports.

[0068] In the operation of the invention, reference is made to the parts list below which identifies the parts by model number and vendor from which they can be obtained. The operation of the parts listed below, as individual components, is well known.

[0069] The gas sensor portion 16 itself is an off-the-shelf Trolex TX 6351/2 Sentro 1 universal gas detector 70. It has the ability to monitor several different gases at once. For a given gas value identified by the detector, this value is provided to the processor 22, which is a PIC 24 processor 22. The processor 22 converts the gas value into a packet form which can be transmitted wirelessly. The gas value provided from the detector 70 to the processor 22 is across a standard serial connection. It is received at pin header 6 of the processor 22, as shown in figures 1B and 2A-2E. The detector 70 provides a specific gas value for a given gas being monitored by the detector 70 in response to a request sent by the processor 22 from its pin header 4. The requests for the different gases, occurs one at a time in sequence, and then is continually repeated so that the different gases being monitored by the detector 70 are continually reviewed over time by the processor 22.

[0070] The packet produced by the processor 22 for a given gas being monitored, is then sent from PIC 24 to the transceiver 48, CC 1110, as shown in figure 1A, where it is received at its pin 34 input 54. From the transceiver 48, the packet signal is then provided to the amplifier 50 CC 1190 which boosts the signal and then transmits it through its antenna 52. The wireless transmitted packet having the value of the gas is then transmitted over the existing CommTrac™ network 66. The PIC 24, CC 1110, CC 1190 and internal antenna 52 form and define the CIM 72

[0071] Signals can also be received by the antenna 52 of the amplifier 50, which modulates the received signal, and provides it to the transceiver 48 where it is outputted through transceiver 48 pin 35 back to the processor 22 that receives it at pin header 6. The signal that is received by the monitor 10 can be a signal to change the set point by the processor 22 for an alarm condition for a given gas being monitored.

[0072] In addition to the gas value that is provided by the gas detector 70 to the processor 22, along the same serial connection and same pin attachments, an alarm signal for a given gas is provided to the processor 22 when the monitor 10 gas is above a certain predetermined value. The processor 22 receives the alarm signal and then activates an audio

alarm 30 as well as a visual alarm 32. The audio alarm 30 is loud enough to be heard by miners in the vicinity of the monitor 10. The visual alarm 32 is formed by a plurality of LED lights that are illuminated when the alarm occurs. A different sequence of colors, or simply different colors are illuminated for a corresponding type of gas, so for instance methane would have a different set of LED lights or different colors of lights activated then the LED lights activated for carbon dioxide. In addition, if so desired, the audio alarm 30 can be set to have a different tone or frequency corresponding to the type of gas detected if desired. The processor 22 also transmits an alarm signal through the transceiver 48 to the CommTrac™ network 66.

[0073] The processor 22, detector, transceiver 48 and amplifier 50 are all powered by battery 14 through a standard battery 14 selection circuit 74. Also available is an external power interface 76 that can receive wired electricity from the mine external power source.

[0074] The wireless communication portion 20 that has been added to the gas detector 70 contains a microcontroller – a CC1110 which is in electrical communication with thee PIC24 microcontroller. The PIC24 is the center of the monitor in that it communicates with the detector's microcontroller to obtain sensor information and also communicates with the CC1110 to send and receive data over the CommTrac™ network 66.

[0075] The software in the PIC24 polls the detector's microcontroller, here the Trolex PIC18, on a continuous basis for sensor information. It packages this sensor information and sends it to the CC1110 to be transmitted over the CommTrac™ system at configurable intervals. The software also monitors the information from the PIC18 on the Trolex detector for alarms and if any are generated, a message will be sent to the CC1110 for transmission via the CommTrac™ network 66.

[0076] The software can also be configured to use the two available I/Os 80, as shown in figures 12 and 13. These I/Os 80 can either be connected to audible and visual alarms 30, 32 – in which case, they would be activated if an alarm condition is reported by the detector 70, as shown in figures 6 and 8. Alternatively, these I/Os 80 can be used as inputs which will cause the software to send a message over CommTrac™ if the circuit on the I/O line is broken. (e.g. a belt stop switch), as shown in figures 7 and 9. In between these activities, the software will put the CC1110 and the PIC24 into sleep mode in order to conserve power.

[0077] The CC110 transceiver 48 receives the message from the PIC 24 and places it into the transmit queue. The CC1110 is then listening for a beacon message from one of the CommTrac™ Communication Nodes (backbone of the network 66). When it hears a beacon message it will select a data slot to transmit the message. During the chosen slot the message is sent and it waits to receive an ack from the Communication Node during the acknowledgement slot. If the ack is properly received the message will be removed from the transmit queue. If it doesn't receive an ack then the message is resent during the next beacon cycle. The CC1190 is typically only used to amplify the transmit and receive signal to allow for greater distances when transmit/receiving.

[0078] The AV unit may be mounted beneath a Wireless Sentro Gas detector 70 with the communication portion 20 with hard wiring between the two units, as shown in figure 11. The sound and light alarms will be activated by switching the battery 14 supply on and off. This can be controlled by software allowing the option of pulsed light and sound alarms.

[0079] The same two outputs of the pic 24 that are used to drive the audible and visual alarms 32 can be configured using software to also be inputs 54. The configuration allows the states of various input devices such as pull cords, emergency stops buttons or fault switches to be transmitted through the CommTrac™ network 66 to the surface for monitoring. The states of the switches are often unrelated to the gas monitoring data that the sensors are transmitting, but the sensors are typically located in remote areas in the mine where other communication networks do not exist. It is quite attractive to give the mine the option of monitoring a remote switch through a communication network 66 that is available in remote areas. Alternately, if the apparatus is not equipped with an audible or visual alarm 30, 32, the available output 56 can be used to drive a low current consumption device that may also be located remotely in the mine where the CommTrac™ network 66 is available.

[0080] In regard to figure 1B, the screw terminal corresponds to the description of figures 8 through 10 can connect to a given output 56 or input 54 depending on the configuration. The pin headers connect to the gas detection portion, here specifically the Trolex assembly card. The program headers connect to the pic 24 through J 3 into the CC1110 through J 5.

[0081] In regard to figures 2A-2E, depending on whether the apparatus is in an input 54 configuration or an output configuration, the pic 24 through L out 1 and L out 2 communicates to control out 1 and control out 2, respectively, of the output control section which then is provided, for instance through output 1 and output 2, respectively, to the audio alarm 30 and the video visual alarm 32, respectively, if in the output configuration. When in the input 54 configuration, the outputs 56 are reversed and are inputs 54, so the pic 24 receives input 54 signals from input 1 (instead of output 1) and from input 2 (instead of output 2) and these input signals follow a reverse direction back to the pic 24 from that described above in the output direction, that is to control out 1 and control out 2, respectively, to L out 1 and L out 2, respectively, of pic 24.

[0082] As explained above, and with reference to figure 6, when in the output configuration, output 1 is used for the visual alarm 32, and output 2 is used for the audible alarm. In the output mode, and with reference to figure 9, terminal 1 has a voltage, for instance 1.2 V, connected to the visual alarm 32 load, and terminal 2 is connected to ground and the visual alarm 32 load. The 1.2 V energizes the visual alarm 32 when the switch is closed. Similarly, output 3 has 1.2 V and energizes the audible alarm, and either terminal 5 or terminal 2 is connected to ground and the audible alarm. In this configuration, the operation of the alarms is as described above.

[0083] If the monitor 10 is desired to be in the input 54 configuration, as shown in figure 7, the monitor 10 is used to monitor 10 whatever the device, such as a field switch or pull cord or emergency stop, is connected to it. Here, terminal 1 has 1.2 V on it and is connected to the device being monitored, here a field switch, as shown in figure 8. Terminal 2 is connected to ground and to the field switch. When the switch is closed, pic 24 senses the 1.2 V going to ground and produces a field switch signal that is then converted by the pic 24 into a form that can be sent wirelessly by the apparatus, as described above in regard to the description of the gas value being sent wirelessly from the apparatus.

[0084] Similarly, and with reference to figure 8, a second device 62, such as a pull cord, can be in electrical connection with terminal 3 having 1.2 V. Terminal 5, which is ground, is electrically connected to the second device 62, such as the pull cord, and the same description is

applicable in sending a signal involving the pull cord being pulled occurs as described for the field switch connected to terminals 1 and 2.

[0085] As shown in figure 10, the terminal is a six position terminal disposed on the housing 12 and accessible from outside the monitor 10. Terminal 1 is either the first output 74 or input, terminal 2 is ground, terminal 3 is the second output 76 or input, terminal 4 is electrically connected to the battery 14, terminal 5 is ground, and terminal 6 is connected to external power for the apparatus to receive external power.

[0086] Accordingly, when in the input 54 configuration, which is established prior to the monitor 10 being positioned at a desired location in the mine, input 1 and input 2 of the terminal can receive signals through hardwired connections with various types of devices, to allow for the devices to be monitored. In the output configuration, the same terminals having input 1 and input 2 are now output 1 and output 2 and are configured as described above, for the pic 24 to send alarm signals to activate the audible and visual alarms 30, 32.

[0087] The following are features of the apparatus.

[0088]	Sound Output Level:	>90 dB at 12 inches
[0089]		Constant tone in range of 2,000 – 4,000 Hz
[0090]		Dual sounders and horns for 180 degree coverage
[0091]	Visual Alarm:	Constantly on high intensity LEDs; color selected by jumper on board
[0092]		Red for C0; Green for CH4; Blue for H2S
[0093]	Supply Voltage:	Typically 3.9VDC, Min 3.5VDC, Max 6VDC
[0094]	Supply Current:	< 80ma consumption of simultaneous AV operation
[0095]	Control Signal:	Power will be switch on/off from Sentro Gas detector 70
[0096]	Mounting Arrangement:	Mounted under the Sentro-1 Wireless Sensor using the two cable glands 28 for fixing and routing the wiring. The module must allow for external 12-30VDC to be connected to the Sentro-1 terminals.

[0097] Powered from commercially available batteries giving 40 to 45 days operating life.

[0098] Wireless output board with internal antenna 52.

[0099] Measures CO, H2S, CH4 options for other gases

[00100] Able to interrogate Modbus registers via wireless system

[00101] Large LCD screen

[00102] Programmable set points

[00103] Option to monitor external relay contacts and to report their state via the wireless system

[00104] Wireless operation removes need for expensive setup and maintain wired setup.

[00105] Measures gas concentrations every 1 second and reports status every 90 seconds, except under warning and alert conditions when changes reported immediately.

[00106] Display backlight is turned on whenever control button is pressed. A warning or alert triggers the screen to flash.

[00107] Sensors draw minimum power to maximize battery 14 life.

[00108] Dual-wall housing 12 gives maximum impact strength.

[00109] Housing 12 cover can be removed with power applied for module replacement and servicing.

[00110] Simultaneously monitor up to 8 different gases, together with levels of temperature, air velocity, pressure, smoke and fire.

[00111] • Power Conditioning

[00112] -(M) provide power conditioning from a (4) D-Cell EN95 battery pack

[00113] -(M) monitor the voltage of the battery pack

[00114] -(M) provide 3.3V 50ma to the controller and display boards

[00115] -(M) power CommTrac™ transceiver

[00116] -(D) powered from external power voltage

[00117] • (D) measure the external power voltage

[00118] • Communications (CommTrac™ Transceiver)

[00119] -(M) Support UART communications with Trolex board

[00120] • (M) Write and Read Mod-Bus registers from the Trolex board

[00121] -(M) Contain an internal antenna

[00122] • I/O

[00123] -(D) Input from a dry contact (state open/closed)

[00124] -(D) Output power to contact (Batt or Ext Pwr)

[00125] Integrated I/O Module

[00126] The following are a list of parts with reference to figures 1a, 1b and 2, all of which are individually alone well known and are identifiable by their part number, description and manufacturer.

[00127]

Line Item	Reference Designator	Quantity	Manufacturer	Part Number	Description	Alt Part Number
1	U$2	1	Linx Technologies, Inc.	CONSMA001-SMD	CONN SMA JACK STR 50 OHM SMD	CONSMA 001-SMD-ND
2						
3	F2	1			1206 SMD, xxA Vfast, fuse	
4	U1	1	Texas Instruments	CC1110F32RSPR	cc1110, QLP	296-22740-1-ND
5	U2	1	Texas Instruments	CC1190RGVT	cc1190, VQFN	296-25826-2-ND
6	U25		Microchip Technology	PIC24FJ64GA004-E/JL		PIC24FJ64 GA004-E/ML-ND
7	R3	1			RESISTOR, xxOMH 1206 SMD	
8	C31, C23, C27, C28, C40, C41	5	Kemet	CBR04C200F5GAC	CAP CER 20PF 50V 1% NPO P402	399-8786-1-ND
9	C1, C2, C3, C4, C6, C7, C8, C9, C32, C33, C35, C36, C37, C38, C39	15	TDK Corporation	C1005X5R1A104K050BA	CAP CER 0.1UF 10V 10% X5R 0402	445-1265-1-ND
10	C5, C19	2	TDK Corporation	C1005X5R1C105K050BC	CAP CER 1UF 16V 10% X5R 0402	445-4978-1-ND
11	C18	1	TDK Corporation	C1005X7R1C103K050BA	CAP CER 10000PF 16V 10% X7R 0402	445-1262-1-ND
12	C17	1		250R07N221JV4T	CAP CER 220PF 25V 5% NP0 0402	709-1125-1-ND
13	C26	1		F950J337MBAAQ2	CAP TANT 330UF	493-5795-

					6.3V 20% 1210	1-ND
14	C25, C53	2	TDK Corporation	CGA2B2C0G1H6R8D050BA	CAP CER 6.8PF 50V NP0 0402	445-5580-1-ND
15	C24	1	TDK Corporation	CGJ2B2C0G1H030C050BA	CAP CER 3PF 50V NP0 0402	445-13278-1-ND
16	C15, C16, C14	3	TDK Corporation	C1005C0G1H470J050BA	CAP CER 47PF 50V 5% NP0 0402	445-1243-1-ND
17	C10	1	TDK Corporation	C1005C0G1H010C050BA	CAP CER 1PF 50V NP0 0402	445-4855-1-ND
18	C11	1	TDK Corporation	C1005C0G1H101J050BA	CAP CER 100PF 50V 5% NP0 0402	445-1247-1-ND
19	C12, C13	2	TDK Corporation	C1005C0G1H1R5B050BA	CAP CER 1.5PF 50V NP0 0402	445-4858-1-ND
20	C42, C43, C44, C34	4	TDK Corporation	C1608X5R1C106M080AB	CAP CER 10UF 16V 20% X5R 0603	445-9065-1-ND
21	C22	2	Johanson Dielectrics, Inc.	500R07S120GV4T	CAP CER 12PF 50V 2% NP0 0402	712-1256-1-ND
22	C29, C30, C46, C50, C51, C52	6	TDK Corporation	C1005C0G1H330J050BA	CAP CER 33PF 50V 5% NP0 0402	445-1241-1-ND
23	C20, C21	2	TDK Corporation	C1005NP01H150J050BA	CAP CER 15PF 50V 5% NP0 0402	445-13788-1-ND
24	L1, L2	2	TDK Corporation	MLG1005S12NJ	INDUCTOR MULTILAYER 12NH 0402	445-3060-1-ND
25	.3, L4	2	TDK Corporation	MLG1005S18NJ	INDUCTOR MULTILAYER 18NH 0402	445-3062-1-ND
26	L5	1	Pulse Electronics Corporation	PE-0603CD680JTT	INDUCTOR WW RF 68NH 600MA 0603	553-1027-1-ND
27	L8	1	TDK Corporation	MLG1005S3N3S	INDUCTOR MULTILAYER 3.3NH 0402	445-3047-1-ND
28	L6	1	TDK Corporation	MLG1005S2N2S	INDUCTOR MULTILAYER 6.2NH 0402	445-3043-1-ND
29	L7	1	TDK Corporation	MLK1005S2N2S	INDUCTOR MULTILAYER 2.2NH 0402	445-1459-1-ND
30	R4, R7, R26, R29, R31	5	Panasonic Electronic Components	ERJ-2RKF1002X	RES 10.0K OHM 1/10W 1% 0402 SMD	P10.0KLCT-ND
31	R1	1	Panasonic Electronic Components	ERJ-2RKF5602X	RES 56.0K OHM 1/10W 1% 0402 SMD	P56.0KLCT-ND
32	R2	1	Panasonic Electronic Components	ERJ-2GEJ332X	RES 3.3K OHM 1/10W 5% 0402 SMD	P3.3KJCT-ND
33	R8	1	Panasonic Electronic Components	ERJ-2RKF22R0X	RES 22.0 OHM 1/10W 1% 0402 SMD	P22.0LCT-ND
34	R10	1	Panasonic Electronic Components	ERJ-2RKF2701X	RES 2.70K OHM 1/10W 1% 0402 SMD	P2.70KLCT-ND

35	Y2	1	ECS, INC.	ECS-122.8-20-5PX-TR	CRYSTAL 12.288MHZ 20PF SMD	XC1278CT-ND
36	Y1, Y4	2	Abracon Corporation	ABS06-32.768KHZ-T	CRYSTAL 32.768KHZ 12.5PF SMD	535-10104-1-ND
37	Y3	1	CTS- Frequency-Controls	403C11A26M00000	CRYSTAL 26.0MHZ 10PF SMD	CTX951CT-ND
38	U26	1	Microchip Technology	23K256-I/ST	IC SRAM 256KBIT 20MHZ 8TSSOP	23K256-I/ST-ND
39	U3	1	TRiQuent Semiconductor	856327	Signal Conditioning 915/26MHz Filter	772-856327 (mouser)
40	U24	1	Torex Semiconductor	XC6210B332MR-C	IC REG LDO 3V 0.7A SOT25	893-1074-1-ND
41	U20	1	STMicroelectronics	L7806ABD2t-TR	IC REG LDO 6V 1.5A D2PAK	497-1172-1-ND
42	U23	1	Texas Instruments	TPS62050DGSR	IC REG BUCK SYNC ADJ 0.8A 10MSOP	296-14392-1-ND
43	U21	1	Linear Technology	LTC4412IS6#TRMPBF	IC OR CTRLR SRC SELECT TSOT23-6	LTC4412IS6#TRMPBFCT-ND
44	U22	1	Faichild Semiconductor	FDC638P	MOSFET P-CH 20V 4.5A SSOT-6	FDC638PCT-ND
45	F1	1			FUSE, xxA, 2410	
46	R6	1			RESISTOR, 2010	
47	D1, D2, D3	3			DIODE, SHOTTKY, 1206	
48	R23	1			RESISTOR, xxK, 2010	
49	R24	1			RESISTOR, xxK, 2010	
50	C47	1	TDK Corporation	C1608X5R1E334M080AC	CAP CER 0.33UF 25V 20% X5R 0603	445-5143-1-ND
51	U31	1	Microchip Technology	MCP6041T-E/OT	IC OPAMP 1.4V SNGL R-R SOT23-5	MCP6041T-E/OTCT-ND
52	IC1, IC2, IC3, IC4	4	Vishay Siliconix	SI1869DH-T1-E3	IC LOAD SW LVL SHIFT 20V SC70-6	SI1869DH-T1-E3CT-ND
53	R5	1	Panasonic Electronic Components	ERJ-8ENF6043V	RES 604K OHM 1/4W 1% 1206 SMD	P604KFCT-ND
54	C49	1		GRM188C81E475KE11D	CAP CER 4.7UF 25V 10% X6S 0603	490-7199-1-ND
55	R11	1	Panasonic Electronic Components	ERJ-2RKF2803X	RES 280K OHM 1/10W 1% 0402 SMD	P280KLCT-ND
56						
57	R13	1	Panasonic Electronic Components	ERJ-3GEYJ473V	RES 47K OHM 1/10W 5% 0603 SMD	P47KGCT-ND
58	D4	1			DIODE, SCHOTTKY	
59	R9	1	Panasonic Electronic Components	ERJ-3GEYJ105V	RES 1M OHM 1/10W 5% 0603 SMD	P1.0MGCT-ND
60	R25, R27	2	Panasonic	ERJ-2GEJ473X	RES 47K OHM 1/10W	P47KJCT-

			Electronic Components		5% 0402 SMD	ND
61						
62						
63	D14, D15, D16, D17, D18, D19, D20, D21, D22, D23, D24, D25, D26, D27, D28, D29, D30, D31, D32, D33, D34, D38, D39, D40	24			DIODE, ZENER, 6.2V, SOT-23	
64	D35, D36, D37	3	Micro Commercial Co.	SMBJ5341B-TP	DIODE, ZENER, 6.2V, 5W, DO-214AC	
65	L9	1	Wurth Electronics, Inc.	7445510	INDUCTOR POWER 10UH 1.2A SMD	732-1335-1-ND
66	C45	1	Kemet	C1210C476M4PACTU	CAP CER 47UF 16V 20% X5R 1210	399-5514-1-ND
67	C54, C55, C48	3	TDK Corporation	C1608X7R1H104K080AA	CAP CER 0.1UF 50V 10% X7R 0603	445-1314-1-ND
68	U28, U30	2	Maxim Integrated	MAX4372HEUK+T	IC AMP CURRENT SENSE SOT23-5	MAX4372HEUK+TCT-ND
69	R18, R19	2			RESISTOR, XXXK, 0402	
70	R15, R14	Na			RESISTOR, 1OHM, 1206	
71	R16, R17	2			RESISTOR, XXXK, 1206	
72	D5, 36, D7, D8, D9, D10	6			DIODE, SHOTTKY, 0603, 50V	
73	R20	1		ERJ-2RKF2803X	RES 280K OHM 1/10W 1% 0402 SMD	P280KLCT-ND
74	R21	1		ERJ-2RKF6043X	RES 604K OHM 1/10W 1% 0402 SMD	P604KLCT-ND
75	R22	1			RESISTOR, XXXXK, 1206	
76	J1, J2	2			HEADER, MALE, .1, 6POS	
77	J6	1			HEADER, SCREW TERMINAL, 6 POS	
78	J5	1			HEADER, MALE, .1, 5 POS	
79	D11, D12, D13	3	Vishay Semiconductor	BZG03C10TR	DIODE, ZENER 10V, D0-214AC	BZG03C10CT-ND
80						
81	R38	1	Panasonic Electronic Components	ERJ-2GEJ624X	RES 620K OHM 1/10W 5% 0402 SMD	P620KJCT-ND

82	R39	1	Panasonic Electronic Components	ERJ-2GEJ104X	RES 100K OHM 1/10W 5% 0402 SMD	P100KJCT -ND

[00128] The present invention pertains to a system 64 for monitoring gases on an oil or gas rig, as shown in figure 13. The system comprises a monitor 10 which detects a gas at the rig and determines a gas value of the gas. The monitor 10 having an audio alarm 30 and a visual alarm 32, which is activated when the detected gas is above a predetermined value, and a transceiver 48 which transmits the gas value. The system 64 comprises a wireless telecommunications network 66 on which the gas value is transmitted from the monitor 10. The system 64 comprises a remote station 68 which receives the gas value from the network 66.

[00129] The remote station 68 may include a receiver which receives the gas value from the network 66, a processor 22 in communication with the receiver which receives the gas value from the receiver, and a display 38 in communication with the processor 22 on which the processor 22 displays an alarm indication when the gas value is above a predetermined level.

[00130] The present invention pertains to a remote station 68 which receives gas values of gas monitors from a wireless network 66. The remote station 68 comprises a receiver which receives the gas values wirelessly from the network 66. The remote station 68 comprises a processor 22 in communication with the receiver which receives the gas values from the receiver. The remote station 68 comprises a display 38 in communication with the processor 22 on which the processor 22 displays an alarm indication when the gas value is above a predetermined level.

[00131] The station 68 may include a housing 12 and the processor 22 and the receiver are disposed in the housing 12 and the display 38 is disposed on a face of the housing 12.

[00132] When the monitors 10 are used on an oil or gas rig, the monitors 10 are placed at various locations throughout the rig. A single communication node, such as a CommTrac™ node is placed with the central control station on the rig, where all of the monitors 10 are monitored. On the rig, since there are no seams or earth to interfere in any way with the transmission and reception of signals by the monitors 10, typically just a single communication node 206 is all that is needed for communication with the monitors 10. The communication node 206 essentially forms a hub network 66 with the monitors 10. The network 66 can be a

CommTrac™ network 66 where data signals are sent over the network 66 as described above between the CommTrac™ communication node 206 and the monitors 10.

[00133] In one embodiment, as shown in figure 16, the receiver of the remote station 68 is part of the transceiver 48 of the CIM 72 described above, disposed in a housing 12 of the remote station 68. The gas value from each of the monitors 10 on the rig is received over the CommTrac™ network 66 at the CIM 72. The CIM 72 provides the gas values the CIM 72 has received to the Moxa 230 Miineport, as described above in regard to the shared power supply 200, which converts the serial data signal from the CIM 72 into an Ethernet format signal. The Ethernet signal is provided to a switch 236 which in turn provides it to a Beagle Bone PC 232 through the switch 236 that prepares the signal for a modbus PLC 234. The PC 232 provide the prepared signal through the switch 236 to the PLC 234 which then causes the prepared signal to be displayed on the display 38 on the housing 12 face, as shown in figure 17. The status of all the monitors 10 are displayed at once on the display 38. The value of the gas, such as methane, at each monitor 10 is displayed as well as an alarm indication at a monitor 10 if the gas value at the monitor 10 is above a predetermined level.

[00134] Regarding the protocol for the gas monitor, the message the monitor 10 sends out at predetermined times, or when queried, to the network 66 may have a byte for battery level. The message may have a byte for external voltage level. The message may have a byte for status. The message may have a byte for gas reading. The message may have a byte for node address. The message may have a byte for serial number.

[00135] The present invention pertains to a communication system 64, as shown in figures 14a and 14b. The system 64 comprises a data network 204 on which solely data is sent. The system 64 comprises a wireless network 202 on which voice and data is sent bi-directionally. The system 64 comprises a plurality of nodes 206 distributed and apart from each other that form the data network 204 and the wireless network 202. Each node 206 has a data portion 223 which receives and sends data on the data network 204, a wireless portion 224 which receives and sends voice signals on the wireless network 202, and a power supply portion 200 in electrical communication with the data portion 224 and the wireless portion 223 which powers the data portion 224 and the wireless portion 223.

[00136] Data on the data network 204 may include tracking information of an individual. The data on the data network 204 may be sent and received at least one node 206 of the plurality of nodes 206 and the data network 204 is bidirectional. The data from the data network 204 may be sent on the data network 204 and the wireless network 202. Each node 206 may include a data converter 226 in communication with the data portion 224 and the wireless portion 223 which converts the data from the data network 204 into a transmission signal that is transmitted on the wireless network 202.

[00137] The present invention pertains to a communication node 206 of a data network 204 and a wireless network 202, as shown in figures 14a and 14b. The node 206 comprises a housing 12. The node 206 comprises a data portion 224 disposed in the housing 12 which receives data wirelessly on the data network 204. The node 206 comprises a wireless portion 223 disposed in the housing 12 which receives and sends voice signals on the wireless network 202. The node 206 comprises a power supply portion 200 disposed in the housing 12 in electrical communication with the data portion 224 and the wireless portion 223 which powers the data portion 224 and the wireless portion 223. The node 206 comprises a data converter 226 disposed in the housing 12 in communication with the data portion 224 and the wireless portion 223 which converts the data from the data network 204 into a transmission signal that is transmitted on the wireless network 202.

[00138] The wireless portion 223 may include a first radio 218 to transmit the transmission signal. The wireless portion 223 may include a switch 221 in communication with the first radio 218 and the data converter. The wireless portion 223 may include an external fiber connector 223 in communication with the switch 221 to connect with an external fiber to transmit the transmission signal.

[00139] The present invention pertains to a method for communicating in a mine. The method comprises the steps of receiving data wirelessly at a data portion 224 of a first node 206 of a plurality of nodes 206 from a data network 204 on which solely data is sent. The plurality of nodes 206 distributed and apart from each other and form the data network 204 and a wireless network 202. There is the step of converting with a data converter 226 in communication with the data portion 224 the data from the data network 204 into a transmission signal that is transmitted on the wireless network 202. The wireless network 202 transmitting

and receiving voice and data bi-directionally. There is the step of transmitting the transmission signal from the first node 206 on the wireless network 202 with a wireless portion 223 of the first node 206. There is the step of powering the data portion 224 and the wireless portion 223 with a power supply portion 200 in electrical communication with the data portion 224 and the wireless portion 223.

[00140] Referring to figure 14B, there is shown a schematic diagram focusing on the shared power supply 200 that is shared by the wireless network 202 and the wireless data network 204 which is separate and distinct and independent from the wireless network 202, all of which is found in a single communication node 206, such as a StrataConnect node 206 A. The wireless network 202 may be that wireless network 202 as described in U.S. Patent Application Publication No. 2014/0362729, which supports and provides for bidirectional voice and data communication. The data network 204 may be the CommTrac™ network 66 sold by Strata Products Worldwide, LLC, Sandy Springs, Georgia. The data network 204 may provide bidirectional data communication, as well as tracking of miners and vehicles and various devices throughout the mine. The node 206 receives data from the data network 204, processes the data so the data can be transmitted on the wireless Wi-Fi voice network 202 with the fibers 222, and then transmits the processed data on to the remote station 68, either through the Wi-Fi network 202 with the fibers 222.

[00141] A node 206 having the functionality of the CommTrac™ network 66 and the wireless network 202 receives power from the mine power supply 208 at power input 210. The power from the mine power supply 208 is at between 12 and 48 VDC. The power input 210 is electrically connected to a POE injector 212 which converts the power to 10 VDC to power the components inside the node 206. Power from the injector 212 at 10 VDC and 1 amp is provided to the first radio 218 and second radio 220 over a Cat5/Ethernet connection connected to each radio. Power from the injector 212 at 10 VDC and 500 mA is provided to the switch 221 in the node 206. Also connected to the switch 221 are external fibers 222 through external fiber connectors 223 over which transmission and reception of communication signals occur. The injector 202 powers the data connection portion 224, here preferably the CommTrac™ portion 224, such as a CIM 72 that communicates with the CommTrac™ network 66 and a data

converter 226, such as a serial to Ethernet converter 226, and specifically a Moxa 230, at 3.3 V and 500 mA.

[00142] The CommTrac™ portion 224 connects with the serial to Ethernet converter 226 through a UART connection at 3.3 VDC and at 115 kb per second which provides the data signal received by the CommTrac™ portion 224 to the serial to Ethernet converter 226. The serial to Ethernet converter 226 converts the data signal received by it from the CommTrac™ portion 224 into a form that can then be transmitted through the fibers 222 or through the radios and provides the converted signal to the switch 221. The switch 221 then transmits the converted signal that was originally received by the CommTrac™ portion 224 through the fibers 222, or if the fiber connection is not available, through the radios.

[00143] In addition, the node 206 may also receive power from another node 206 through a Cat 5 connection 228 and also provide power to another node through a Cat 5 connection 228 to form a daisy chain of nodes 206. Each of the Cat 5 power connections 228 are RJ45 connectors. The power level of the Cat 5 connections 228 coming in or going out of the node 206 is the same as the power level received by the node 206 from the mine power supply 208.

[00144] Figure 14B shows a non-IS node 206. Figure 14C shows a node 206 that is IS. The node 206 operates essentially the same as the node 206 of figure 14B, except that certain power levels are different, as indicated, and the external Cat 5 connections 228 are omitted.

[00145] The present invention pertains to a miner communicator 298 in a communications network 66, as shown in figure 15. The communicator 298 comprises a housing 12. The communicator 298 comprises a processor 22 disposed in the housing 12. The communicator 298 comprises a transceiver 48 disposed in the housing 12 and in communication with the processor 22 and the network 66 to send to and receive from the network 66 only data but not including text. The communicator 298 comprises an input 300 disposed on the housing 12 and in communication with the processor 22 which provides a trigger signal to the processor 22. The communicator 298 comprises an alarm 302 in contact with the housing 12 and in communication with the processor 22 that is activated by the processor 22 when an alarm 302 signal is received by the transceiver 48. The communicator 298 comprises a tracking portion 310 disposed in the housing 12 which provides a tracking signal that is transmitted by the transceiver to the network from which the location of the housing in the mine is determined

along with an ID of the communicator 298. The transceiver 48 transmits the ID and tracking signal to the network 66 to a communication node 206, ideally the closest node 206, and then to the remote station 68. The tracking portion 310 may be part of the CC 1110. The CC 1110 is an off the shelf transceiver that is purchased and also provides tracking ability by measuring the signal strength of the CommTrac™ node 205 ideally closest to the transceiver 48, whose location is known and stored in a server in the remote station 68. The signal strength is sent through the network 66 to the server, and using triangulation by the server, which receives the signal strength, determines the location of the transceiver 48, as is more fully explained below and is already part of the CommTrac™ network 66.

[00146] The input 300 may be a single button 304. The alarm 302 may be a first LED 306 that illuminates when the alarm 302 signal is received by the transceiver 48. The alarm 302 may be a plurality of LEDs 306 which is illuminated when the alarm 302 signal is received by the transceiver 48. There may be no display 38 and no key board or key pad, only the single button 304.

[00147] The trigger signal may be a fixed shape signal whose duration corresponds to how long the button 304 is activated. The alarm 302 may be activated only when an alarm 302 signal is received during to listening intervals in a listening period by the transceiver 48. The activation of the button 304 may cause the processor 22 to produce an indicator signal to the network 66 through the transceiver 48 corresponding to the activation length and activation frequency of the button 304.

[00148] The transceiver 48 may have its settings changed by the processor 22 when the communicator 298 is within a predetermined distance of a communication node so the transceiver 48 is not saturated by the communication node. When the communicator 298 transitions from an area of surface communication nodes to only underground communication nodes, the processor 22 may transmit to the network 66 through the transceiver 48 a check in message that the communicator 298 is present in the mine.

[00149] The present invention pertains to a method for communicating with a miner in a mine. The method comprises the steps of sending an alarm 302 signal wirelessly through a wireless communication network 66 to a miner communicator 298 carried by a miner in the mine. The communicator 298 is only able to receive data but not voice. There is the step of

receiving the alarm 302 signal by the communicator 298. There is the step of activating an alarm 302 of the communicator 298 by a processor 22 of the communicator 298 in response to the communicator 298 receiving the alarm 302 signal. There is the step of activating a button 304 of the communicator 298 to cause the transmitter to transmit from the communicator 298 to the network 66 an indicator signal regarding the miner's status, and with the indicator signal is an id of the communicator 298 and information associated with the position of the communicator 298, The communicator 298 does not have a display 38 or a keyboard.

[00150] The communicator 298 for communicating with a user, such as a miner, provides for limited but important information transfer between the user and a monitoring station. This limited information transfer is bidirectional to provide the remote station 68 with information about the user, and to provide the user with critical emergency alert information. The communicator 298 is very lightweight so that it is easily carried or worn by the user and is battery powered.

[00151] The communicator 298 sends position messages that report the ID, the current position data by providing the signal strength of signals received by the communicator 298 from a closest operable communication node 206 in the mine to the communicator 298, the ID of the closest communication node 206 and possibly battery level, and event information at predetermined intervals wirelessly over a network 66 to the remote station 68 so the miner can be tracked. The network 66 can be the CommTrac™ network 66 or the StrataConnect network 66, which is comprised of the CommTrac™ network 66 and a WiFi network 66, as described above. The communicator 298 will listen for any messages sent to it at different predetermined intervals.

[00152] The communicator 298 includes a processor 22, such as a PIC 24, and a transceiver 48, such as a CC1110, and can be the CIM 72, the operation of which is already described above in regard to the operation of the wireless gas monitor 10. The CommTrac™ network 66 is synchronized with the communicator 298 so that when the communicator 298 sends information or receives information at the appropriate predetermined intervals, the CommTrac™ network 66 knows to send or receive the respective information in the appropriate timeframe.

[00153] When the communicator 298 is within a predetermined distance of a CommTrac™ node, the transceiver 48 is attenuated by about 10 db, and its RSSI values are

adjusted upward by the same amount. This is to deal with the condition of a CommTrac™ node being very close to the communicator 298 and saturating the transceiver 48. The transmission power of the transceiver 48 is also reduced by 10 db if the communicator 298 is close to the CommTrac™ node so as to prevent saturating the CommTrac™ node transceiver 48.

[00154] During listening periods by the communicator 298 to receive information, a mine-wide alert state bit is used to determine that an emergency condition exists. This bit must be detected in at least two listening intervals within a predetermined listening period to be considered valid. By requiring information received by the communicator 298 in at least two listening intervals in a predetermined listening period to have this bit, it reduces the possibility of false alarms. When none of the listening intervals in the predetermined listening period do not have this bit, the alert state is considered no longer present.

[00155] A light on the apparatus will flash, preferably in a distinct pattern, when the mine-wide alert is recognized by the communicator 298. After a mine-wide alert is recognized; the miner will press a button 304 one, two or three times to indicate the miner's status. For instance, if the button 304 is pushed once, it means the miner is fine. If the button 304 is placed twice in succession, it means the miner is trapped. If the miner pushes the button 304 three times in succession, it means the miner is injured. The miner can push the button 304 twice, then wait a few seconds and push it again three times to indicate he is trapped and injured. The communicator 298 will send an emergency response acknowledgment with the position message to indicate the miner's response. The light may be several LEDs 306 of different color.

[00156] A quick press on the button 304 performs a communication check and battery status update. Holding down the button 304 for an extended period of time or multiple presses of the button 304 during a short period of time is used to trigger an emergency message. Holding down the button 304 for an extended period of time shall remove this condition. Two quick presses of the button 304 turn the LED 306 flasher on or off. In response to a mine-wide alert message, one, two or three presses indicate the user's response condition.

[00157] One bit of received information in a listening interval is used to indicate if the CommTrac™ node is a surface node. Transitioning from an area of surface nodes to only underground nodes triggers the apparatus to issue a check in message. A checkout message is transmitted when transitioning in the other direction-transmitting a checkout message when

only surface nodes are heard and the apparatus is formally in a "check in" state. The apparatus only waits for the network 66 level acknowledgment that indicates the check in/out message made it successfully to the CommTrac™ node. The apparatus does not need to wait for check in/out acknowledgment.

[00158] For a communication check, after the button 304 is quickly pressed, the LEDs 306 flash once immediately to provide feedback. After a short pause, a series of 1-3 LED 306 flashes indicate battery life (1 – needs replacing soon, 2 – middle life, 3 – new). After another pause, a second series of flashes indicate strength of node (1 – weak, 3 – strong). The LEDs 306 will flash in a pattern indicative of an emergency state. For example, a – flash with pauses in between will indicate an emergency state. The LEDs 306 will flash in a basic pattern used only for visual warning. During a mine-wide alert message, the LEDs 306 blink in a pattern making it very clear the apparatus is in an alert state.

[00159] The housing of the communicator 298 has a l x w x h of less than 110 mm x 210 mm x 50 mm and is preferably about 72 mm x 165 mm x 20 mm. It has a weight of less than 150 gm and is preferably about 75 gm.

[00160] Then present invention pertains to a miner apparatus 450 of a wireless network, as shown in figure 18 and figure 21. The apparatus 450 comprises a housing 12 which is carried by the miner. The apparatus 450 comprises a tracking portion 310 disposed in the housing 12 which transmits information associated with the miner's location wirelessly to the network 66. The apparatus 450 comprises a battery 14 disposed in the housing 12 and connected to the tracking portion 310 which powers the tracking portion 310. The apparatus 450 comprises a cap lamp 400 electrically connected to the battery 14 which is powered by the battery 14 to provide light. The cap lamp 400 is worn by the miner.

[00161] The tracking portion 310 may be part of a transceiver 48, described above, and the location of the housing 12 is determined, as described.

[00162] The present invention pertains to a miner apparatus 450 of a wireless network 66, as shown in figure 19 and figure 21. The apparatus 450 comprises a housing 12 which is carried by the miner. The apparatus 450 comprises a tracking portion 310 disposed in the housing 12 which transmits information associated with the miner's location wirelessly to the network. The apparatus 450 comprises a battery 14 disposed in the housing 12 and connected to the tracking

portion 310 which powers the tracking portion 310. The apparatus 450 comprises a proximity device 402 electrically connected to the battery 14 and disposed in the housing 12 which is powered by the battery 14 to provide a detectable presence to a proximity detector 404 when the miner gets too close to the proximity detector 404, the proximity device 402 worn by the miner.

[00163] The present invention pertains to a miner apparatus 450 of a wireless network, as shown in figure 20 and figure 21. The apparatus 450 comprises a housing 12 which is carried by the miner. The apparatus 450 comprises a tracking portion 310 disposed in the housing 12 which transmits information associated with the miner's location wirelessly to the network 66. The apparatus 450 comprises a battery 14 disposed in the housing 12 and connected to the tracking portion 310 which powers the tracking portion 310. The apparatus 450 comprises a proximity device electrically connected to the battery 14 and disposed in the housing 12 which is powered by the battery 14 to provide a detectable presence to a proximity detector when the miner gets too close to the proximity detector. The proximity device is worn by the miner. The apparatus 450 comprises a cap lamp 400 electrically connected to the battery 14 which is powered by the battery 14 to provide light. The cap lamp 400 is worn by the miner. Together these components of tracking, light and proximity are referred to as TPL.

[00164] The present invention pertains to a method for a miner to move through a mine. The method comprises the steps of powering a light of a cap lamp 400 on the miner's head with a battery 14 in a housing 12 carried by the miner. There is the step of sending information associated with location information of the miner's location in the mine from the housing 12 identified with a tracking portion 310 in the housing so the miner can be tracked as the miner moves through the mine. There is the step of stopping a machine with a proximity sensor connected to the machine, because the proximity sensor has sensed a proximity device in the housing 12 has come within a predetermined distance to the proximity device.

[00165] The following information may be contained in a message sent from the proximity detector 404. The message may include at least one byte regarding the health of a generator of the proximity detector 404. The message may include at least one byte that a miner has moved close enough to the proximity detector 404 that a warning has occurred. The message may include at least one byte that a miner has moved close enough to the proximity detector 404 that a hazard has occurred which has effectively stopped the operation of the

machine associated with the proximity detector 404. The message may include at least one byte which identifies the magnetic field strength of a generator. The message may include at least one byte that identifies the ID of a proximity device 402, such as a personal alarm device (PAD), of a miner which has triggered a warning or hazard depending on how close the proximity device 402 is to the proximity detector 404. The message may include at least one byte which identifies the battery strength of the proximity device 402 which has triggered a warning or a hazard. The proximity device 402 and the proximity detector 404 themselves are sold by Strata Products Worldwide, LLC, Sandy Springs, Georgia, USA. The PAD sends an ID signal to the proximity detector 404 so the proximity detector 404 knows the ID of the PAD that has caused a warning or a hazard which effectively turns the machine off.

[00166] The present invention pertains to a proximity detector 404 attached to a machine 475, as shown in figure 21. The detector 404 for detecting a miner's presence comprises a generator 477 which produces a magnetic field. The detector 404 comprises a processor 22. The detector 404 comprises a transceiver 48 for sending a message produced by the processor 22 having information about the generator's health and an ID of a PAD of a miner that has triggered a warning or hazard that has effectively stopped operation of the machine 475.

[00167] Preferably, the tracking portion 310 is a CIM 72 and the wireless network 66 is the CommTrac™ network 66. In one embodiment the CIM 72 and the battery 14 are in the housing 12 and the housing 12 is attached to the cap lamp 400 with wiring extending from the housing 12 to the lamp through a socket in the cap to power the lamp. In another embodiment, the housing 12 is positioned in a pocket or on a belt held with a buckle of the miner, and wiring extends from the battery 14 through the housing 12 up to the back of the cap lamp 400 and attached to a socket of the cap to power the lamp. The cap may be a standard miner helmet modified to have the socket to receive the power wire from the battery 14 in the housing 12.

[00168] In an alternative embodiment, the CIM 72 and the battery 14 are disposed in the housing 12 along with a proximity device 402. The battery 14 powers the CIM 72 and the proximity device 402 so that proximity detection and tracking of the miner are located in the housing 12 which is carried by the miner.

[00169] In yet another embodiment, the CIM 72, the battery 14 and the proximity device 402 are all disposed in the housing 12, with the battery 14 powering the CIM 72 and the

proximity device 402. In addition, wiring extending from the battery 14 and out through the housing 12 to the back of a cap lamp 400 worn by a miner to power the lamp.

[00170] With reference to figures 22 and 23 that are schematic circuit diagrams for the miner communicator 298, the following is a parts list for the communicator 298.The operation of the processor 22 and transceiver 48, that form the CIM 72 is the same, but there is additional circuitry for the features of the communicator 298. All of the following parts are themselves alone well known and are identifiable by their part number, description and manufacturer. Figure 24 shows an overhead view of the circuit board having the circuitry described in figures 22 and 23.

[00171]

Line Item	Reference Designator	Quantity	Manufacturer	Part Number	Description
1	C1, C2, C3, C6, C7, C9, C32, C35, C36, C37, C38, C39	12	Taiyo Yuden	EMK105B7104KV-F	CAP CER 0.1UF 16V 10% X7R 0402
2	C4, C18	2	TDK Corporation	CGA2B2X7R1H102 K050BA	CAP CER 1000PF 50V 10% X7R 0402
3	C5, C19	2	TDK Corporation	C1005X5R1C105K0 50BC	CAP CER 1UF 16V 10% X5R 0402
	C8, C52, L14	3	Panasonic Electronic Components	ERJ-2GE0R00X	RES 0.0 OHM 1/10W JUMP 0402 SMD
4	C10	1	TDK Corporation	C1005C0G1H010C0 50BA	CAP CER 1PF 50V NP0 0402
5	C11	1	TDK Corporation	C1005C0G1H101J05 0BA	CAP CER 100PF 50V 5% NP0 0402
6	C12, C13	2	TDK Corporation	C1005C0G1H1R5B0 50BA	CAP CER 1.5PF 50V NP0 0402
7	C14, C15, C16	3	TDK Corporation	C1005C0G1H470J05 0BA	CAP CER 47PF 50V 5% NP0 0402
8	C17	1	Johanson Dielectrics Inc	250R07N221JV4T	CAP CER 220PF 25V 5% NP0 0402
10	C20, C21, C45, C61	4	TDK Corporation	C1005NP01H150J05 0BA	CAP CER 15PF 50V 5% NP0 0402
11	C22	1	Johanson Dielectrics Inc	500R07S120GV4T	CAP CER 12PF 50V 2% NP0 0402
12	C23, C27, C28, C31, C40, C41	6	Murata Electronics North America	GRM1555C1H200G A01D	CAP CER 20PF 50V 2% NP0 0402
13	C24	1	TDK Corporation	C1005C0G1H030C0 50BA	CAP CER 3PF 50V NP0 0402
14	C25, C51	2	TDK Corporation	CGA2B2C0G1H6R8 D050BA	CAP CER 6.8PF 50V NP0 0402

15	C26, C29, C30	3	TDK Corporation	C1005C0G1H330J050BA	CAP CER 33PF 50V 5% NP0 0402
	C33	1	TDK Corporation	C1005C0G1H270J050BA	CAP CER 27PF 50V 5% NP0 0402
16	C34	1	Taiyo Yuden	UMK105CG181JV-F	CAP CER 180PF 50V 5% NP0 0402
17	C42, C43, C44, C60	4	TDK Corporation	C1608X5R1A106M080AC	CAP CER 10UF 10V 20% X5R 0603
18	C46, C49	0		DNP	
19	C47, C48, C50	3	TDK Corporation	C2012X5R1A226M085AC	CAP CER 22UF 10V 20% X5R 0805 0.95MM THICK
	C59	1	TDK Corporation	C1005C0G1H221J050BA	CAP CER 220PF 50V 5% NP0 0402
20	D1, D2	2	Avago Technologies US Inc.	HSMZ-C170	LED CHIP ALINGAP2 RED TOP MOUNT 0805
21	D4, D5, D6	3	Diodes	B0520WS-7-F	DIODE SCHOTTKY 20V 0.5A SOD323
22	E1	1	Vishay	VJ5301M915MXBSR	RF ANTENNA, 915 MHz
23	F1	1	Littelfuse	0466.500NR	FUSE .500A 63V FAST 1206
	H1	1	Tech-Etch		EMI Shield 0.500in. x 0.800in. x 0.060in.
24	J3	1	Samtec	MTMM-105-05-F-D-250	
25	L1, L2	2	TDK Corporation	MLG1005S12NJ	INDUCTOR MULTILAYER 12NH 0402
26	L3, L4	2	TDK Corporation	MLG1005S18NJ	INDUCTOR MULTILAYER 18NH 0402
27	L5	1	Coilcraft	0603HP-68NXJLU	INDUCTOR WIREWOUND 68NH 0603 5%
28	L6	1	TDK Corporation	MHQ1005P6N2S	INDUCTOR MULTILAYER 6.2NH 0402
29	L7	1	TDK Corporation	MHQ1005P2N2S	INDUCTOR MULTILAYER 2.2NH 0402
30	L8, L11	2	TDK Corporation	MHQ1005P3N3S	INDUCTOR MULTILAYER 3.3NH 0402
31	L9	1	Taiyo Yuden	NR6045T6R3M	INDUCTOR 6.3UH 3.8A 20% SMD
32	L10	1		DNP	
	L12, L13	2	Murata Electronics North America	BLM15HG102SN1D	FILTER CHIP 1000 OHM 250MA 0402
	L15	1		DNP	
34	P1, P2, P3, P4, P5, P6	6	Keystone	56	BATTERY CLIP AAA SMD
35	R1	1	Panasonic Electronic Components	ERJ-2RKF5602X	RES 56K OHM 1/10W 1% 0402 SMD
36	R2	1	Panasonic Electronic Components	ERJ-2GEJ332X	RES 3.3K OHM 1/10W 5% 0402 SMD
37	R3	1	Panasonic	ERJ-2RKF4993X	RES 499K OHM 1/10W 1% 0402

			Electronic Components		SMD
38	R4, R12	2	Panasonic Electronic Components	ERJ-2RKF1133X	RES 113K OHM 1/10W 1% 0402 SMD
39	R5, R7, R9, R29	4	Panasonic Electronic Components	ERJ-2RKF1002X	RES 10K OHM 1/10W 1% 0402 SMD
40	R6	1	Panasonic Electronic Components	ERJ-8GEY0R00V	RES 0.0 OHM 1/4W JUMP 1206 SMD
41	R8	1	Yageo	RC0402FR-0722RL	RES 22.0 OHM 1/16W 1% 0402 SMD
42	R10, R16	2	Panasonic Electronic Components	ERJ-2RKF2701X	RES 2.7K OHM 1/10W 1% 0402 SMD
43	R11	1	Panasonic Electronic Components	ERJ-2RKF51R0X	RES 51 OHM 1/10W 1% 0402 SMD
44	R13	1	Panasonic Electronic Components	ERJ-2RKF1004X	RES 1M OHM 1/10W 1% 0402 SMD
	R14, R15	2	Panasonic Electronic Components	ERJ-2RKF24R9X	RES 24.9 OHM 1/10W 1% 0402 SMD
45	R17, R18, R19, R22, R23, R24, R25, R26	8	Panasonic Electronic Components	ERJ-2RKF1001X	RES 1K OHM 1/10W 1% 0402 SMD
46	R20	1	Panasonic Electronic Components	ERJ-2RKF2003X	RES 200K OHM 1/10W 1% 0402 SM
47	R21	1	Panasonic Electronic Components	ERJ-2RKF6043X	RES 604K OHM 1/10W 1% 0402 SMD
	R27	1	Panasonic Electronic Components	ERJ-2RKF10R0X	RES 10 OHM 1/10W 1% 0402 SMD
	R28	1	Panasonic Electronic Components	ERJ-2RKF47R0X	RES 47 OHM 1/10W 1% 0402 SMD
48	S4	1	Coto Technology	CT05-1535-G1	REED SWITCH MOLDED 140V 15-35AT
49	S2	1	C&K Components	PTS645VH39-2 LFS	SWITCH TACTILE SPST-NO 0.05A 12V
50	S3	1	SignalQuest	SQ-MIN-200	SQ-MIN-200
51	U1	1	Texas Instruments	CC1190RGVT	IC RF FRONT-END 16VQFN
52	U2	1	Microchip	PIC24FJ64GA004-I/ML	IC MCU 16BIT 64KB FLASH 44QFN
53	U3	1	Texas Instruments	TPS62040DGQR	IC REG BUCK SYNC ADJ 1.2A 10MSOP
54	U4	1	Epcos	B39921B3588U410	Signal Conditioning 915MHz

					50ohms 2.9dB
55	U6	1	Microchip	MCP6041T-I/OT	IC OPAMP GP 14KHZ RRO SOT23-5
56	U7	1	Microchip	23K256-I/ST	IC SRAM 256KBIT 20MHZ 8TSSOP
57	U8	1	Texas Instruments	CC1110F32RHHT	IC SOC RF TXRX W/8051 MCU 36-VQF
58	Y1, Y4	2	Abracon	ABS06-32.768KHZ-T	CRYSTAL 32.768KHZ 12.5PF SMD
59	Y2	1	TXC	7M-12.288MAAJ-T	CRYSTAL 12.288MHZ 18PF SMD
60	Y3	1	CTS	403C11A26M00000	CRYSTAL 26MHZ 10PF SMD
	PCB	1	Strata Products Worldwide	PCBU000098 Rev C	

[00172] With reference to figures 25 - 28 which are schematic circuit diagrams for the miner apparatus 450, the following is a parts list for the miner apparatus 450. The operation of the processor 22 and transceiver 48, that form the CIM 72 is the same, but there is additional circuitry for the features of the miner apparatus 450. All of the following parts are themselves alone are well known and are identifiable by their part number, description and manufacturer.

[00173]

Line Item	Designator	Quantity	Manufacturer	Part Number	Description
1	BZ1	1	PUI AUDIO	AI-1027-TWT-5V-R	BUZZER MAGN 5VDC 2.7KHZ PCB
2	C1	1	Kemet	T495D337K010ATE150	CAP TANT 330UF 10V 10% 2917
3	C2, C3, C4, C7, C20, C21, C27, C28, C29, C32, C33, C34, C36, C37, C38, C39, C41, C42, C43, C44, C101, C102, C103	23	Panasonic	C0603C104K4RACTU	CAP CER 0.1UF 16V 10% X7R 0603
4	C8	1	Samsung Electro-Mechanics America	CL21B106KOQNNNE	CAP CER 10UF 16V 10% X7R 0805
5	C9, C10, C11, C12, C19	5	Panasonic	C0603C103K4RACTU	CAP CER 0.1UF 16V 10% X7R 0603
6	C13	1	TDK Corporation	C1005C0G1H680J050BA	CAP CER 68PF 50V 5% NP0 0402
7	C14	1	TDK Corporation	C1005X7R1H103K0	CAP CER 10000PF 50V 10%

				50BB	X7R 0402
8	C15, C17, C48	3	TDK Corporation	C1005C0G1H101J050BA	CAP CER 100PF 50V 5% NP0 0402
9	C16	1	Panasonic	ERJ-2GE0R00X	JUMPER 0 OHM 1/10W 0402 SMD
10	C18, R34, R35, R36, TP9	5			DO NOT INSTALL
11	C5, C22	2	Kemet	C0603C105K4RACTU	CAP CER 1UF 16V 10% X7R 0603
12	C23, C24, C56, C63	4	TDK Corporation	C1005NP01H150J050BA	CAP CER 15PF 50V 5% NP0 0402
13	C25	1	TDK Corporation	C1608X5R1E106M080AC	CAP CER 10UF 25V 20% X5R 0603
14	C26, C30, C49, C50, C51, C52	6	Kemet	CBR04C200F5GAC	CAP CER 20PF 50V 1% NP0 0402
15	C31, C57, C60	3	TDK Corporation	C1005X5R1A104K050BA	CAP CER 0.1UF 10V 10% X5R 0402
16	C35, C53	2	TDK Corportation	C1005X5R1C105K050BC	CAP CER 1UF 16V 10% X5R 0402
17	C40, C47	2	TDK Corporation	C1005C0G1H1R5B050BA	CAP CER 1.5PF 50V ±0.1PF NP0 0402
18	C45, C61, C64	3	TDK Corporation	C1005C0G1H470J050BA	CAP CER 47PF 50V 5% NP0 0402
19	C46	1	TDK Corporation	C1005C0G1H010C050BA	CAP CER 1PF 50V ±0.25PF NP0 0402
20	C54	1	TDK Corporation	C1005X7R1C103K050BA	CAP CER 10000PF 16V 10% X7R 0402
21	C55	1	Johanson Dielectrics Inc	250R07N221JV4T	CAP CER 220PF 25V 5% NP0 0402
22	C58	1	TDK Corporation	CGA2B2C0G1H6R8D050BA	CAP CER 6.8PF 50V NP0 0402
23	C59	1	TDK Corporation	CGJ2B2C0G1H030C050BA	CAP CER 3PF 50V NP0 0402
24	C62	1	Johanson Technology Inc	500R07S120GV4T	CAP CER 12PF 50V 5% NP0 0402
25	D1	1	OSRAM Opto Semiconductors	LR A67F-U2AB-1-Z	LED SIDELED RED 625NM CLR RA SMD
26	D6, D7, D8	3	OSRAM Opto Semiconductors	LB Q39G-L2N2-35-1	LED CHIPLED BLUE 470NM 0603 SMD
27	E1, E2	2	Pulse Electronics Corporation	W3113, W3114	
28	F1	1	Littelfuse	0466002.NR	FUSE 2A 63V FAST 1206
29	L1	1	Panasonic	ELL-6RH8R2M	COIL 8.2UH 1200MA CHOKE SMD
30	L2	1	TDK Corporation	MLG1005S47NJT000	INDUCTOR MULTILAYER 47NH 0402
31	L3, L4	2	TDK Corporation	MLG1005S6N8JT000	INDUCTOR MULTILAYER 6.8NH 0402
32	L5, L7	2	TDK Corporation	MLG1005S12NJ	INDUCTOR MULTILAYER 12NH 0402
33	L6, L8	2	TDK Corporation	MLG1005S18NJ	INDUCTOR MULTILAYER

					18NH 0402
34	L9	1	Pulse Electronics Corporation	PE-0603CD680JTT	INDUCTOR WW RF 68NH 600MA 0603
35	L10	1	TDK Corporation	MLG1005S3N3S	INDUCTOR MULTILAYER 3.3NH 0402
36	L11	1	TDK Corporation	MLK1005S2N2S	INDUCTOR MULTILAYER 2.2NH 0402
37	L12	1	TDK Corporation	MLG1005S6N2S	INDUCTOR MULTILAYER 6.2NH 0402
38	P1	1	Samtec	SSW-106-01-L-D	Header, 6-Pin, Dual row
39	P2	1	Samtec	TSW-104-06-L-S	Header, 4-Pin, Single row
40	P3	1	Samtec	TSW-105-06-L-S	Header, 5-Pin, Single row
41	P4	1	Samtec	SLW-105-01-L-S	
42	Q1, Q2, Q3, Q4, Q5	5	International Rectifier	IRLML2502TRPBF	MOSFET N-CH 20V 4.2A SOT-23
43	Q6	1	Fairchild Semiconductor	MMBT3904	TRANSISTOR GP NPN AMP SOT-23
44	R1, R12, R24, R29, R30, R31, R32, R54, R63, R64, R65, R66, R67, R68, R69	15	Bourns	ERJ-8ENF4990V	RES 499 OHM 1/4W 1% 1206 SMD
45	R2	1	Panasonic	ERJ-M1WSF20MU	RES 0.02 OHM 1W 1% 2512 SMD
46	R3	1	Bourns	CRM1206-FZ-R050ELF	RES 0.05 OHM 1/2W 1% 1206 SMD
47	R4, R5, R9, R10, R15, R16, R19, R20, R22, R23	10	Bourns	CRA2512-FZ-R100ELF	RES 0.1 OHM 3W 1% 2512 SMD
48	R6	1	Panasonic	ERJ-3EKF5102V	RES 51K OHM 1/10W 1% 0603 SMD
49	R7, R8, R13, R14, R18	5	Stackpole Electronics	CSRN2512FKR680	RES 0.68 OHM 2W 1% 2512
50	R11	1	Panasonic	ERJ-3EKF10R0V	RES 10 OHM 1/10W 1% 0603 SMD
51	R17	1	Panasonic	ERJ-14NF40R2U	RES 40.2 OHM 1/2W 1% 1210 SMD
52	R21	1	Panasonic	ERJ-3EKF1502V	RES 15K OHM 1/10W 1% 0603 SMD
53	R25, R44, R45, R46	4	Panasonic	ERJ-3EKF1001V	RES 1K OHM 1/10W 1% 0603 SMD
54	R26	1	Panasonic	ERJ-3EKF2001V	RES 2K OHM 1/10W 1% 0603 SMD
55	R27	1	Panasonic	ERJ-3EKF1003V	RES 100K OHM 1/10W 1% 0603 SMD
56	R28, R40, R41, R42,	9	Panasonic	ERJ-3EKF1002V	RES 10K OHM 1/10W 1% 0603 SMD

	R43, R47, R48, R49, R50				
57	R33, R37, R38, R39	4	Panasonic	ERJ-3EKF1000V	RES 100 OHM 1/10W 1% 0603 SMD
58	R51	1	Panasonic	ERJ-2RKF2701X	RES 2.7K OHM 1/10W 1% 0603 SMD
59	R52	1	Panasonic	ERJ-8ENF6043V	RES 604K OHM 1/4W 1% 1206 SMD
60	R53	1	Panasonic	ERJ-3EKF2803V	RES 280K OHM 1/10W 1% 0402 SMD
61	R55, R56, R57, R58	4	Panasonic	ERJ-3EKF4702V	RES 47K OHM 1/10W 1% 0603 SMD
62	R59	1	Panasonic	ERJ-2GEJ105X	RES 1M OHM 1/10W 1% 0603 SMD
63	R60	1	Panasonic	ERJ-2RKF22R0X	RES 22 OHM 1/10W 1% 0402 SMD
64	R61	1	Panasonic	ERJ-2RKF5602X	RES 56K OHM 1/10W 1% 0402 SMD
65	R62	1	Panasonic	ERJ-2GEJ332X	RES 3.3K OHM 1/10W 1% 0402 SMD
66	S1, S2, S3	3	C&K Components	KSC641GLFS	SWITCH TACTILE SPST-NO 0.05A 32V
67	U1	1	International Rectifier	IRF8714PbF	MOSFET N-CH 30V 13.8A 8-SOIC
68	U2	1	Linear Tech	LT4356IS-1#PBF	IC OVERVOLT PROT REG 16-SOIC
69	U3	1	Microchip	MCP1525T-I/TT	IC VREF SERIES PREC 2.5V SOT23-3
70	U4	1	International Rectifier	IRF7406TRPBF	MOSFET P-CH 30V 5.8A 8-SOIC
71	U5	1	Texas Instruments	INA199A1DCK	IC OPAMP CURR SENSE 14KHZ SC70-6
72	U6	1	Vishay Siliconix	SI1869DH-T1-E3	IC LOAD SW LVL SHIFT 20V SC70-6
73	U7	1	Avago Technologies US	MGA-68563-TR1G	IC AMP LNA MMIC GAAS SMD SOT-363
74	U8	1	Linx Technologies	TXM-916-ES	TRANSMITTER RF 916MHZ 10PIN SMD
75	U9	1	Microchip	MCP1826S-3002E/DB	IC REG LDO 3V 1A SOT223-3
76	U10	1	Microchip Technology	PIC24FJ64GA004-I/PT	IC MCU 16BIT 64KB FLASH 44TQFP
77	U11, U13, U15	3	Texas Instruments	SN74LVC2T45DCT	IC BUS TRANSCVR 2BIT N-INV SM8
78	U12	1	MICROCHIP	23K256-I/ST	IC SRAM 256KBIT 20MHZ 8TSSOP
79	U14	1	Microchip Technology	MCP6041T-E/OT	IC OPAMP GP 14KHZ RRO SOT23-5
80	U16	1	Texas Instruments	CC1110F32RHHR	IC SOC RF TXRX W/8051 MCU 36-VQF
81	U17	1	TriQuint Semiconductor	856327	Signal Conditioning 915/26MHz Filter

82	U18	1	Texas Instruments	CC1190RGVT	RF Front End 850 - 950MHz
83	U101	1	Texas Instruments	SN74LVC1G332DCKR	IC GATE OR 1CH 3-INP SC-70-6
84	U102	1	Texas Instruments	SN74LVC1G11DCKR	IC GATE AND 1CH 3-INP SC-70-6
85	Y1	1	TXC CORPORATION	AX-12.288MAGV-T	CRYSTAL 12.288MHZ 8PF SMD
86	Y2, Y4	2	Abracon Corporation	ABS06-32.768KHZ-T	CRYSTAL 32.768KHZ 12.5PF SMD
87	Y3	1	CTS-Frequency Controls	403C11A26M00000	CRYSTAL 26MHZ 10PF SMD

[00174] Figure 29 is an exploded view of the miner apparatus 450, and specifically the TPL. The housing 12 encases the tracking portion 310 that carries the circuitry shown in figures 25 – 28, which includes the CIM 72. There is the proximity device 402 which is a standard proximity device 402 that is currently available and exists in the proximity device sold by Strata Products Worldwide, LLC. There is the battery 14 and circuitry 602 through which the battery and the tracking portion 310 and the proximity detector 402 is connected to the terminals 600 in the housing 12. There is a data port cover 606 that covers over a port to which the software operations can be reprogrammed if necessary in the apparatus 450. There is also a cover plate 612 that covers the terminals 600 on the outside of the housing 12. In the cover 612, there is a wiring port 604 through which the wiring from the terminals 600 extend to the cap lamp 400 to power and trigger the components of the cap lamp 400.

[00175] Figure 30 is a close-up view of the terminals 600. Wiring from terminal 607 extends to power the light in the cap lamp 400. Wiring from the terminal 608 extends to the battery 14 to receive power from the battery 14. Wiring from terminal 609 extends to an LED in the cap lamp 400 to power the LED. Wiring from the terminal 610 extends to a sounder in the cap lamp 400 that makes a noise to alert the miner when they have come to close to a proximity detector 404 and a warning or a hazard state is triggered. Terminal 611 receives wiring from the cap lamp 400 and provides a ground or a return from the cap lamp 400.

[00176] Although the invention has been described in detail in the foregoing embodiments for the purpose of illustration, the scope of the claims should not be limited by particular embodiments set forth herein, but should be construed in a manner consistent with the specification as a whole.

CLAIMS:

1. A monitor of a communication network for gases in a mine comprising:

a housing;

a battery disposed in the housing;

a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine, wherein the gas sensor portion includes a full range by volume between zero and 100% methane sensor;

an alarm portion disposed in the housing, powered by the battery and in electrical communication with the battery which emits a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold;

a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing to the network in the mine that the gas sensor portion has sensed of either the first or second gas and receives a signal to change a set point for a given gas being monitored, wherein the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion; and

a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, alarm portion, sensor portion and battery, the processor changing the set point for a given gas being monitored from the signal received by the wireless communication portion.

2. The monitor of claim 1 wherein the gas sensor portion includes a carbon monoxide sensor and a H2S sensor and the wireless communication portion transmits wirelessly from the housing a carbon monoxide value of carbon in the mine sensed by the sensor portion and an H2S value of H2S in the mine sensed by the sensor portion.

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3. The monitor of claim 1 wherein the processor receives a gas value signal from the gas sensing portion and converts the gas value signal into a converted signal form of the gas value which can be sent wirelessly by the communication portion from the housing.

4. The monitor of claim 1 wherein the communication portion includes a transceiver in communication with the processor.

5. The monitor of claim 4 wherein the communication portion includes an amplifier with an internal antenna in communication with the transceiver.

6. The monitor of claim 5 wherein the processor provides the converted signal form of the gas value to the transceiver which then transmits the converted signal form of the gas value wirelessly through the amplifier and the internal antenna from the housing.

7. The monitor of claim 1 wherein the alarm portion includes a visual alarm and an audible alarm and the processor receives an alarm signal from the gas sensor portion and activates the visual alarm and the audible alarm based on the alarm signal.

8. A monitor of a communication network for gases in a mine comprising:

a housing;

a battery disposed in the housing;

a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine;

a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing to the network in the mine that the gas sensor portion has sensed of either the first or second gas, and receives a signal to change a set point for a given gas being monitored, wherein the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion;

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at least one input for connection to a remote device, the one input receiving a status signal regarding the remote device, wherein the status signal is transmitted by the wireless communication portion; and

a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, the input, sensor portion and battery, the processor changing the set point for a given gas being monitored from the signal received by the wireless communication portion.

9. A method for monitoring gases in a mine comprising the steps of:

detecting with a gas sensor portion a first gas and at least a second gas different from the first gas in the mine, the gas sensor portion powered by a battery and in electrical communication with the battery, the gas sensor portion and the battery disposed in the housing, wherein the gas sensor portion includes a full range by volume between zero and 100% methane sensor and wherein the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion;

emitting with an alarm portion powered by the battery, disposed in the housing and in electrical communication with the battery a visual alert and an audible alert when the gas sensor portion senses that either the first or second gas is above a predetermined threshold;

sending with a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion a wireless signal from the housing that the gas sensor portion has sensed either the first or second gas and if the first gas is sensed, the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion;

receiving by the wireless communication portion a signal to change or set point for a given gas being monitored; and

changing the set point of a given gas being monitored by the processor from the signal received by the wireless communication portion.

10. A monitor of a communication network for gases in a mine comprising:

a housing;

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a battery disposed in the housing;

a gas sensor portion powered by the battery and in electrical communication with the battery which detects a first gas and at least a second gas different from the first gas in the mine;

a wireless communication portion disposed in the housing, powered by the battery and in electrical communication with the battery and the sensor portion, which sends a wireless signal from the housing to the network in the mine that the gas sensor portion has sensed of either the first or second gas;

a processor disposed in the housing, powered by the battery and in electrical communication with the wireless communication portion, alarm portion, sensor portion and battery; and

a terminal portion that has two states, an output configuration state in which an output signal is sent from the processor to a first device, and an input configuration state in which an input signal is received from a second device, which of the two states the terminal portion is in is established prior to the monitor being positioned at a desired location in the mine.

11. A system for monitoring gases underground comprising:

a monitor which detects a gas located in a tunnel underground and determines a gas value of the gas, the monitor having an audio alarm and a visual alarm which is activated when the detected gas is above a predetermined value, and a transceiver which transmits the gas value, the monitor having a gas sensor portion, wherein the gas sensor portion includes a full range by volume between zero and 100% methane sensor and wherein the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion;

a wireless telecommunications network in the tunnel on which the gas value is transmitted from the monitor; and

a remote station which receives the gas value from the network and displays an alarm indication when the gas is above a predetermined value and the monitor associated with the alarm indication.

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12. The system of claim 11 wherein the transceiver receives a signal from the network to change a set point for an alarm condition for the gas to be determined by the monitor.

13. A system for monitoring gases on an oil or gas rig comprising:

a monitor which detects a gas at the rig and determines a gas value of the gas, the monitor having an audio alarm and a visual alarm which is activated when the detected gas is above a predetermined value, and a transceiver which transmits the gas value, the monitor having a gas sensor portion, wherein the gas sensor portion includes a full range by volume between zero and 100% methane sensor and wherein the wireless communication portion transmits wirelessly from the housing a methane value of methane in the mine sensed by the sensor portion;

a wireless telecommunications network on which the gas value is transmitted from the monitor; and

a remote station which receives the gas value from the network.

14. The system of claim 13 wherein the remote station includes a receiver which receives the gas value from the network, a processor in communication with the receiver which receives the gas value from the receiver, and a display in communication with the processor on which the processor displays an alarm indication when the gas value is above a predetermined level.

15. A remote station which receives gas values of gas monitors from a wireless network comprising:

a receiver which receives the gas values from the gas monitors wirelessly from the network;

a processor in communication with the receiver which receives the gas values from the receiver;

a switch in communication with the processor and the receiver and disposed between the processor and the receiver; and

a display in communication with the processor through the switch on which the processor displays an alarm indication when the gas value is above a predetermined level, the

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gas value and the gas monitor associated with the alarm indication, and displays a status of the gas monitors at once.

16. The station of claim 15 including a housing and the processor and the receiver and the switch are disposed in the housing and the display is disposed on a face of the housing.

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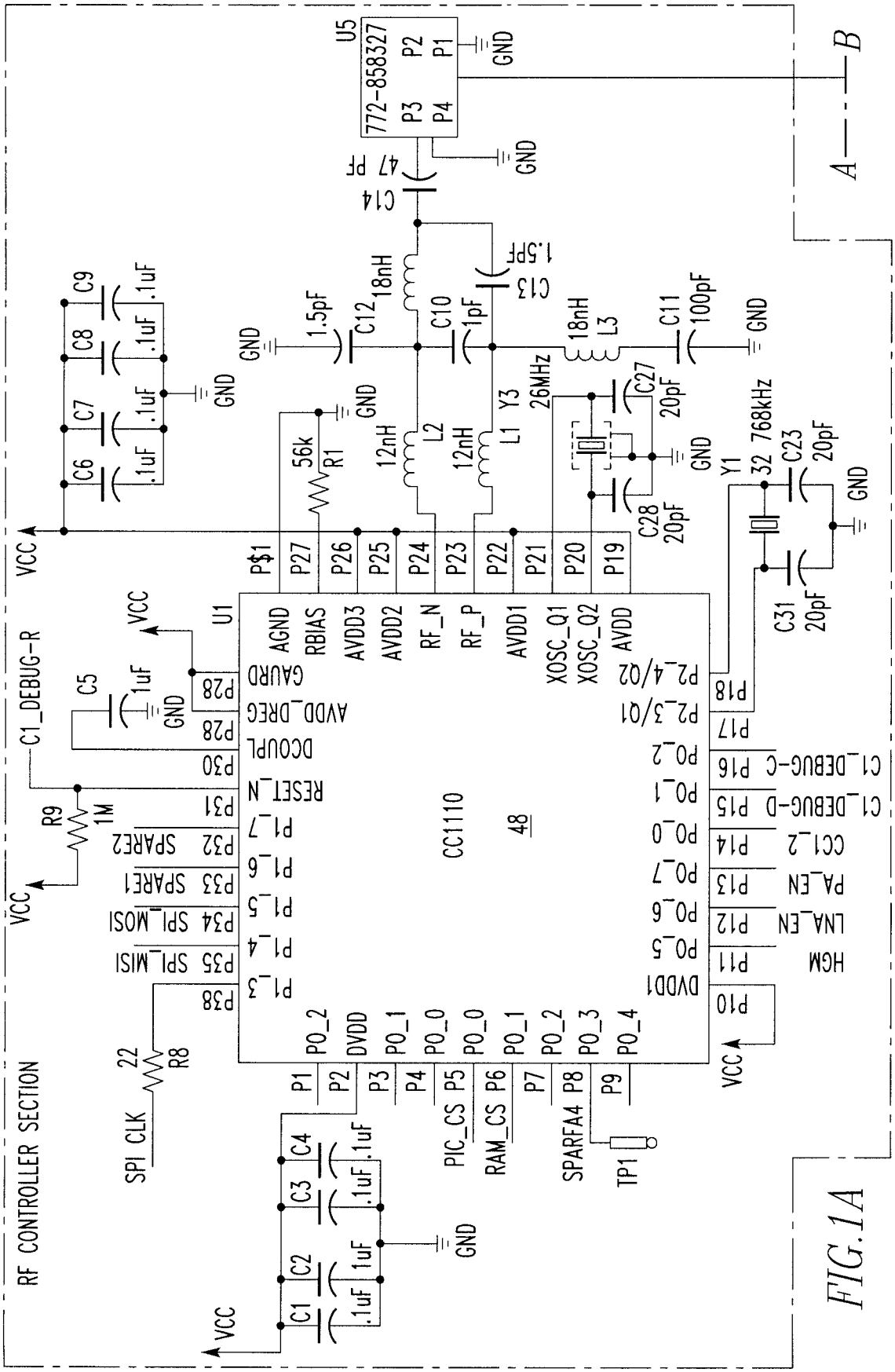

RF CONTROLLER SECTION
CC1110
U1
U5
772-858327
A
B
VCC
GND
C1_DEBUG-R
SPI CLK
TP1
Y1
32.768kHz
26MHz
HGM
LNA_EN
PA_EN
CC1_2
C1_DEBUG-D
C1_DEBUG-C

FIG.1A

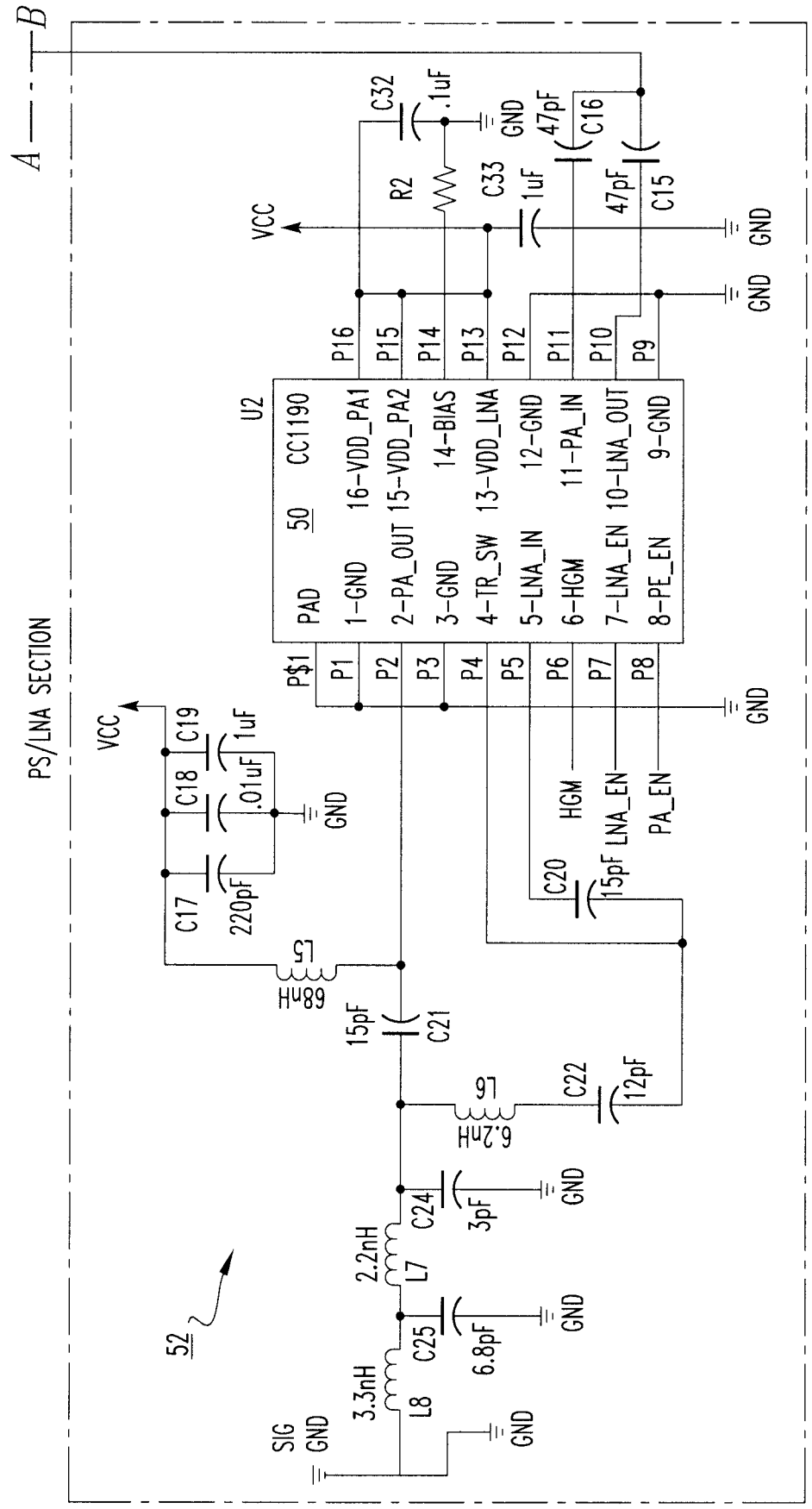
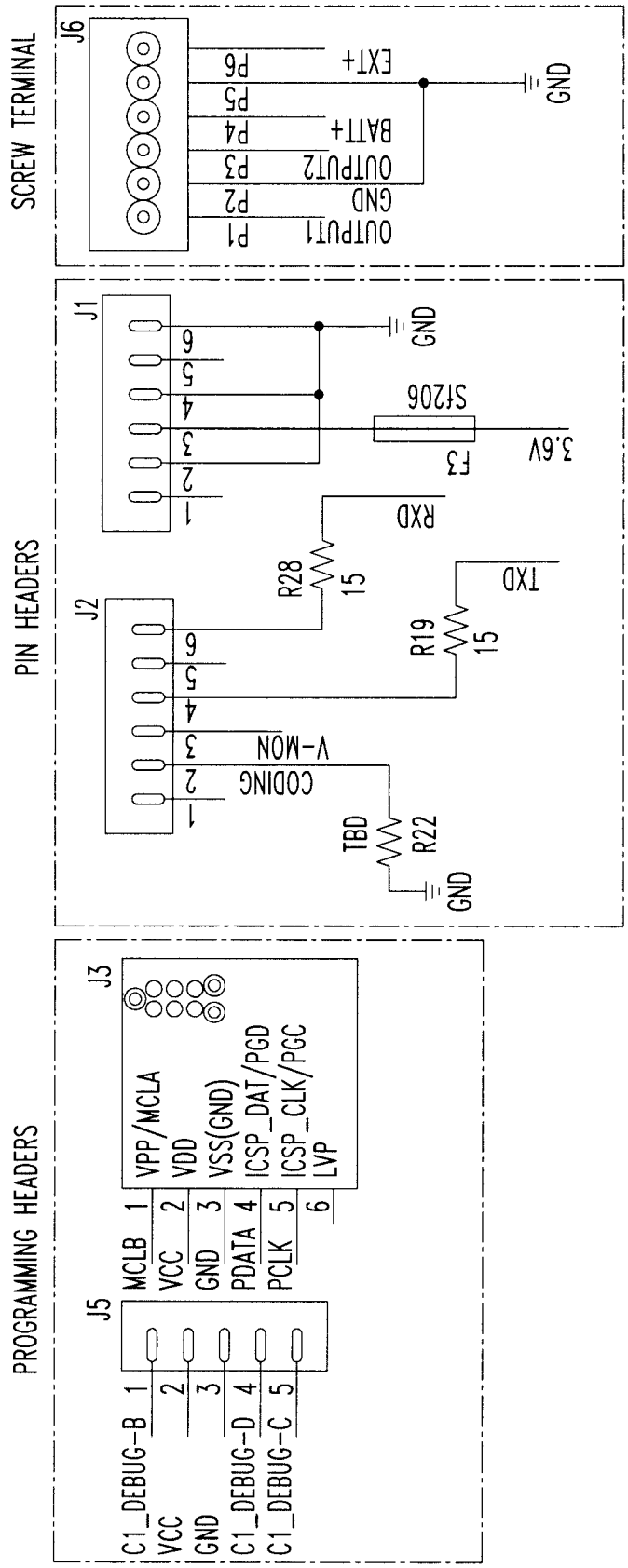

A
B
PS/LNA SECTION
U2
CC1190
PAD
1-GND
2-PA_OUT
3-GND
4-TR_SW
5-LNA_IN
6-HGM
7-LNA_EN
8-PE_EN
16-VDD_PA1
15-VDD_PA2
14-BIAS
13-VDD_LNA
12-GND
11-PA_IN
10-LNA_OUT
9-GND
P$1
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
VCC
GND
HGM
LNA_EN
PA_EN
C32
.1uF
R2
C33
1uF
47pF
C16
47pF
C15
C19
1uF
C18
.01uF
C17
220pF
L5
68nH
15pF
C21
C20
15pF
L6
6.2nH
C22
12pF
C24
3pF
2.2nH
L7
C25
6.8pF
3.3nH
L8
SIG
52

FIG.1AA


SCREW TERMINAL
J6
P6
P5
P4
P3
P2
P1
EXT+
BATT+
OUTPUT2
GND
OUTPUT1
GND
PIN HEADERS
J1
6
5
4
3
2
1
GND
SF206
F3
3.6V
RXD
R28
15
TXD
R19
15
J2
6
5
4
3
2
1
V-MON
CODING
TBD
R22
GND
PROGRAMMING HEADERS
J3
VPP/MCLA
VDD
VSS(GND)
ICSP_DAT/PGD
ICSP_CLK/PGC
LVP
1
2
3
4
5
6
J5
MCLB
VCC
GND
PDATA
PCLK
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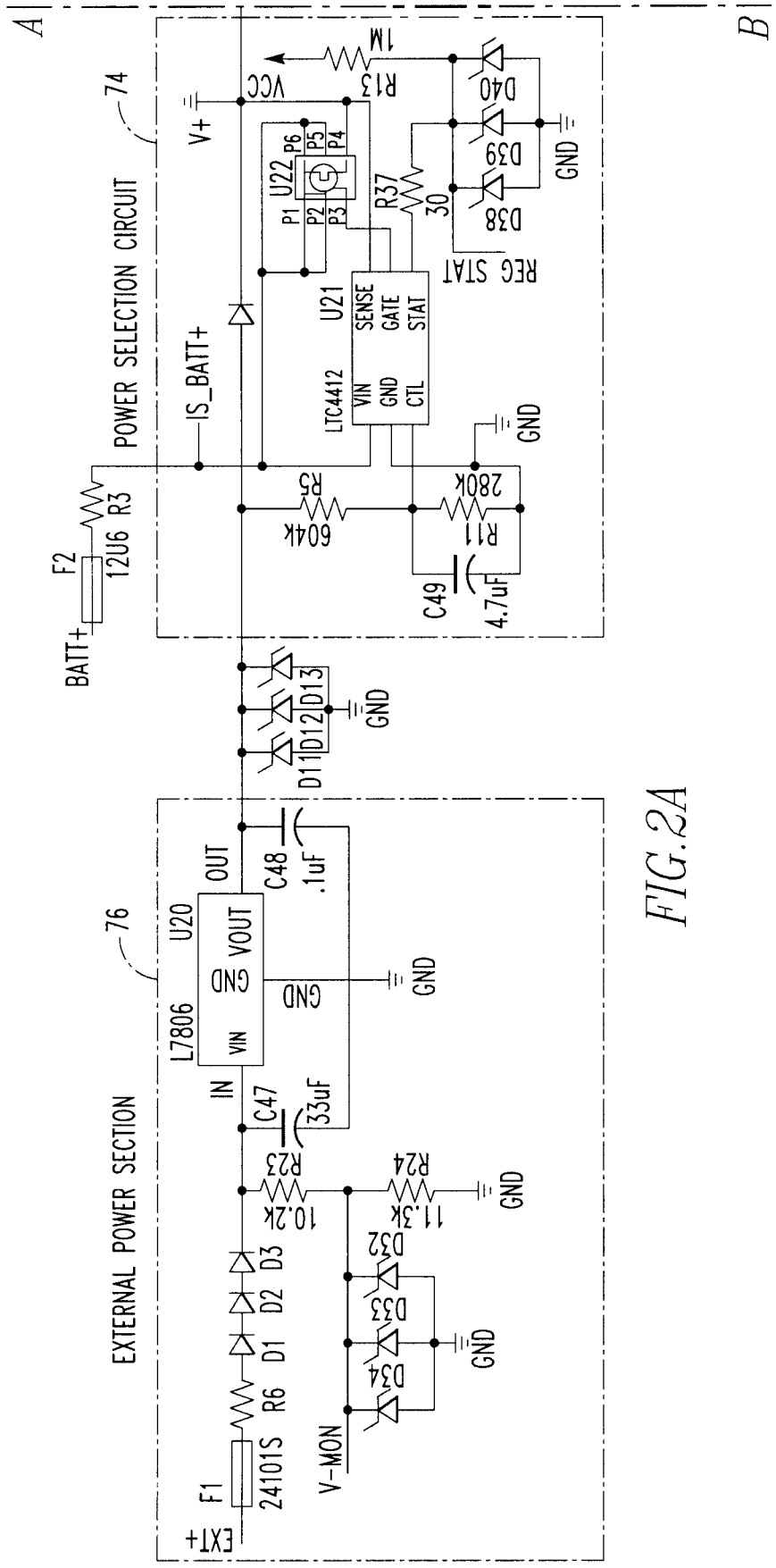
2
3
4
5
C1_DEBUG-B
VCC
GND
C1_DEBUG-D
C1_DEBUG-C

FIG.1B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B
74
POWER SELECTION CIRCUIT
V+
VCC
1M
R13
D40
D39
D38
GND
U22
P6
P5
P4
P1
P2
P3
R37
30
REG STAT
U21
LTC4412
VIN
GND
CTL
SENSE
GATE
STAT
IS_BATT+
GND
280k
R11
604k
R5
C49
4.7uF
F2
12U6
R3
BATT+
D11
D12
D13
GND
76
EXTERNAL POWER SECTION
U20
L7806
VIN
GND
VOUT
OUT
IN
GND
C48
.1uF
C47
33uF
R23
10.2k
R24
11.3k
GND
D32
D33
D34
GND
D1
D2
D3
R6
24101S
F1
EXT+
V-MON

FIG.2A

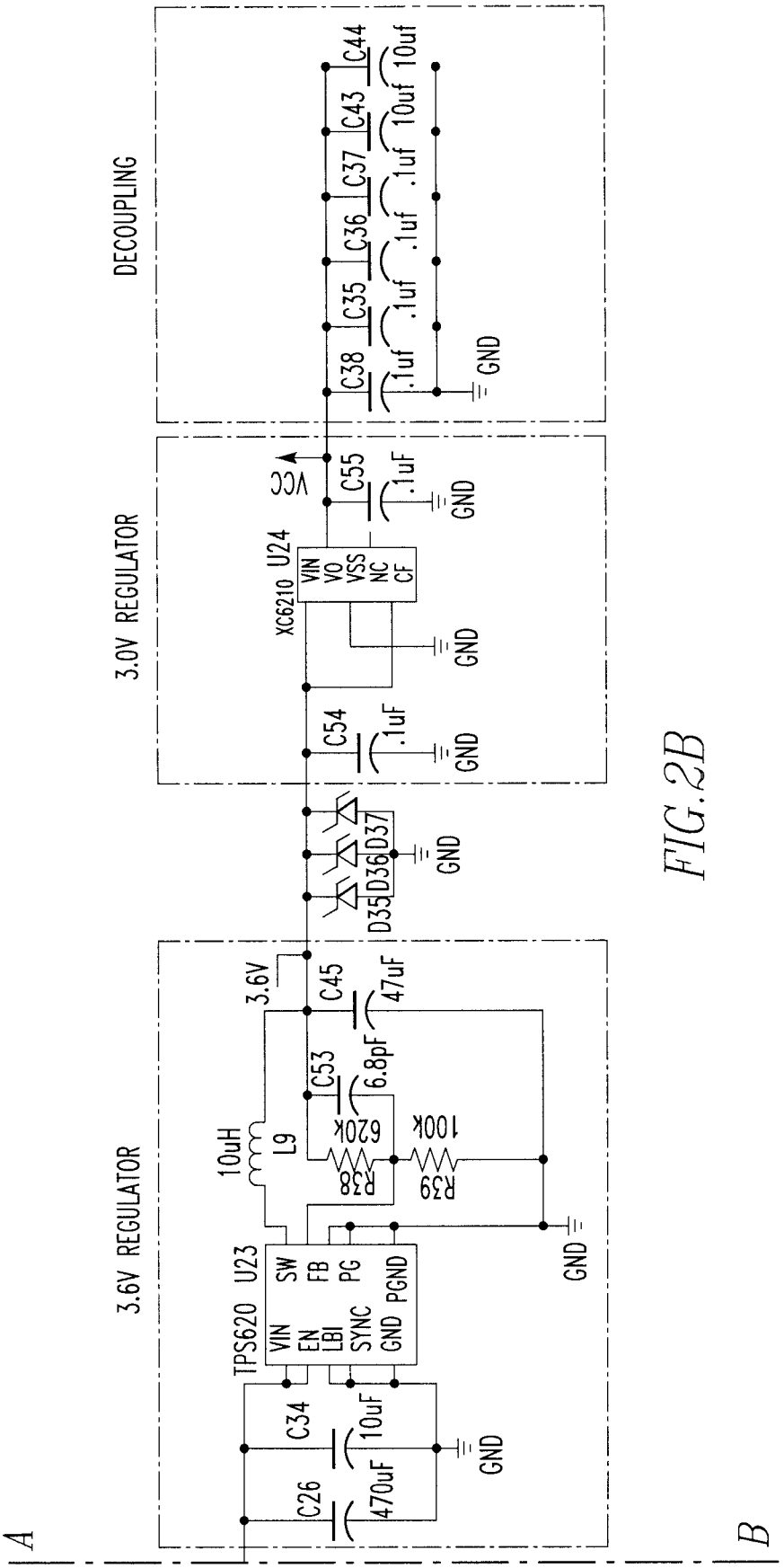

DECOUPLING
C44
10uf
C43
10uf
C37
.1uf
C36
.1uf
C35
.1uf
C38
.1uf
GND
3.0V REGULATOR
VCC
C55
.1uF
GND
U24
XC6210
VIN
VO
VSS
NC
CF
GND
C54
.1uF
GND
D35
D36
D37
GND
3.6V REGULATOR
3.6V
C45
47uF
C53
6.8pF
10uH
L9
620K
R38
100K
R39
GND
U23
TPS620
VIN
EN
LBI
SYNC
GND
SW
FB
PG
PGND
C34
10uF
GND
C26
470uF
A
B

FIG.2B

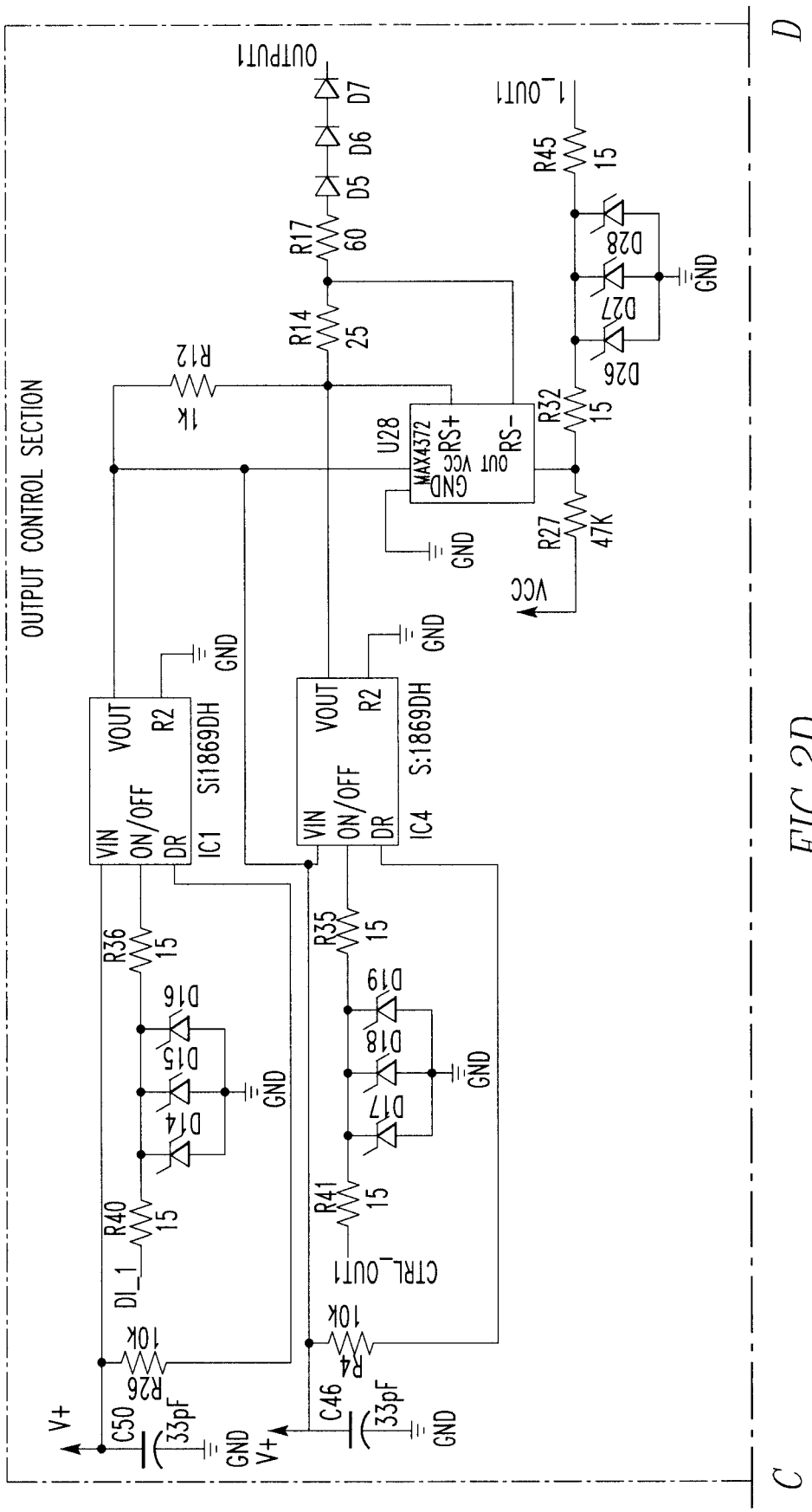

OUTPUT CONTROL SECTION
OUTPUT1
D7
D6
D5
R17
60
R14
25
R12
1K
U28
MAX4372
GND
OUT
VCC
RS+
RS-
GND
R27
47K
VCC
R45
15
D28
D27
D26
R32
15
GND
1_OUT1
IC1
Si1869DH
VIN
ON/OFF
DR
VOUT
R2
GND
IC4
S:1869DH
VIN
ON/OFF
DR
VOUT
R2
GND
R36
15
D16
D15
D14
GND
R40
15
DI_1
10K
R26
C50
33pF
GND
V+
R35
15
D19
D18
D17
GND
R41
15
CTRL_OUT1
10K
R4
C46
33pF
GND
V+
C
D

FIG.2D

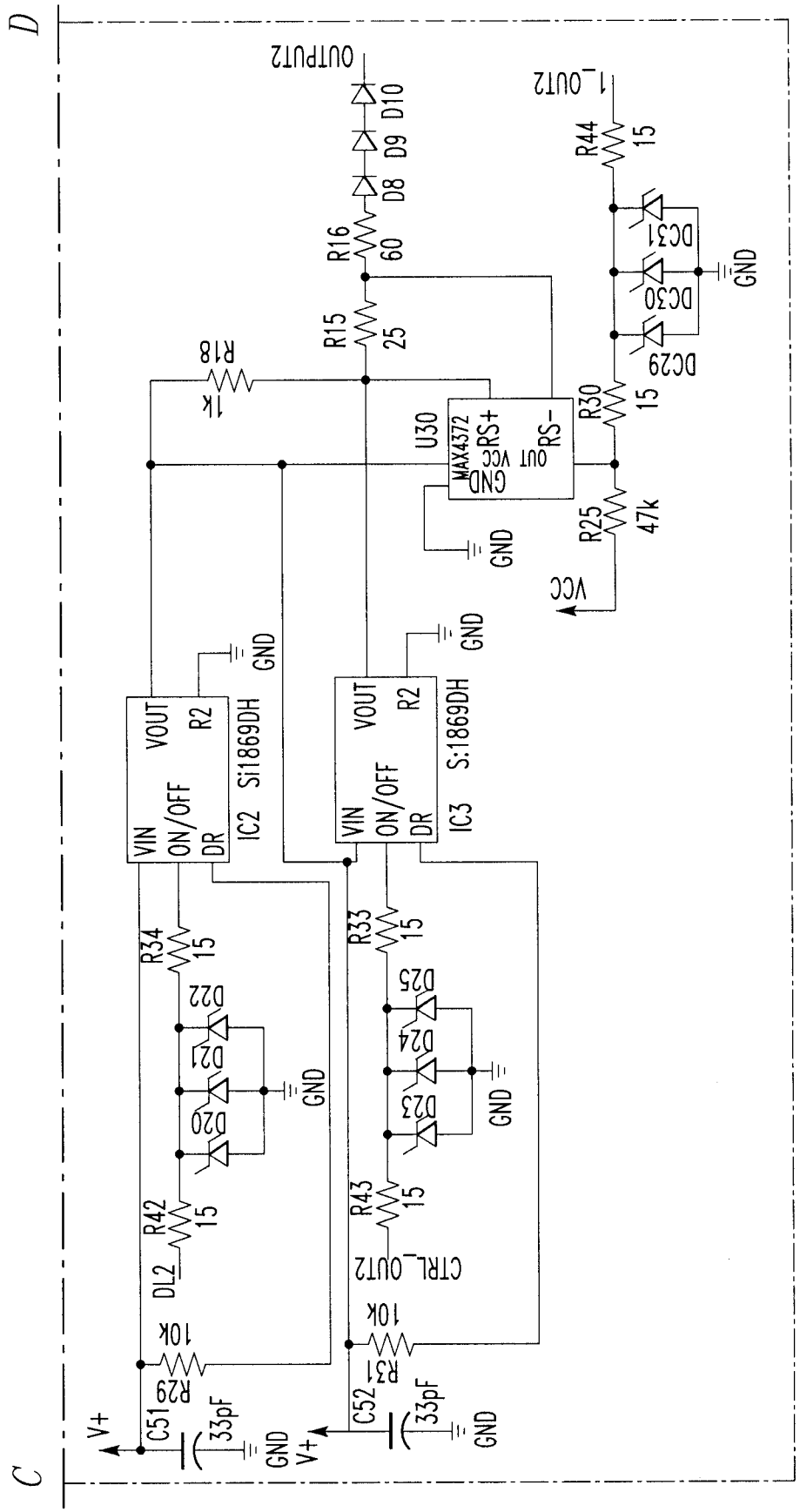

D
C
OUTPUT2
I_OUT2
D10
D9
D8
R16
60
R15
25
R18
1K
R44
15
DC31
DC30
DC29
GND
U30
MAX4372
VCC
OUT
RS+
RS-
GND
R30
15
R25
47k
VCC
IC2 Si1869DH
VIN
ON/OFF
DR
VOUT
R2
GND
IC3 S:1869DH
VIN
ON/OFF
DR
VOUT
R2
GND
R34
15
D22
D21
D20
GND
R42
15
DL2
10K
R29
C51
33pF
GND
V+
R33
15
D25
D24
D23
GND
R43
15
CTRL_OUT2
10K
R31
C52
33pF
GND
V+

FIG.2E

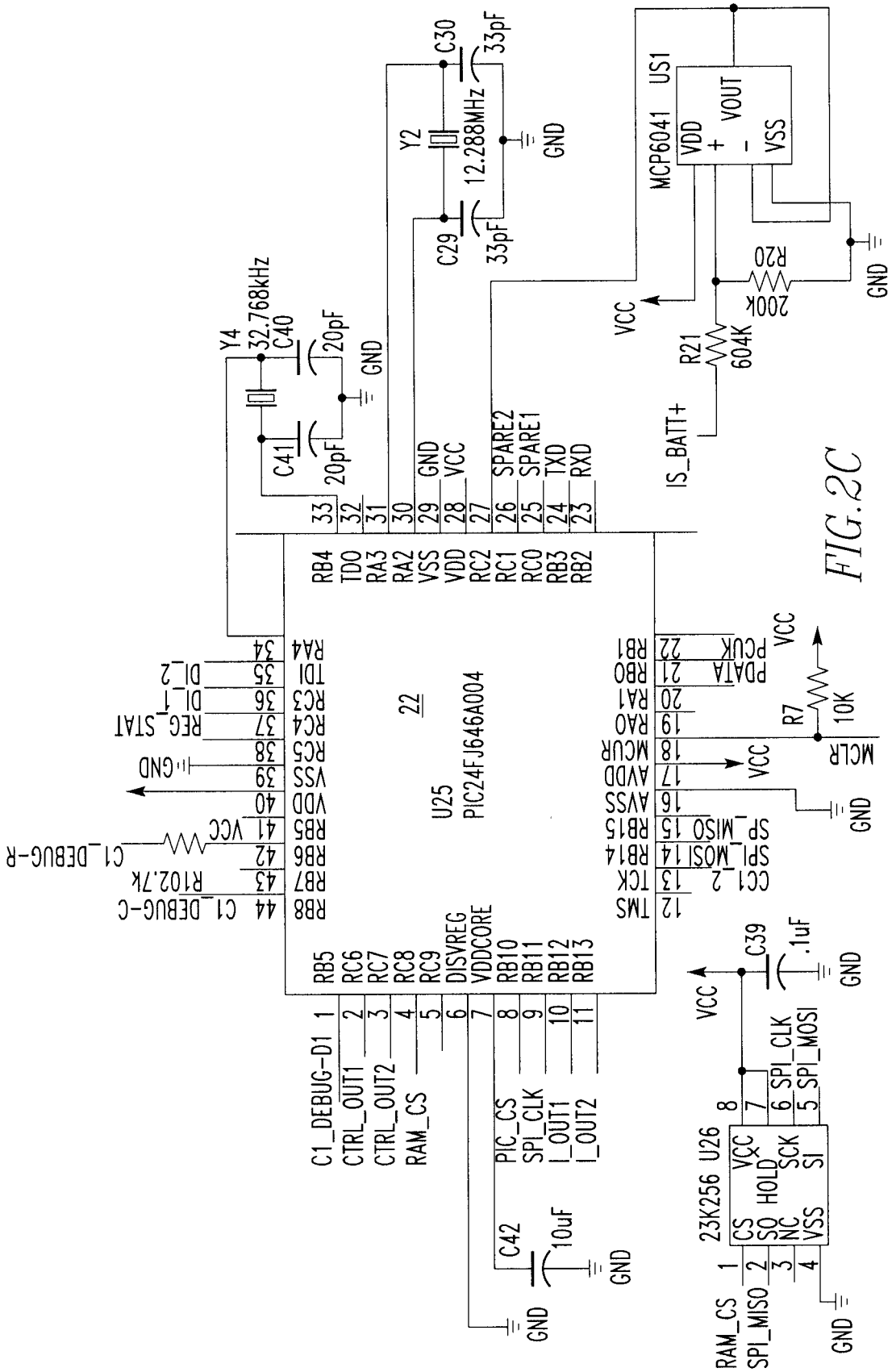

U25
PIC24FJ646A004
22
MCP6041 US1
VDD
VOUT
VSS
VCC
GND
R20
200K
R21
604K
IS_BATT+
Y2
12.288MHz
C30
33pF
C29
33pF
Y4
32.768kHz
C40
20pF
C41
20pF
SPARE2
SPARE1
TXD
RXD
GND
VCC
RB4
TDO
RA3
RA2
VSS
VDD
RC2
RC1
RC0
RB3
RB2
RA4
TDI
RC3
RC4
RC5
VSS
VDD
RB5
RB6
RB7
RB8
RB9
RB10
RB11
RB12
RB13
RB14
RB15
AVSS
AVDD
MCLR
RA0
RA1
RB0
RB1
PGD
PGC
TMS
TCK
SPI_MISO
SPI_MOSI
PCUK
PDATA
R7
10K
MCLR
DI_2
DI_1
REG_STAT
GND
VCC
R102.7k
C1_DEBUG-R
C1_DEBUG-C
C1_DEBUG-D1
CTRL_OUT1
CTRL_OUT2
RAM_CS
PIC_CS
SPI_CLK
I_OUT1
I_OUT2
C42
10uF
C39
.1uF
23K256 U26
CS
SO
NC
VSS
HOLD
VCC
SCK
SI
SPI_CLK
SPI_MOSI
SPI_MISO

FIG.2C

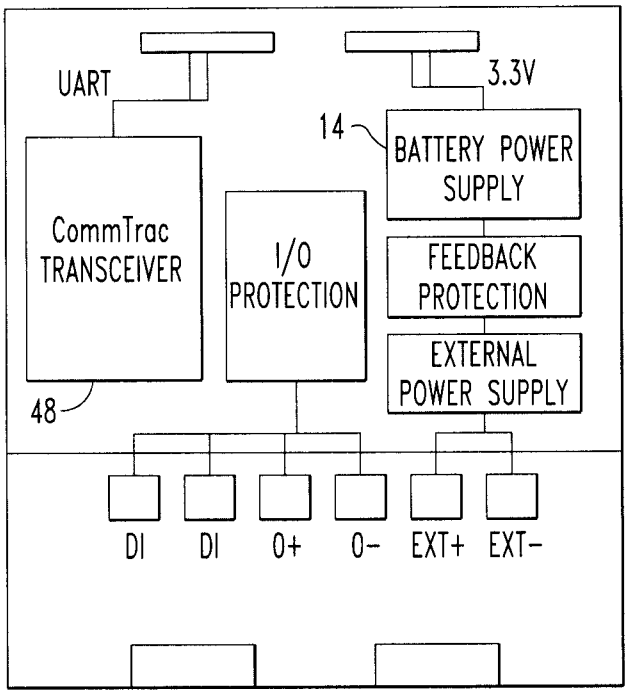

UART
3.3V
14
BATTERY POWER SUPPLY
CommTrac TRANSCEIVER
I/O PROTECTION
FEEDBACK PROTECTION
EXTERNAL POWER SUPPLY
48
DI
DI
O+
O-
EXT+
EXT-

FIG.3

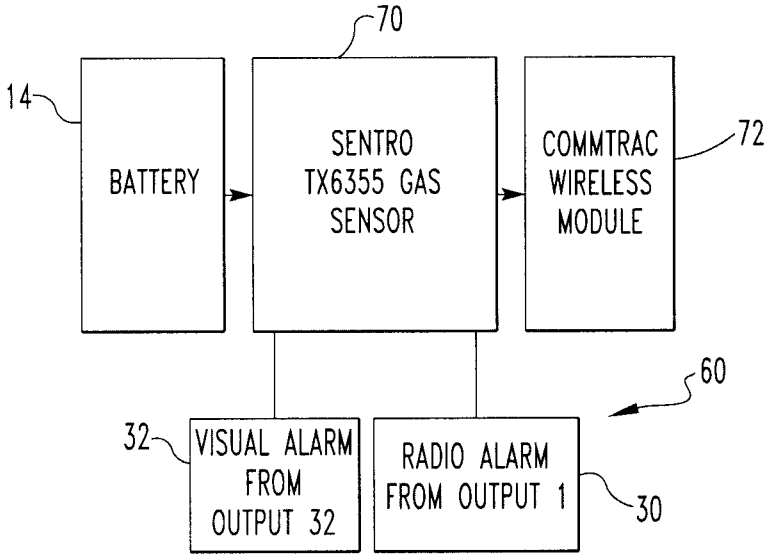

70
14
BATTERY
SENTRO TX6355 GAS SENSOR
COMMTRAC WIRELESS MODULE
72
60
32
VISUAL ALARM FROM OUTPUT 32
RADIO ALARM FROM OUTPUT 1
30

FIG.4

THEORY OF OPERATION

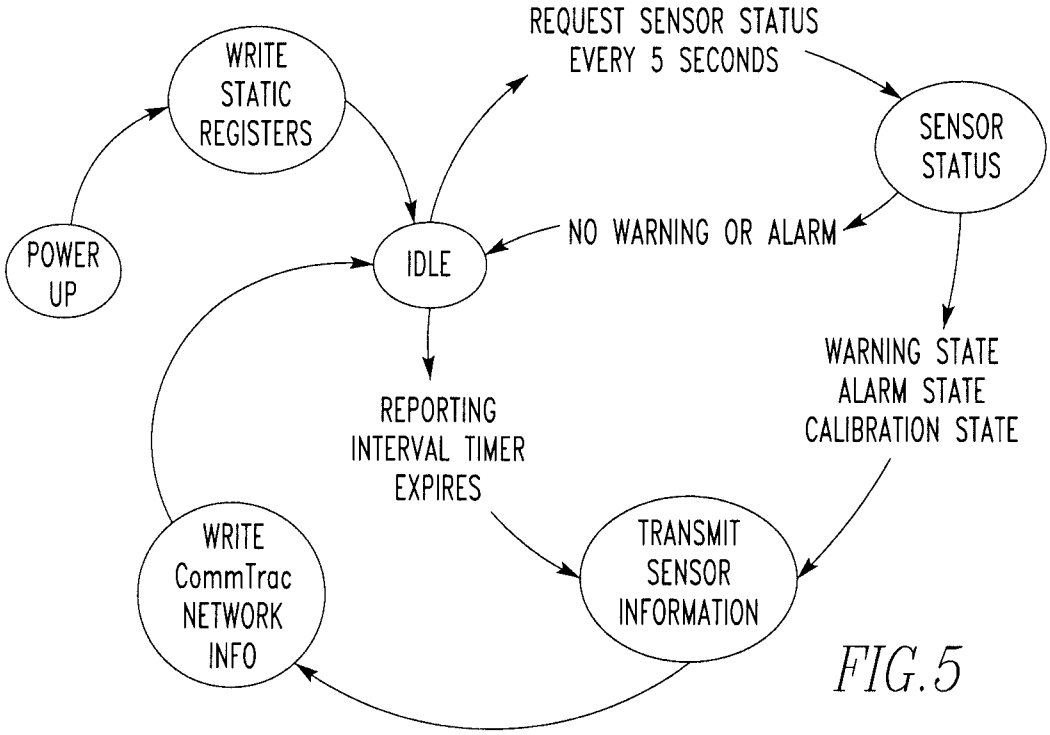


FIG.5

OUTPUT CONFIGURATION

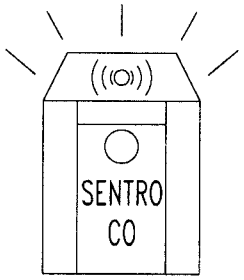


FIG.6

INPUT CONFIGURATION

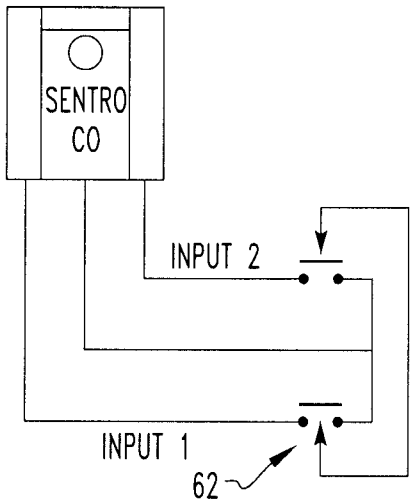


FIG.7

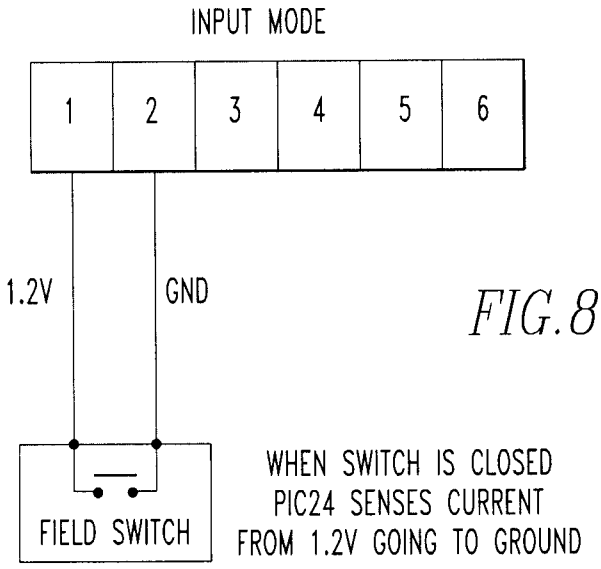


FIG.8

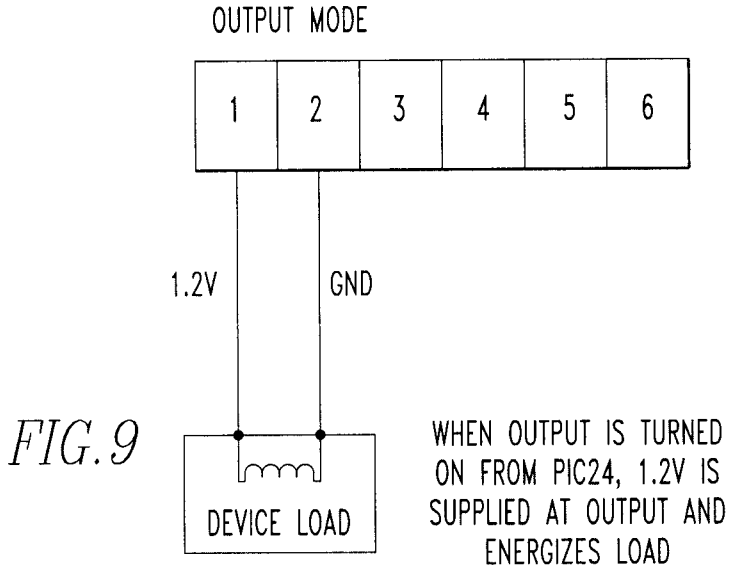


FIG.9

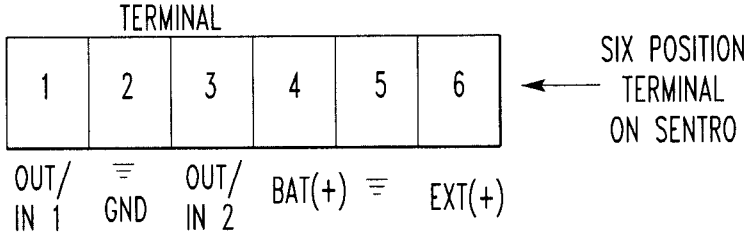


FIG.10

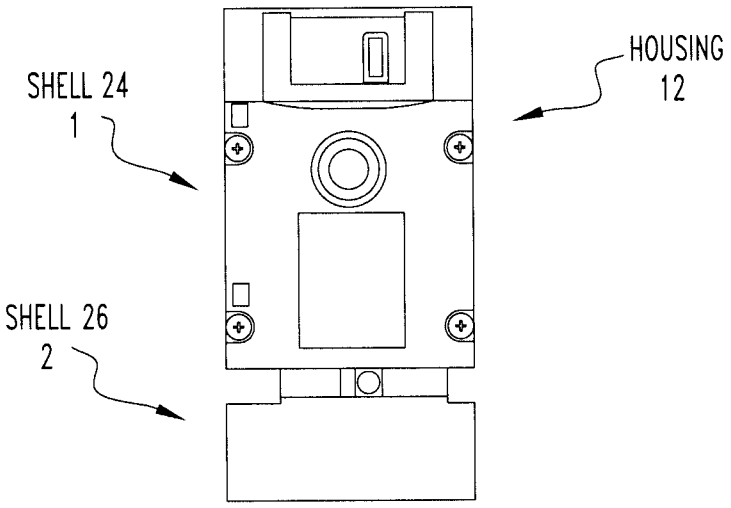

SHELL 24
1
HOUSING
12
SHELL 26
2

FIG.11

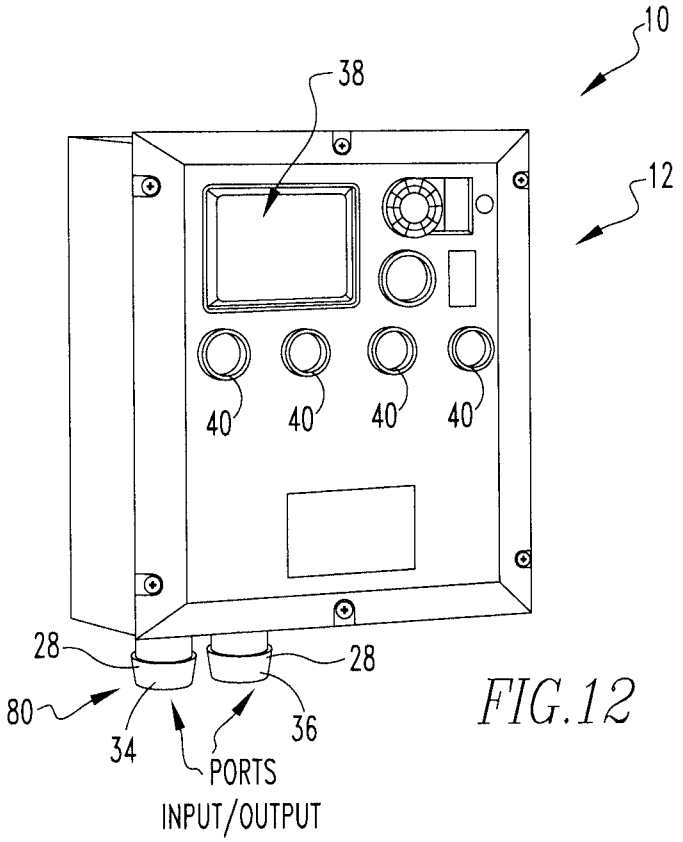

10
38
12
40
40
40
40
28
28
80
34
36
PORTS
INPUT/OUTPUT

FIG.12

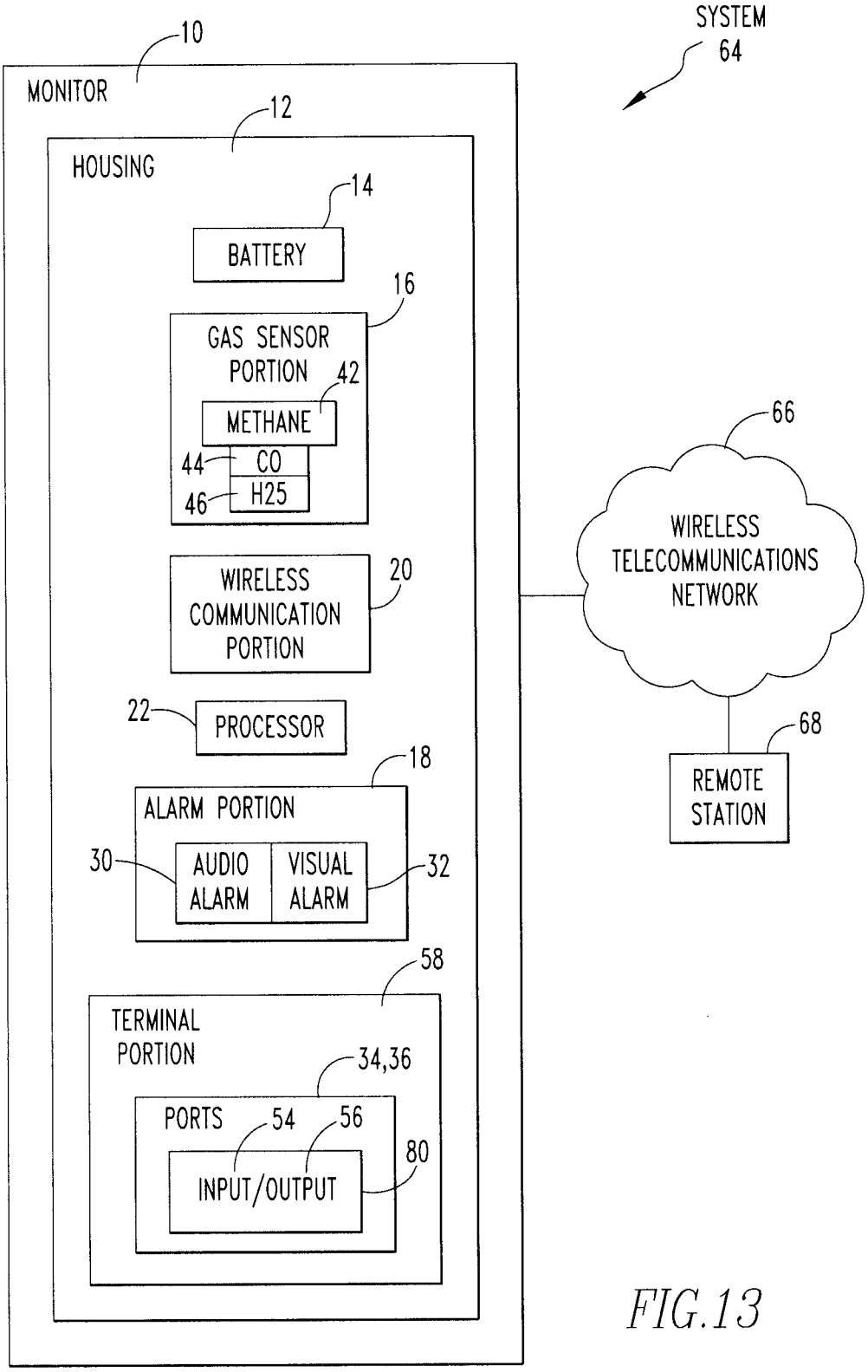

SYSTEM
64
10
MONITOR
12
HOUSING
14
BATTERY
16
GAS SENSOR
PORTION
42
METHANE
44
CO
46
H25
20
WIRELESS
COMMUNICATION
PORTION
22
PROCESSOR
18
ALARM PORTION
30
AUDIO
ALARM
VISUAL
ALARM
32
58
TERMINAL
PORTION
34,36
PORTS
54
56
80
INPUT/OUTPUT
66
WIRELESS
TELECOMMUNICATIONS
NETWORK
68
REMOTE
STATION

FIG.13

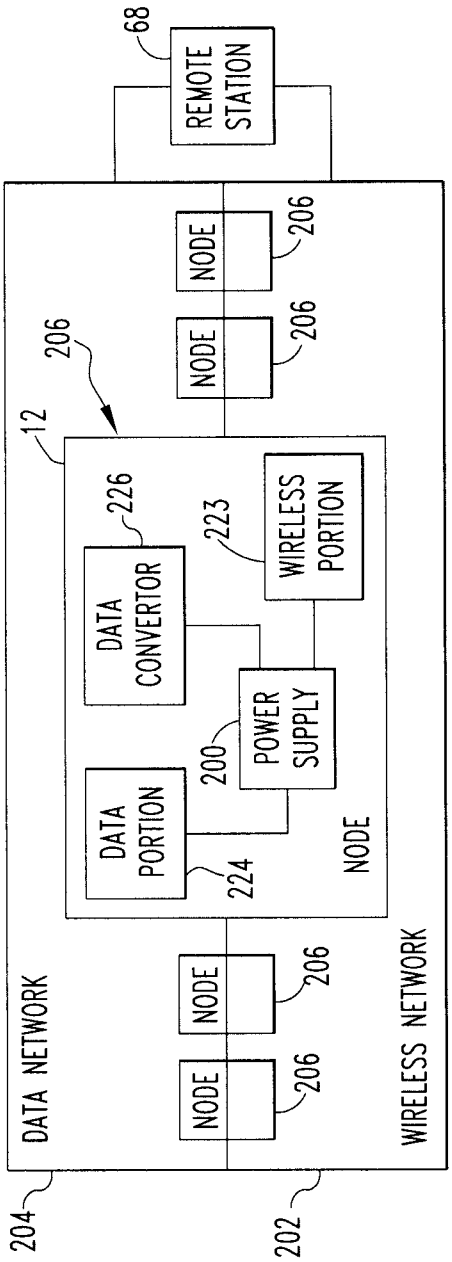

68
REMOTE STATION
NODE
206
NODE
206
206
12
226
DATA CONVERTOR
223
WIRELESS PORTION
200
POWER SUPPLY
DATA PORTION
224
NODE
NODE
206
NODE
206
DATA NETWORK
WIRELESS NETWORK
204
202

FIG.14A

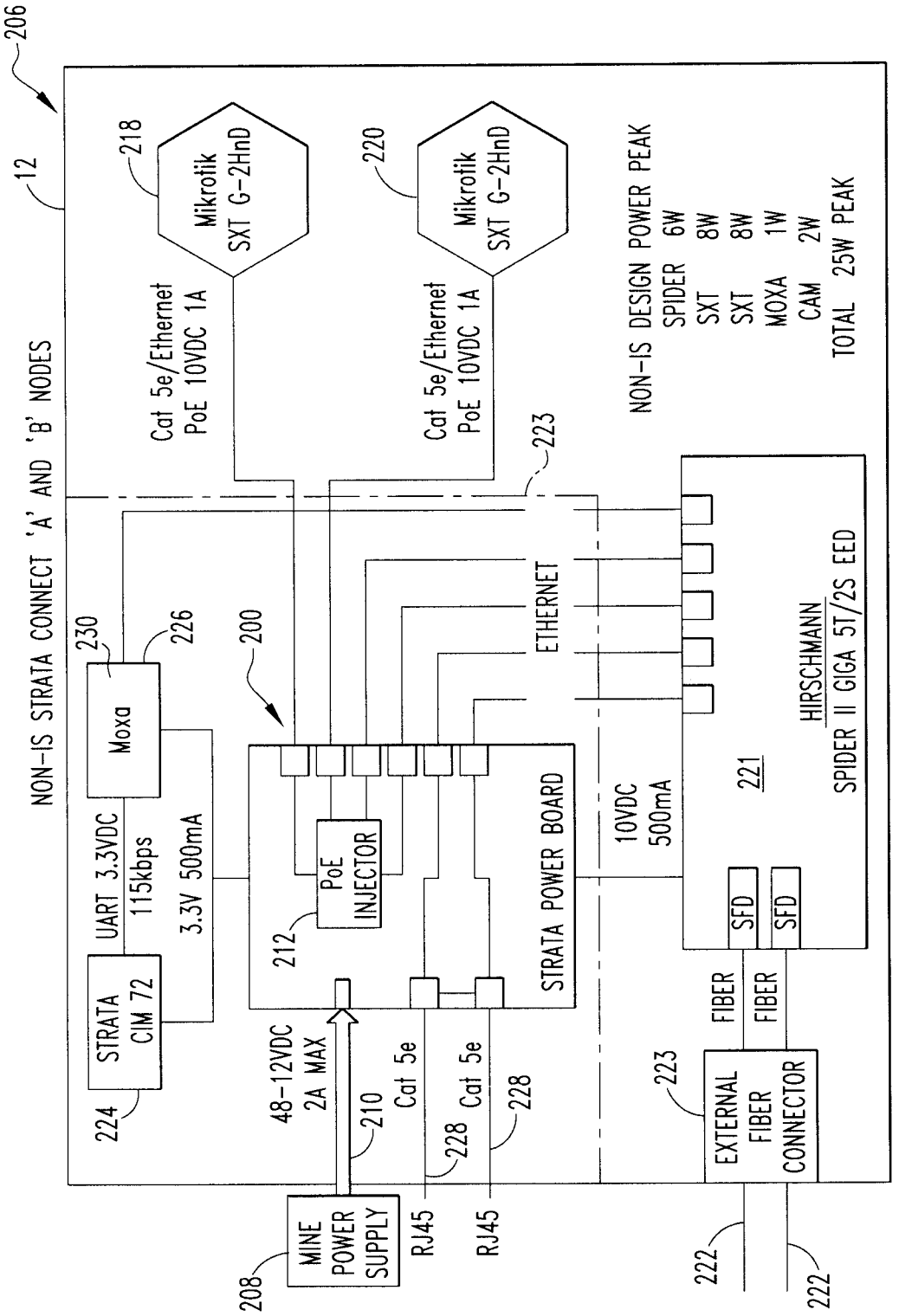

206
12
NON-IS STRATA CONNECT 'A' AND 'B' NODES
218
Mikrotik SXT G-2HnD
220
Mikrotik SXT G-2HnD
Cat 5e/Ethernet PoE 10VDC 1A
Cat 5e/Ethernet PoE 10VDC 1A
223
NON-IS DESIGN POWER PEAK
SPIDER 6W
SXT 8W
SXT 8W
MOXA 1W
CAM 2W
TOTAL 25W PEAK
230
Moxa
226
200
ETHERNET
UART 3.3VDC 115kbps
3.3V 500mA
PoE INJECTOR
212
STRATA POWER BOARD
10VDC 500mA
221
HIRSCHMANN SPIDER II GIGA 5T/2S EED
SFD
SFD
STRATA CIM 72
224
48-12VDC 2A MAX
210
Cat 5e
228
Cat 5e
228
FIBER
FIBER
223
EXTERNAL FIBER CONNECTOR
MINE POWER SUPPLY
208
RJ45
RJ45
222
222

FIG.14B

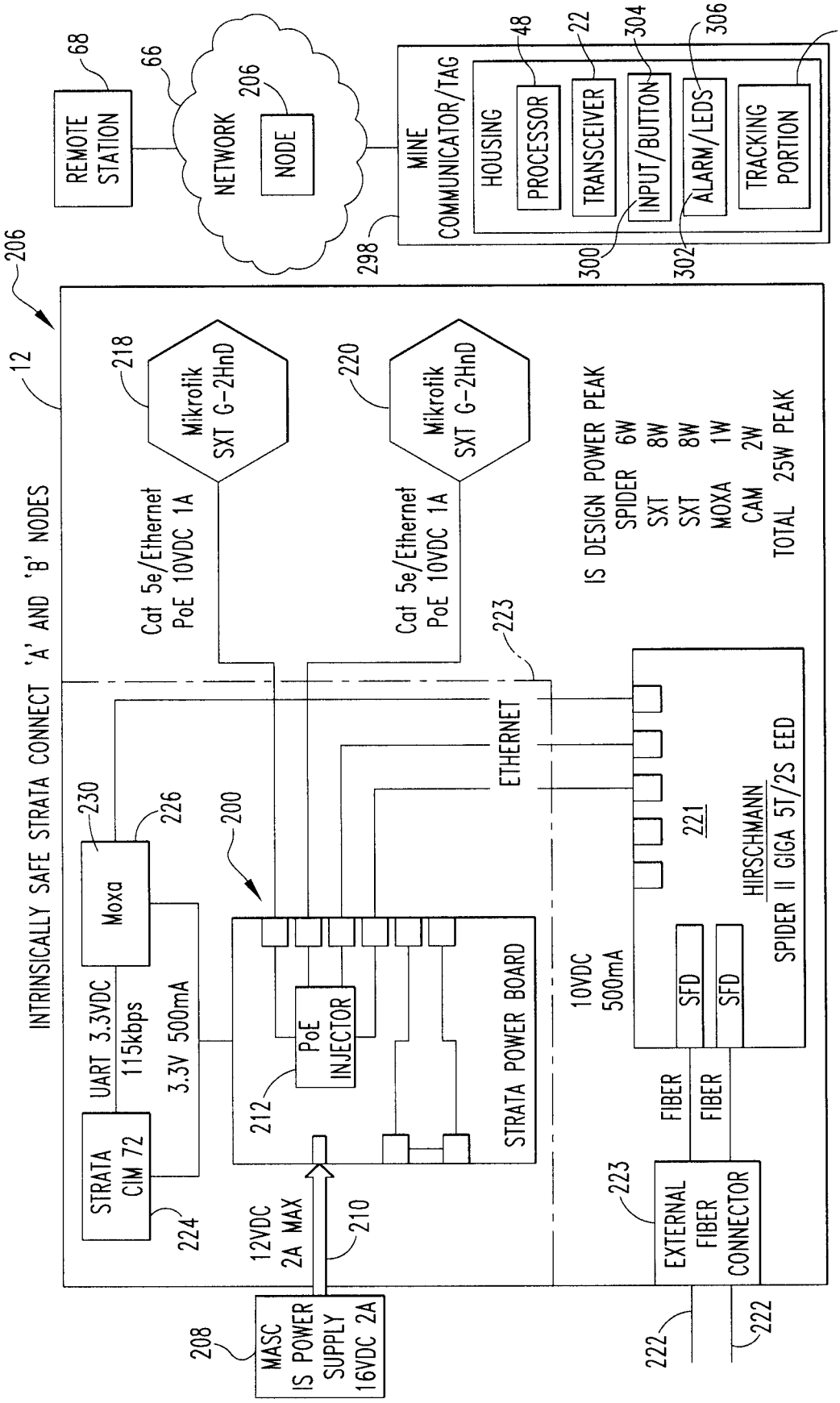


FIG.15

FIG.14C

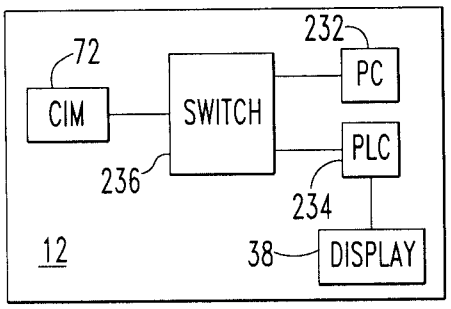


FIG.16

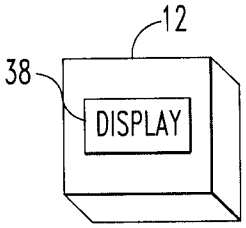


FIG.17

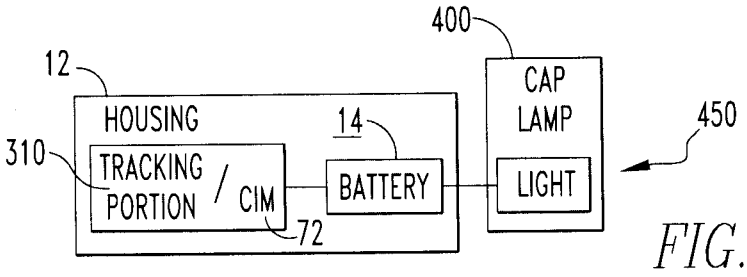


FIG.18

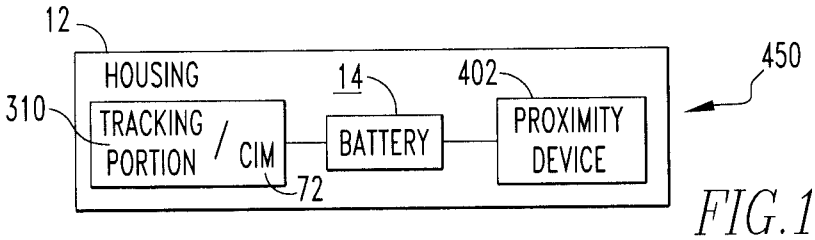


FIG.19

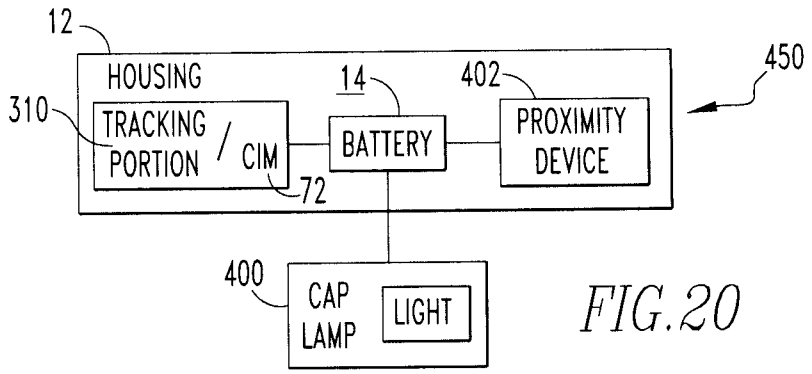


FIG.20

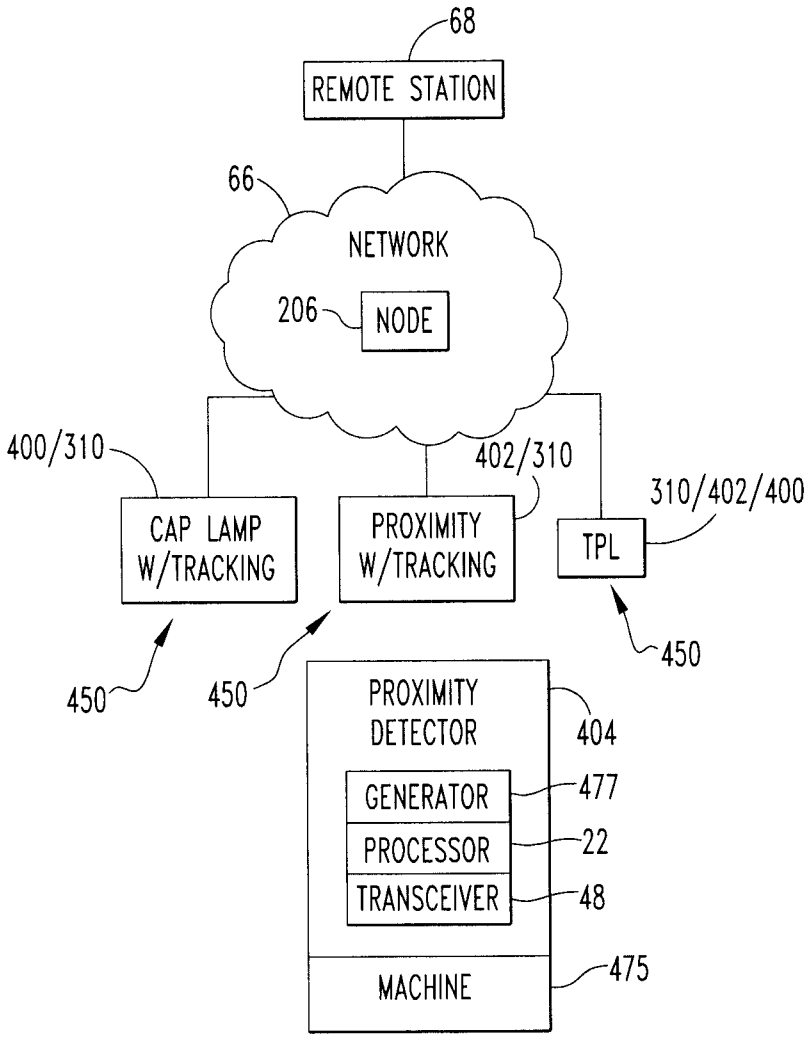

68
REMOTE STATION
66
NETWORK
206
NODE
400/310
CAP LAMP
W/TRACKING
402/310
PROXIMITY
W/TRACKING
310/402/400
TPL
450
450
450
PROXIMITY
DETECTOR
404
GENERATOR
477
PROCESSOR
22
TRANSCEIVER
48
MACHINE
475

FIG.21

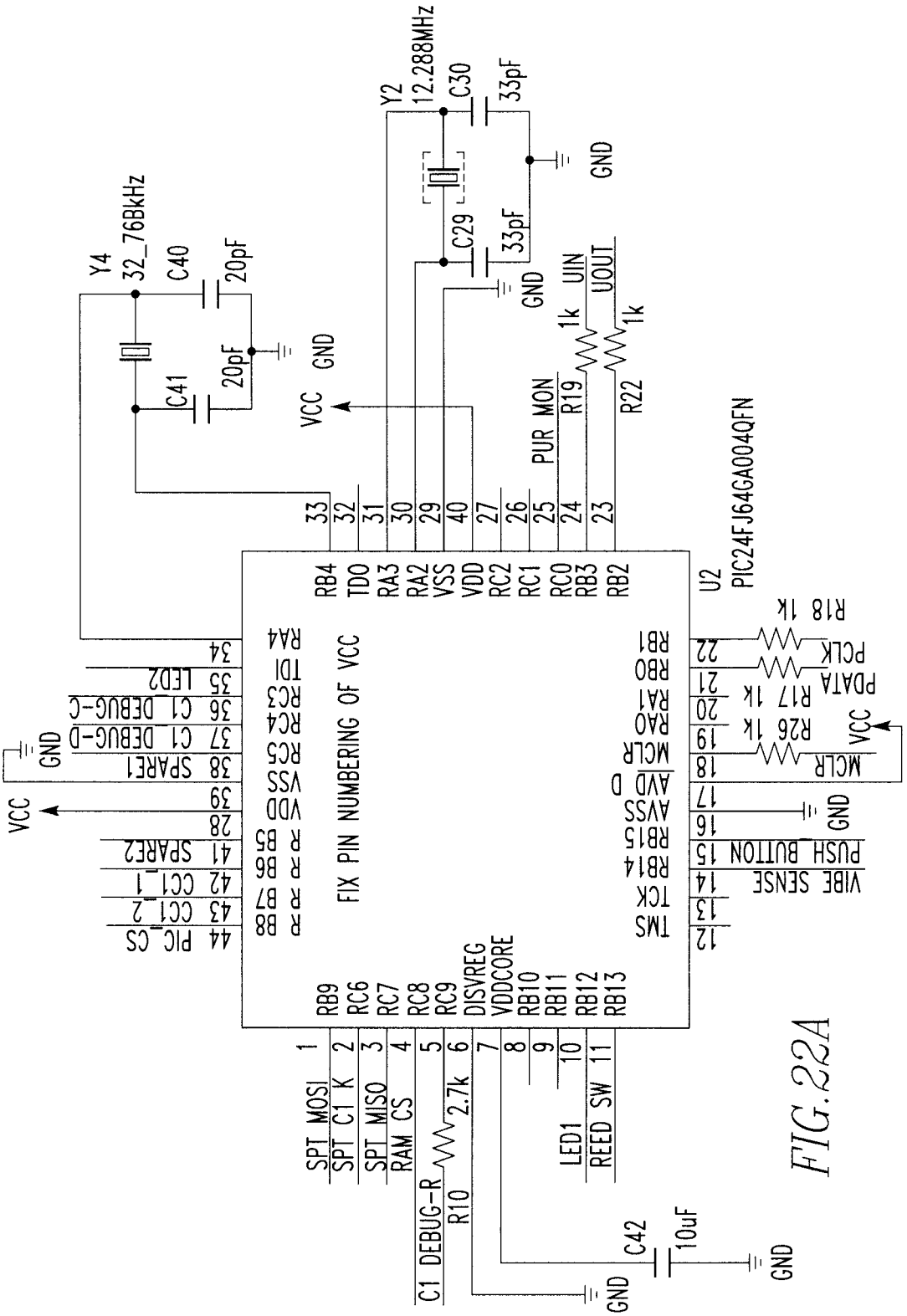

U2
PIC24FJ64GA004QFN
FIX PIN NUMBERING OF VCC
Y2
12.288MHz
C30
33pF
C29
33pF
GND
Y4
32_76BkHz
C40
20pF
C41
20pF
VCC
GND
PUR MON
R19
1k
UIN
R22
1k
UOUT
R18 1k
PCLK
PDATA
R17 1k
R26 1k
MCLR
VCC
GND
VIBE SENSE
PUSH BUTTON
SPT MOSI
SPT CLK
SPT MISO
RAM CS
C1 DEBUG-R
R10
2.7k
LED1
REED SW
C42
10uF
GND
LED2
C1 DEBUG-C
C1 DEBUG-D
SPARE1
SPARE2
C1_1
C1_2
PIC_CS
VCC
GND

FIG. 22A

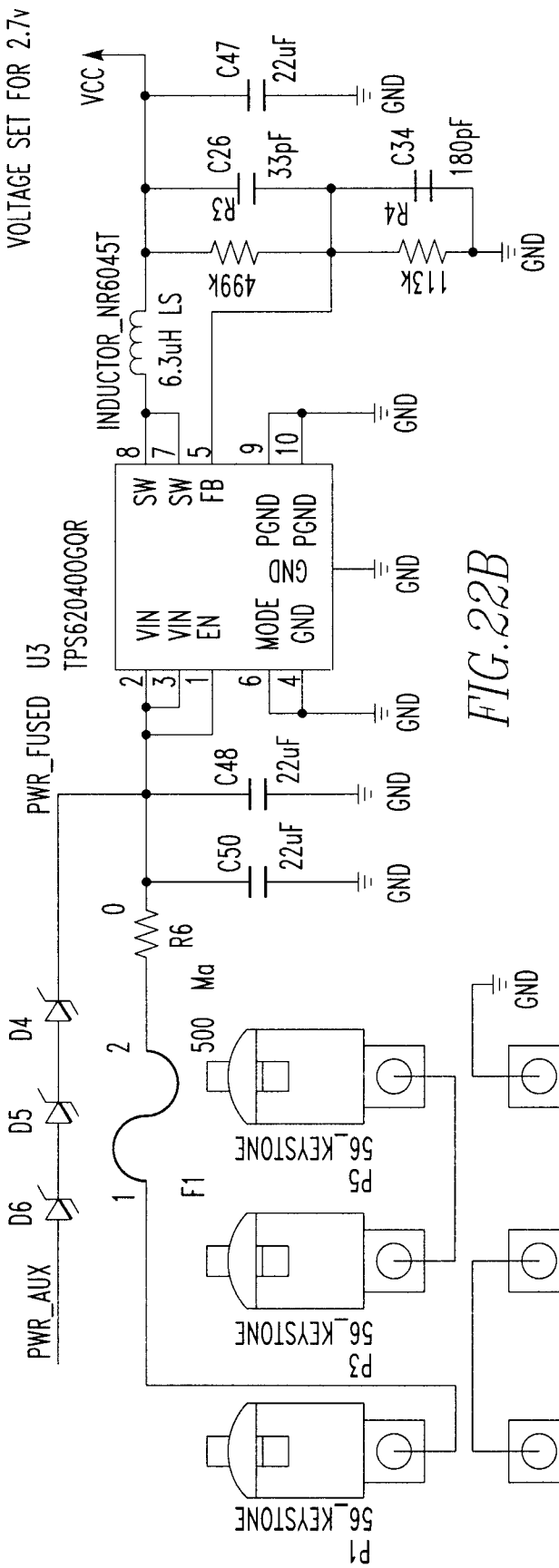


FIG.22B

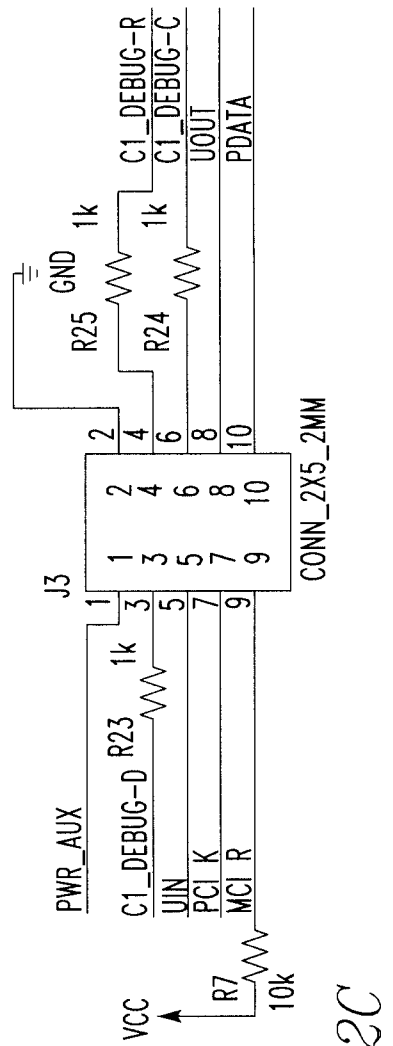


FIG.22C

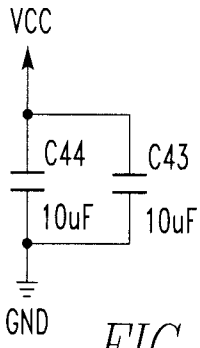


FIG.22D

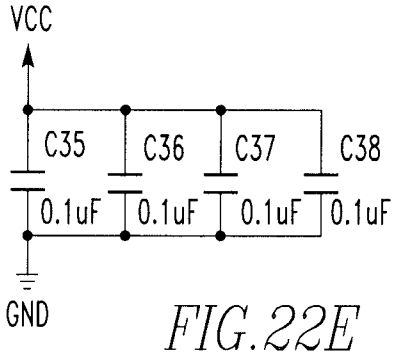


FIG.22E

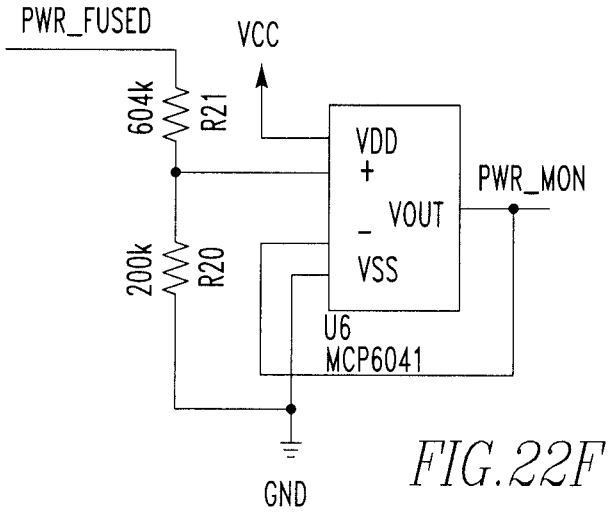


FIG.22F

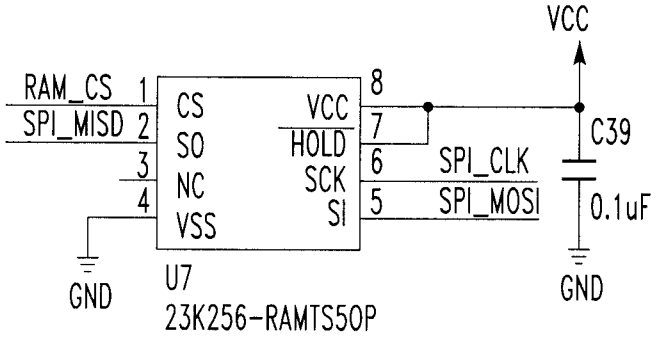


FIG.22G

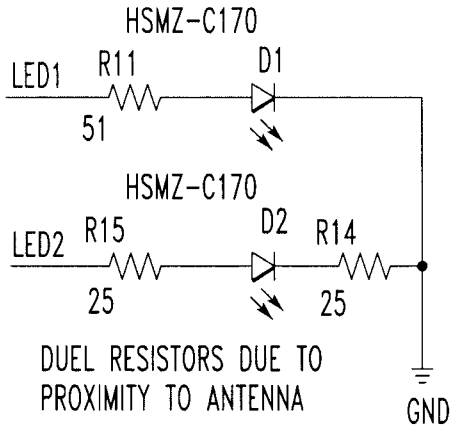


FIG.22H

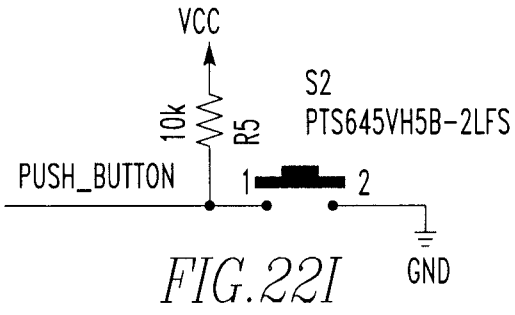


FIG.22I

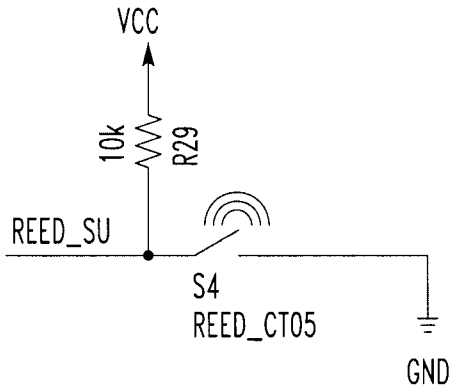


FIG.22J

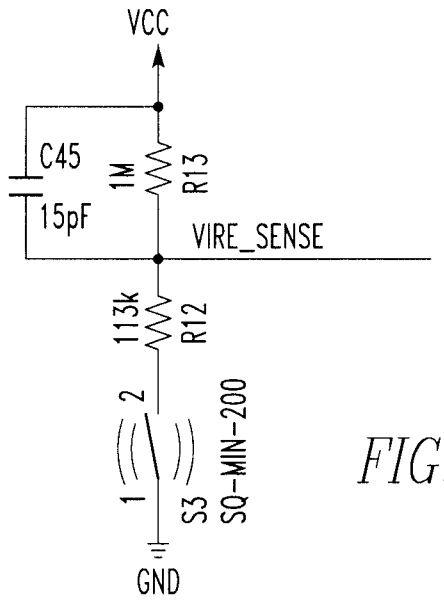


FIG.22K

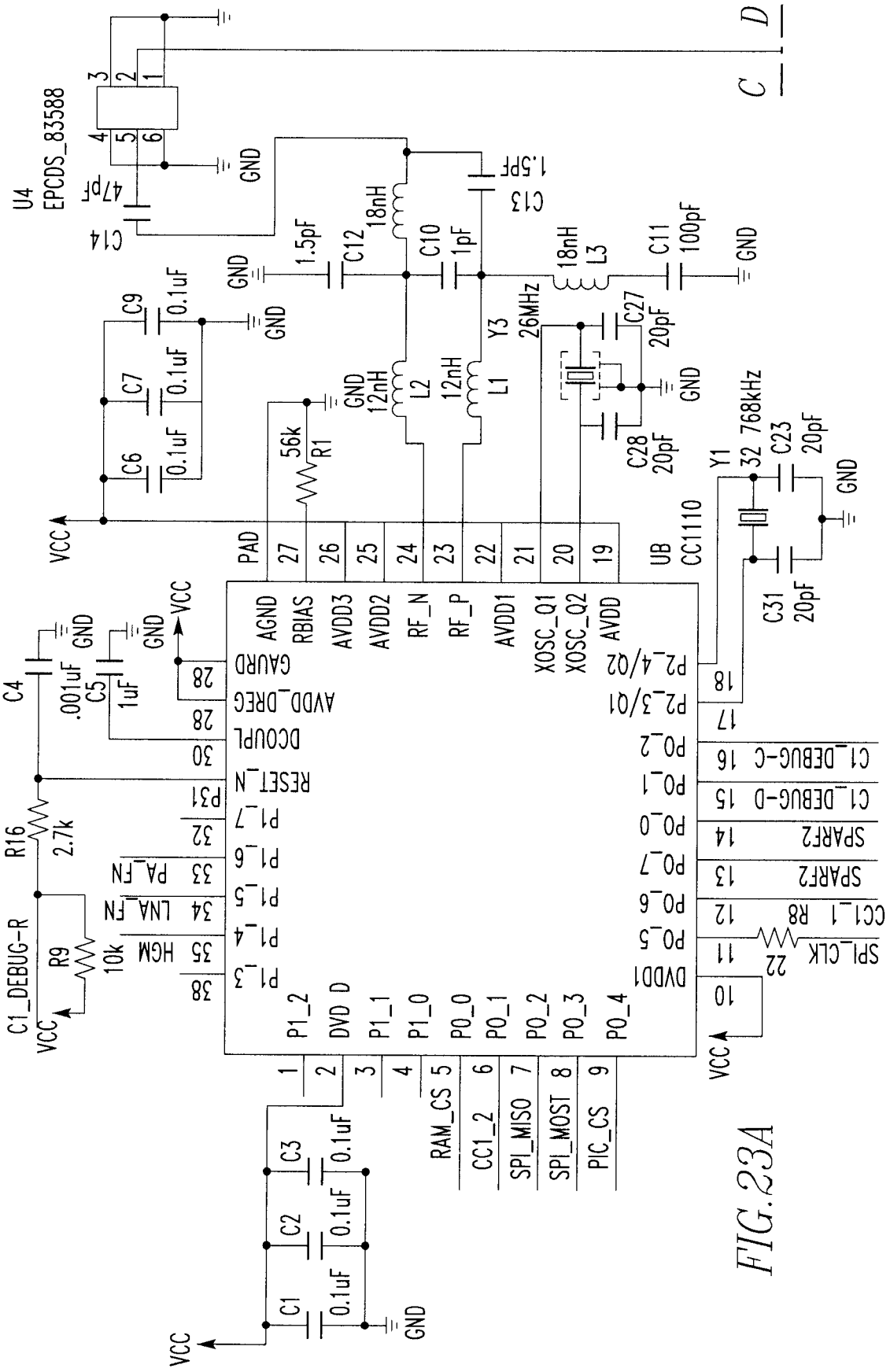

C
D
U4
EPCDS_83588
C14
47pF
GND
1.5PF
C13
1.5pF
C12
18nH
C10
1pF
18nH
L3
C11
100pF
GND
C9
0.1uF
GND
C7
0.1uF
C6
0.1uF
56k
R1
GND
12nH
L2
12nH
L1
Y3
26MHz
C27
20pF
GND
C28
20pF
Y1
32.768kHz
C23
20pF
GND
C31
20pF
VCC
PAD
27
26
25
24
23
22
21
20
19
UB
CC1110
AGND
RBIAS
AVDD3
AVDD2
RF_N
RF_P
AVDD1
XOSC_Q1
XOSC_Q2
AVDD
GAURD
AVDD_DREG
DCOUPL
RESET_N
P1_7
P1_6
P1_5
P1_4
P1_3
P1_2
DVD D
P1_1
P1_0
P0_0
P0_1
P0_2
P0_3
P0_4
DVDD1
P2_4/02
P2_3/01
P0_2
P0_1
P0_0
P0_7
P0_6
P0_5
C4
.001uF
C5
1uF
R16
2.7k
R9
10k
C1_DEBUG-R
PA_FN
LNA_FN
HGM
C1_DEBUG-C
C1_DEBUG-D
SPARF2
SPARF2
CC1_1
R8
22
SPI_CLK
RAM_CS
CC1_2
SPI_MISO
SPI_MOST
PIC_CS
C3
C2
C1
0.1uF
VCC
GND

FIG. 23A

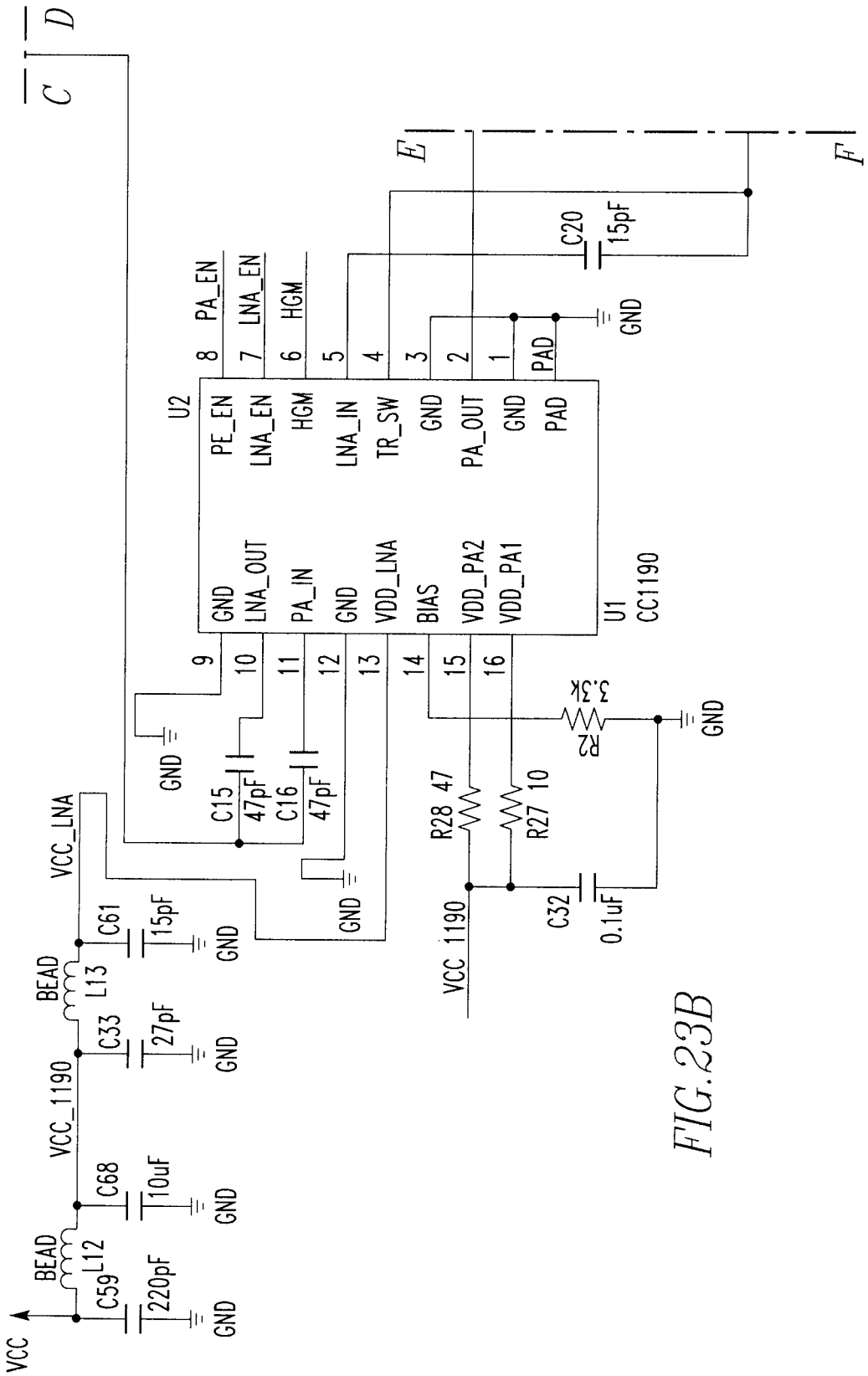

C
D
E
F
VCC
BEAD
L12
C59
220pF
GND
VCC_1190
C68
10uF
GND
BEAD
L13
C33
27pF
GND
VCC_LNA
C61
15pF
GND
GND
C15
47pF
C16
47pF
GND
U2
PE_EN
LNA_EN
HGM
LNA_IN
TR_SW
GND
PA_OUT
GND
PAD
8 PA_EN
7 LNA_EN
6 HGM
5
4
3
2
1
PAD
GND
C20
15pF
GND
LNA_OUT
PA_IN
GND
VDD_LNA
BIAS
VDD_PA2
VDD_PA1
U1
CC1190
9
10
11
12
13
14
15
16
R28 47
R27 10
VCC 1190
C32
0.1uF
3.3K
R2
GND

FIG.23B

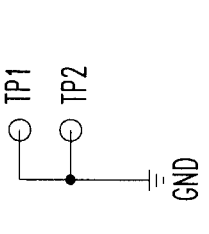


FIG.23D

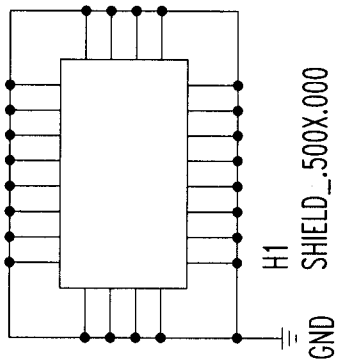


FIG.23E

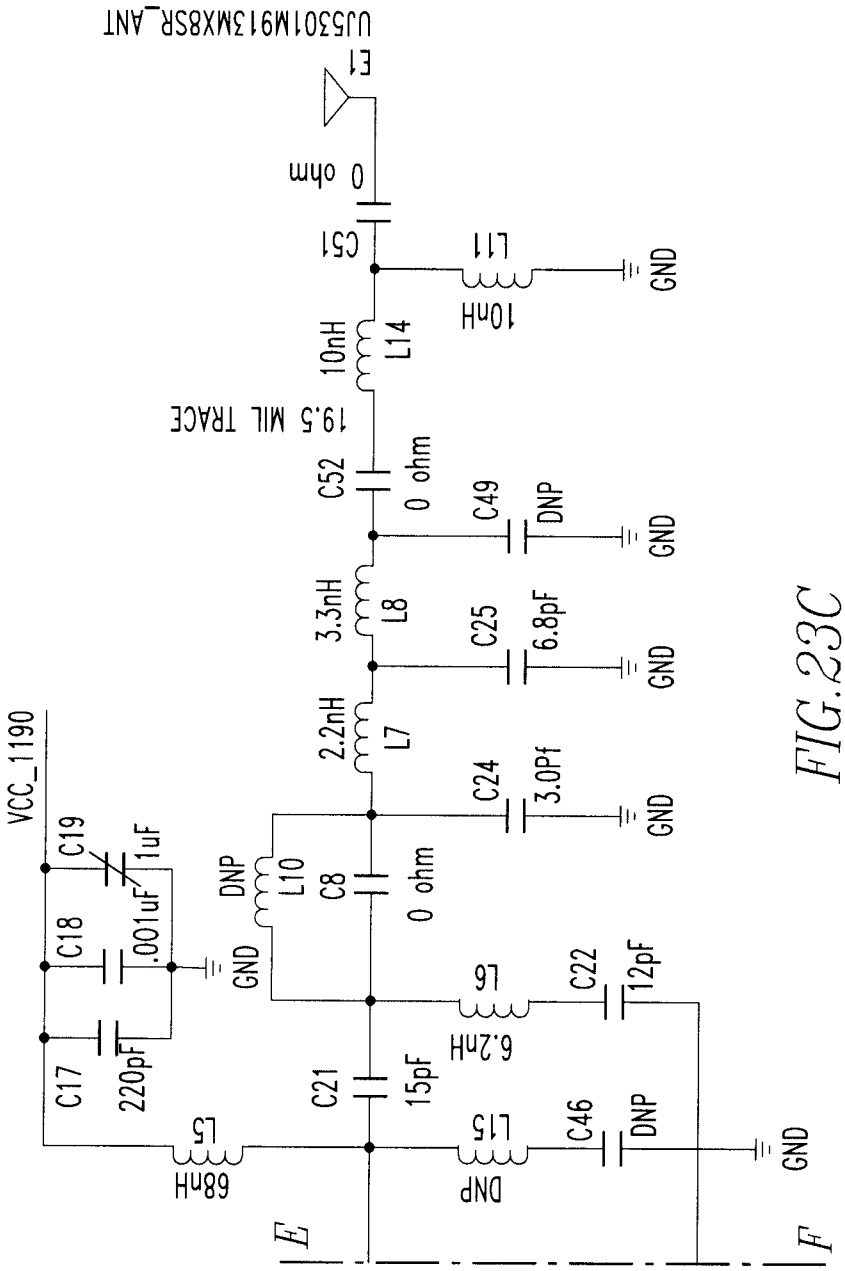


FIG.23C

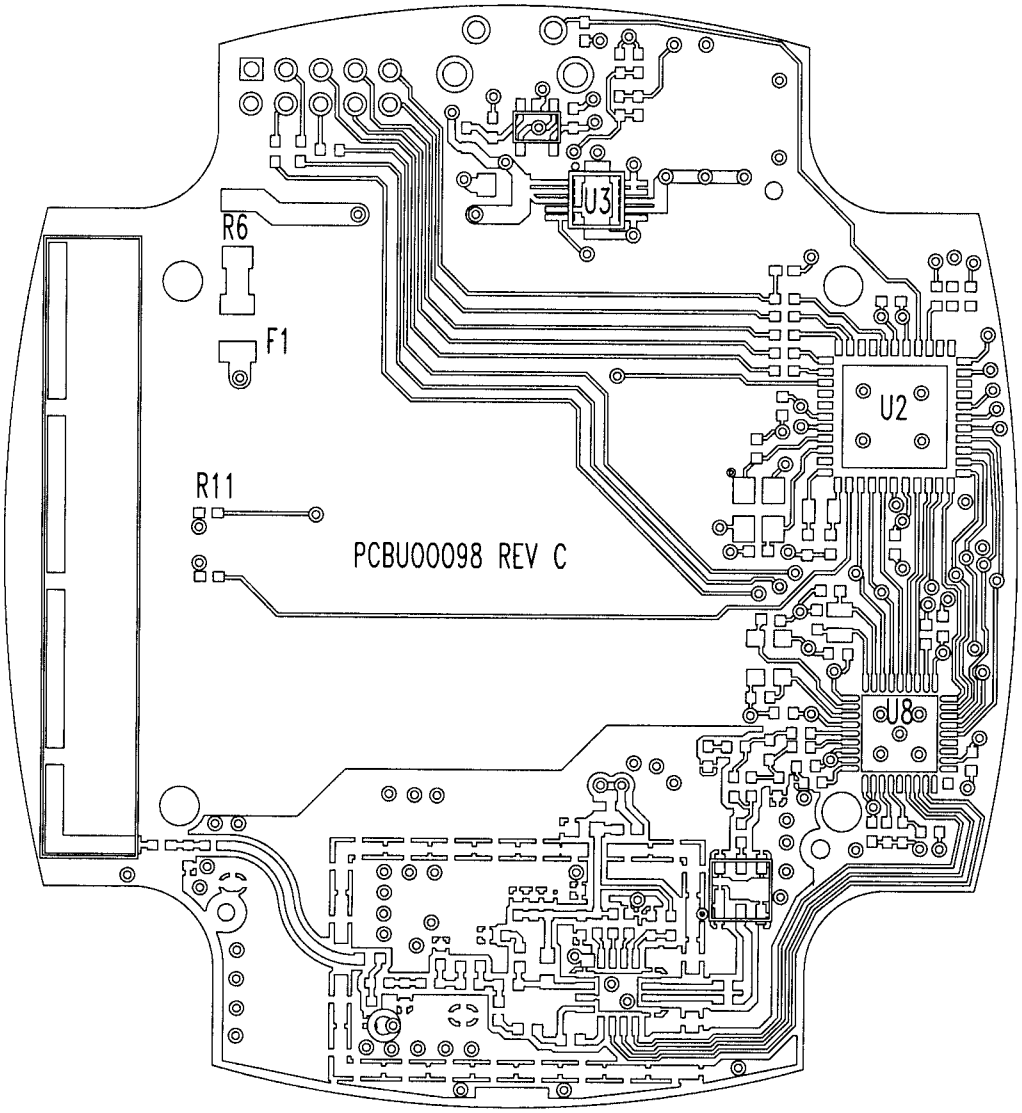


FIG.24

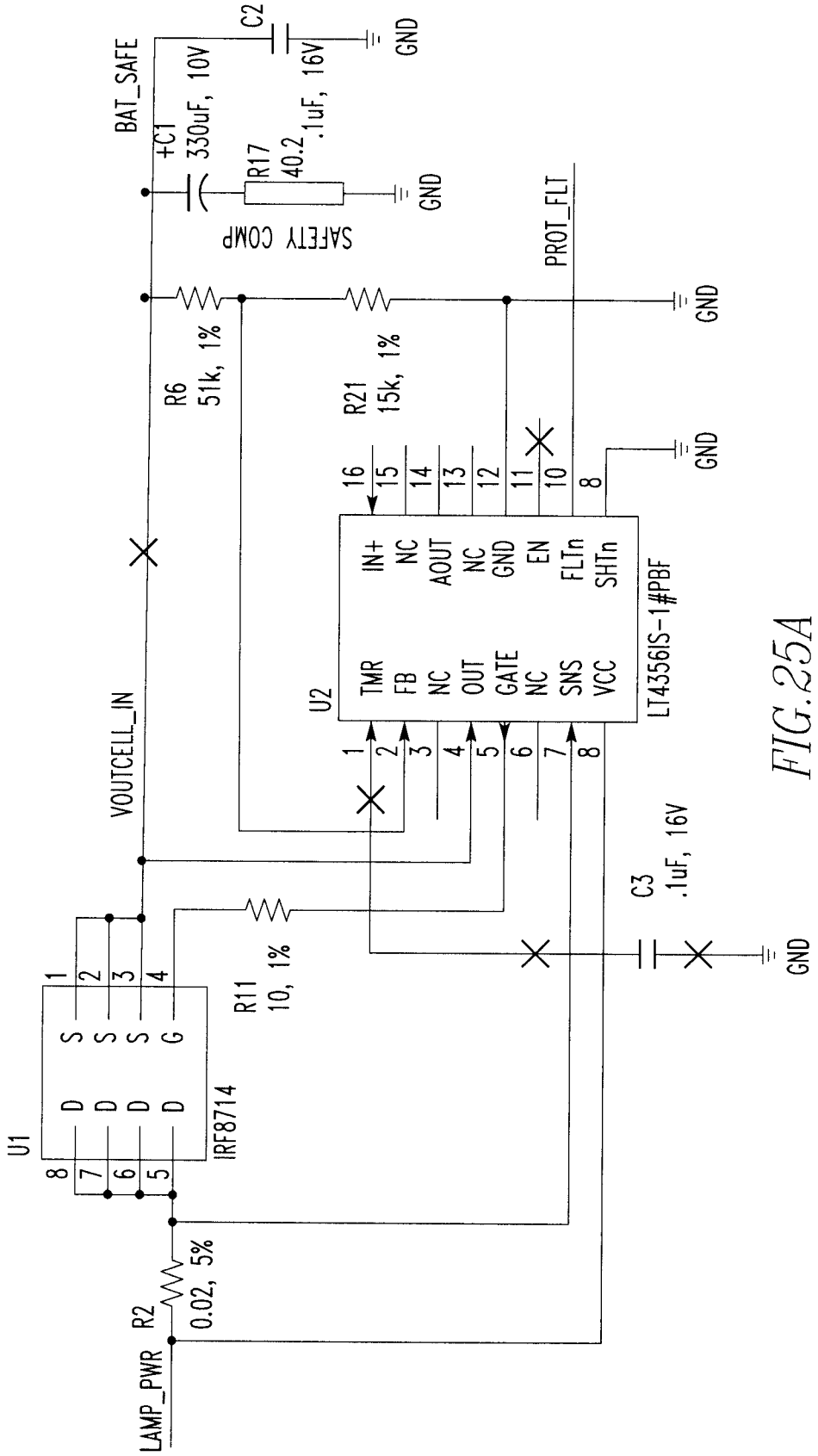

BAT_SAFE
+C1
330uF, 10V
C2
.1uF, 16V
GND
R17
40.2
GND
SAFETY COMP
PROT_FLT
R6
51k, 1%
R21
15k, 1%
GND
GND
U2
LT4356IS-1#PBF
IN+
NC
AOUT
NC
GND
EN
FLTn
SHTn
TMR
FB
NC
OUT
GATE
NC
SNS
VCC
VOUTCELL_IN
C3
.1uF, 16V
GND
R11
10, 1%
U1
IRF8714
S
S
S
G
D
D
D
D
R2
0.02, 5%
LAMP_PWR

FIG.25A

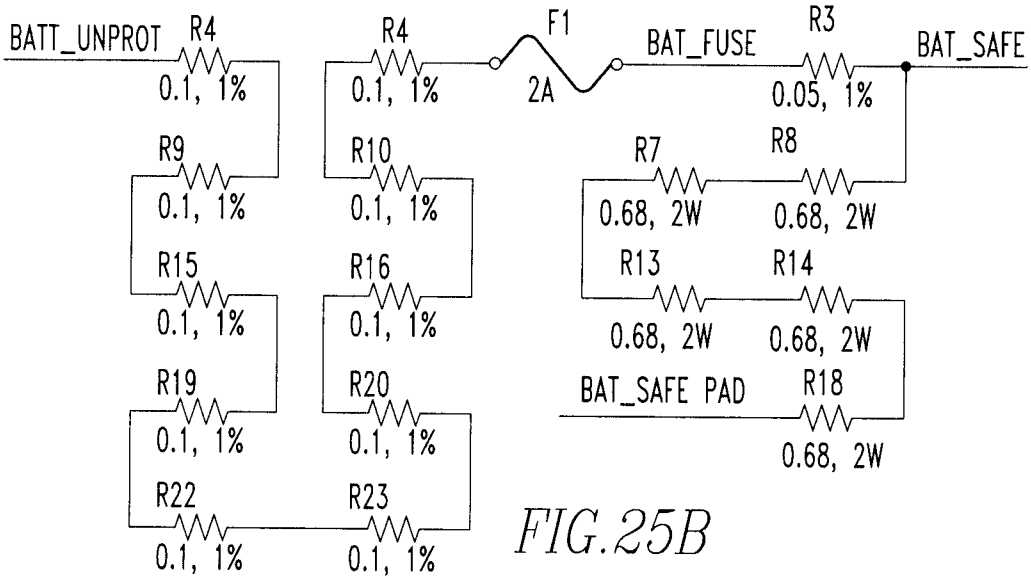


FIG.25B

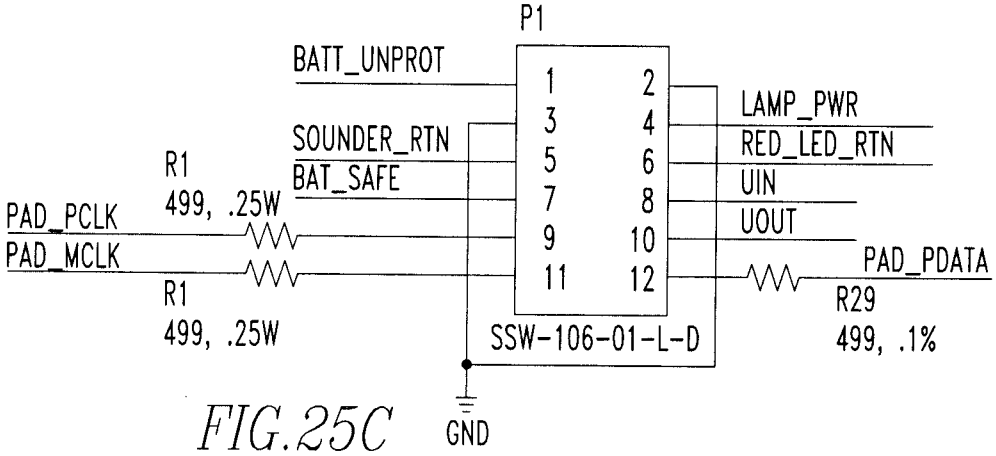


FIG.25C

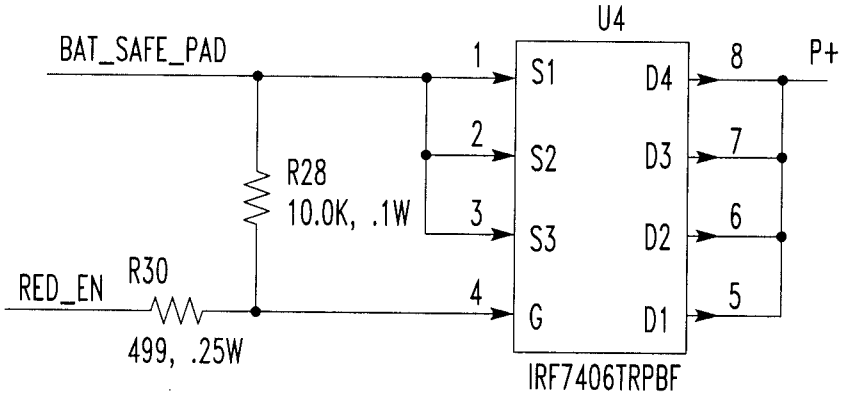


FIG.25D

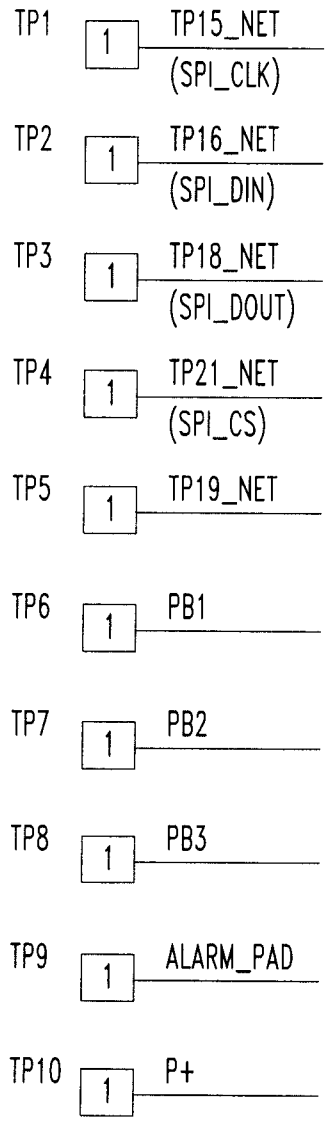


FIG.25E

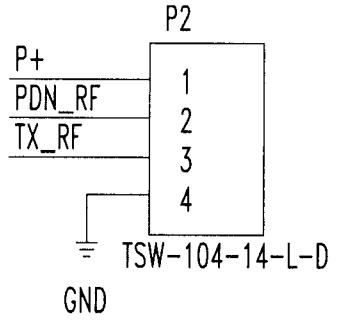


FIG.25F

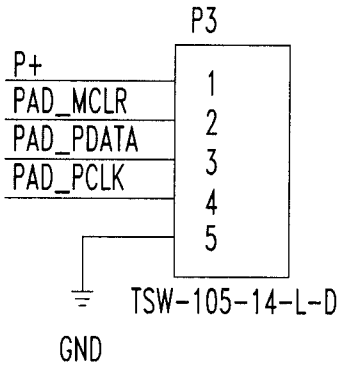


FIG.25G

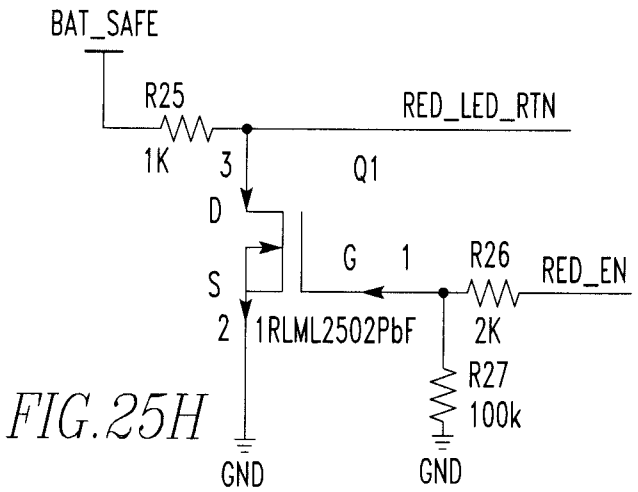


FIG.25H

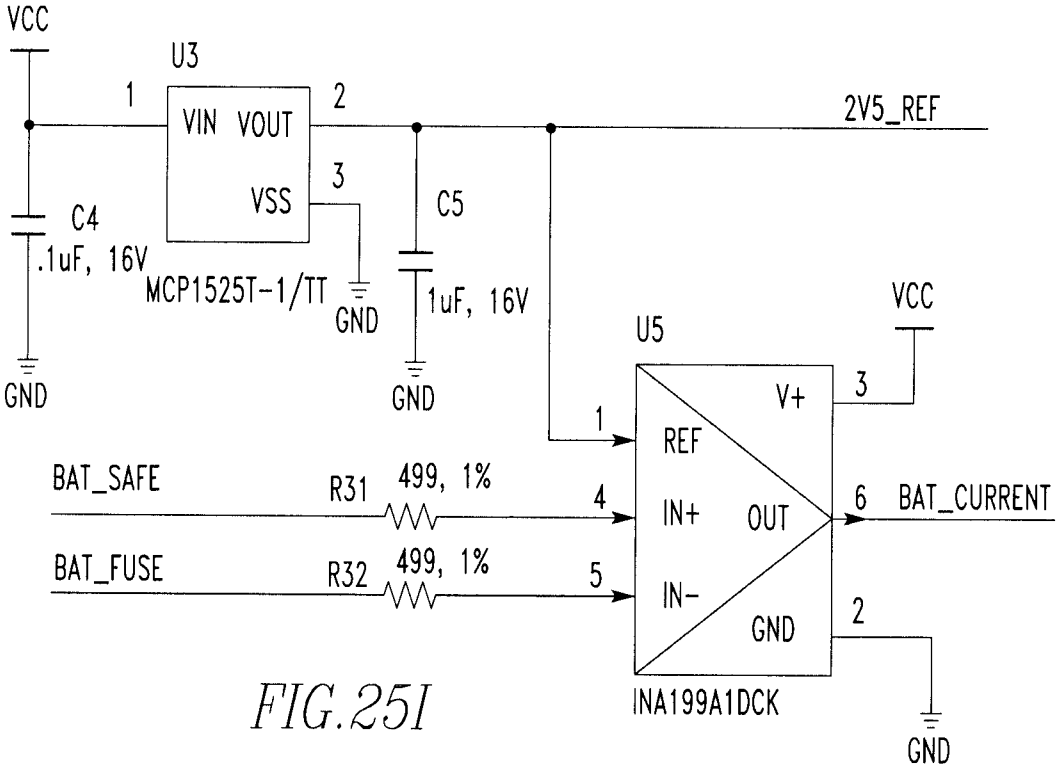


FIG.25I

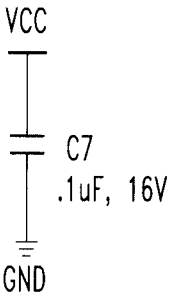


FIG.25J

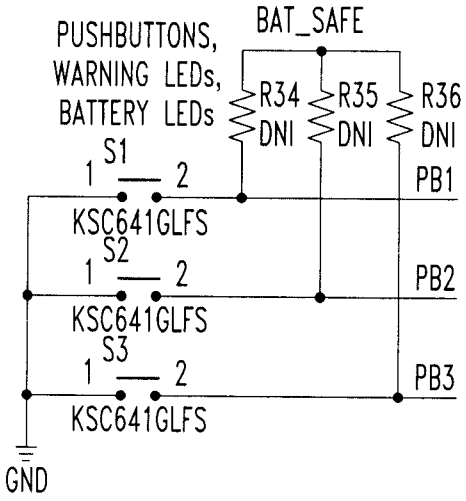


FIG.26A

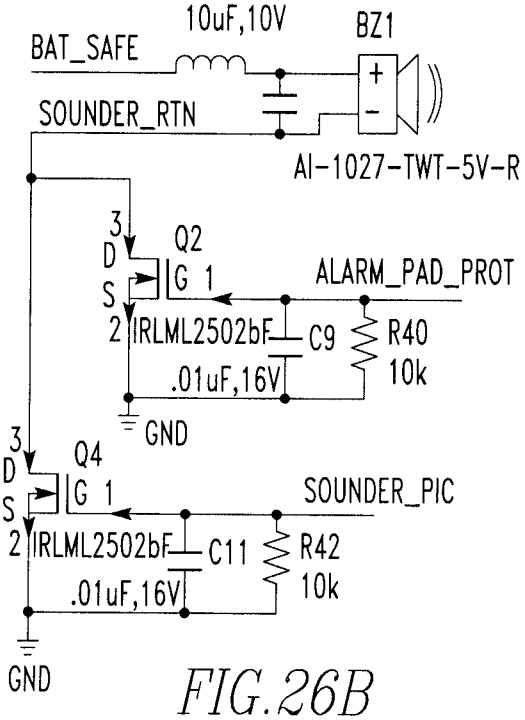


FIG.26B

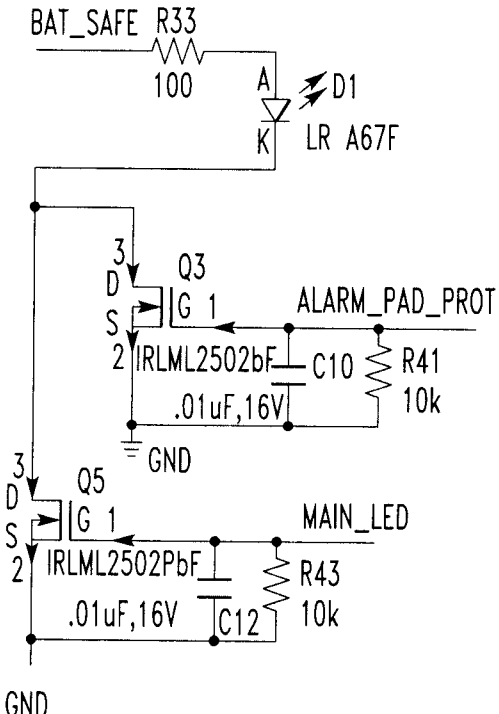


FIG.26C

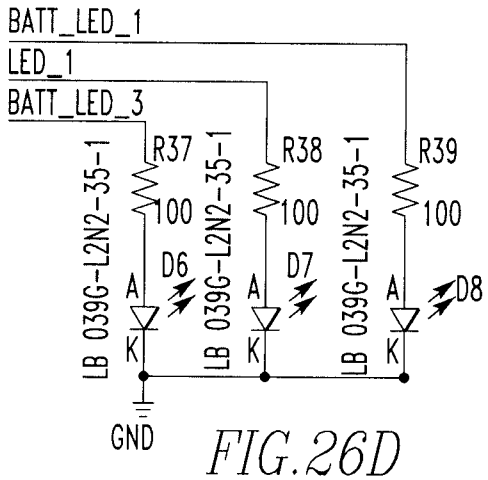


FIG.26D

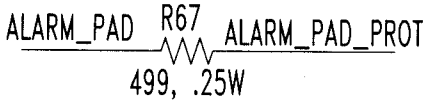


FIG.26E

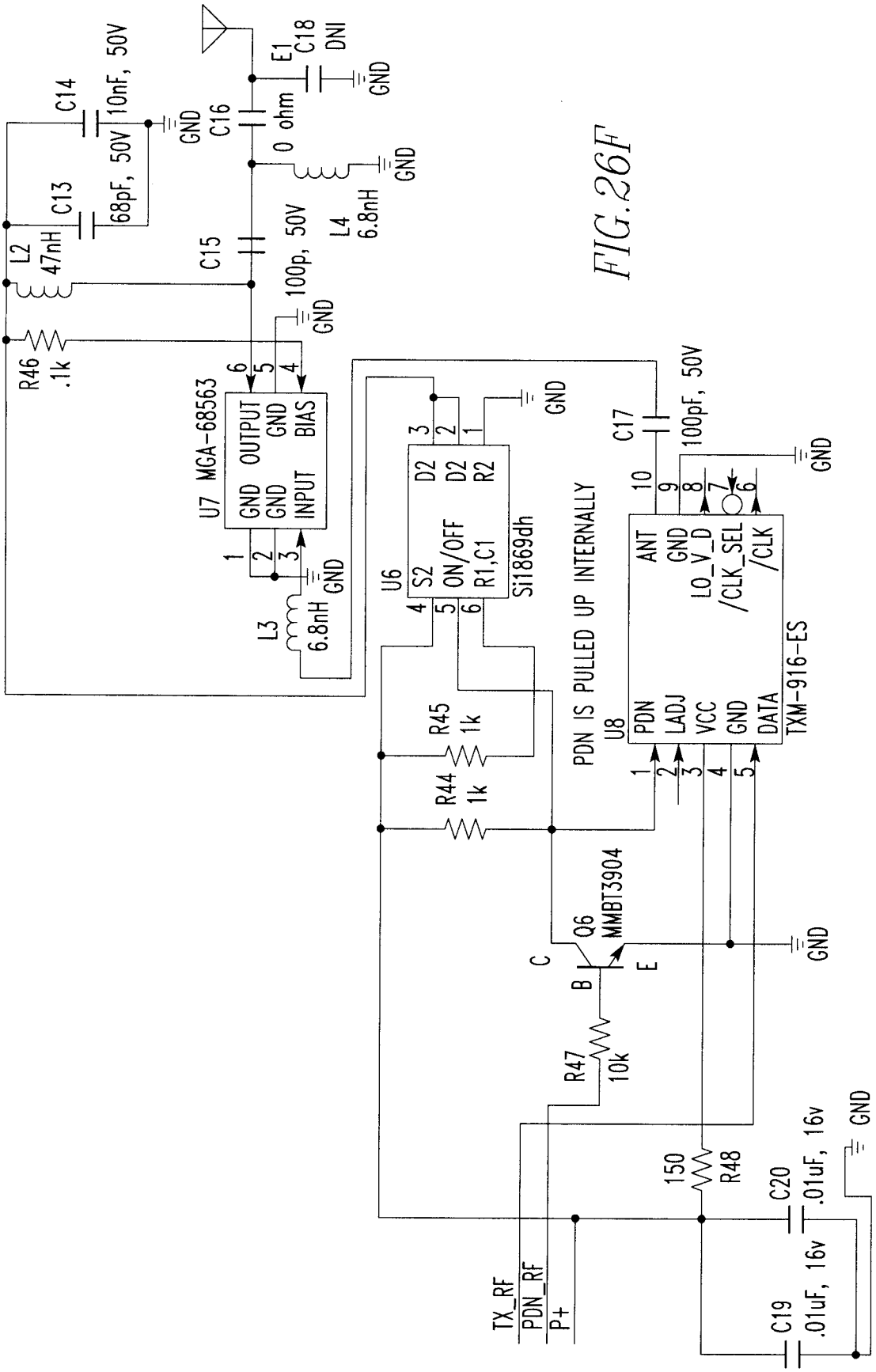

C14
10nF, 50V
C13
68pF, 50V
L2
47nH
R46
.1k
GND
C16
0 ohm
E1
C18
DNI
L4
6.8nH
C15
100p, 50V
U7 MGA-68563
GND OUTPUT GND BIAS
GND GND INPUT
L3
6.8nH
U6
S2 ON/OFF R1,C1 Si1869dh
D2 D2 R2
R45
1k
R44
1k
PDN IS PULLED UP INTERNALLY
C17
100pF, 50V
U8
PDN LADJ VCC GND DATA
ANT GND LO_V_D /CLK_SEL /CLK
TXM-916-ES
Q6
MMBT3904
C B E
R47
10k
150
R48
C20
.01uF, 16v
C19
.01uF, 16v
TX_RF
PDN_RF
P+

FIG.26F

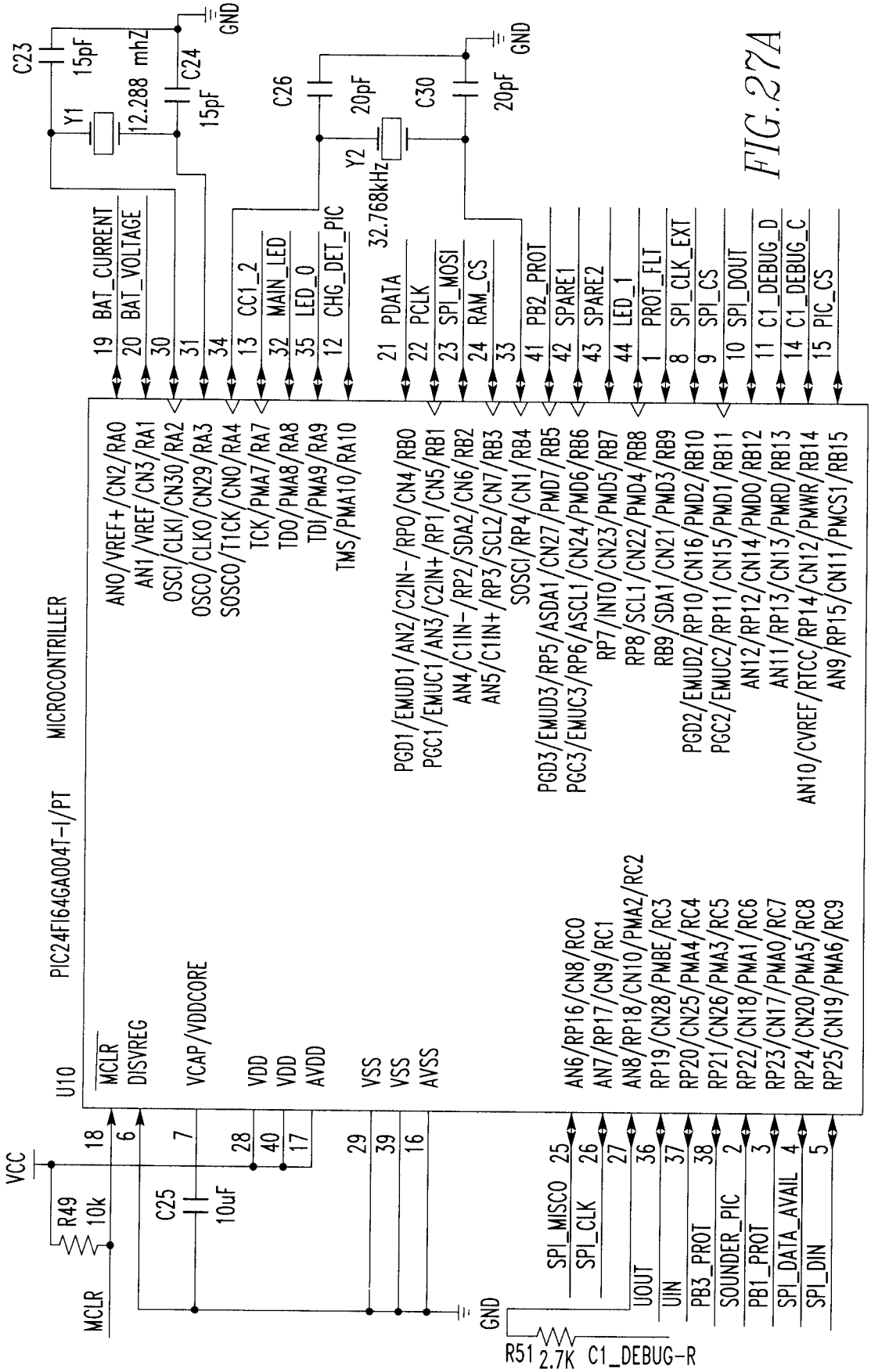

U10
PIC24FI64GA004T-I/PT
MICROCONTRILLER
MCLR
DISVREG
VCAP/VDDCORE
VDD
VDD
AVDD
VSS
VSS
AVSS
AN0/VREF+/CN2/RA0
AN1/VREF-/CN3/RA1
OSCI/CLKI/CN30/RA2
OSCO/CLKO/CN29/RA3
SOSCO/T1CK/CN0/RA4
TCK/PMA7/RA7
TDO/PMA8/RA8
TDI/PMA9/RA9
TMS/PMA10/RA10
PGD1/EMUD1/AN2/C2IN-/RP0/CN4/RB0
PGC1/EMUC1/AN3/C2IN+/RP1/CN5/RB1
AN4/C1IN-/RP2/SDA2/CN6/RB2
AN5/C1IN+/RP3/SCL2/CN7/RB3
SOSCI/RP4/CN1/RB4
PGD3/EMUD3/RP5/ASDA1/CN27/PMD7/RB5
PGC3/EMUC3/RP6/ASCL1/CN24/PMD6/RB6
RP7/INT0/CN23/PMD5/RB7
RP8/SCL1/CN22/PMD4/RB8
RB9/SDA1/CN21/PMD3/RB9
PGD2/EMUD2/RP10/CN16/PMD2/RB10
PGC2/EMUC2/RP11/CN15/PMD1/RB11
AN12/RP12/CN14/PMD0/RB12
AN11/RP13/CN13/PMRD/RB13
AN10/CVREF/RTCC/RP14/CN12/PMWR/RB14
AN9/RP15/CN11/PMCS1/RB15
AN6/RP16/CN8/RC0
AN7/RP17/CN9/RC1
AN8/RP18/CN10/PMA2/RC2
RP19/CN28/PMBE/RC3
RP20/CN25/PMA4/RC4
RP21/CN26/PMA3/RC5
RP22/CN18/PMA1/RC6
RP23/CN17/PMA0/RC7
RP24/CN20/PMA5/RC8
RP25/CN19/PMA6/RC9
19 BAT_CURRENT
20 BAT_VOLTAGE
30
31
34
13 CC1_2
32 MAIN_LED
35 LED_0
12 CHG_DET_PIC
21 PDATA
22 PCLK
23 SPI_MOSI
24 RAM_CS
33
41 PB2_PROT
42 SPARE1
43 SPARE2
44 LED_1
1 PROT_FLT
8 SPI_CLK_EXT
9 SPI_CS
10 SPI_DOUT
11 C1_DEBUG_D
14 C1_DEBUG_C
15 PIC_CS
SPI_MISO 25
SPI_CLK 26
27
UOUT 36
UIN 37
PB3_PROT 38
SOUNDER_PIC 2
PB1_PROT 3
SPI_DATA_AVAIL 4
SPI_DIN 5
C23 15pF
Y1 12.288 mhZ
C24 15pF
GND
C26 20pF
Y2 32.768kHz
C30 20pF
GND
VCC
R49 10k
MCLR
18
6
7
C25 10uF
28
40
17
29
39
16
GND
R51 2.7K C1_DEBUG-R

FIG.27A

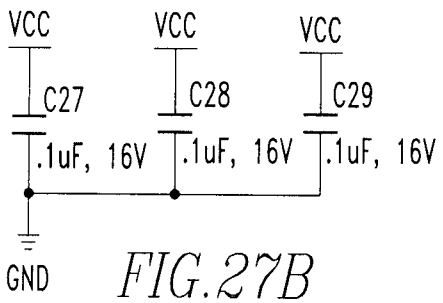


FIG.27B

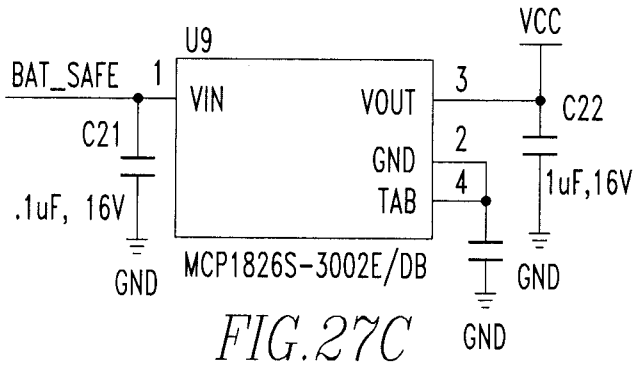


FIG.27C

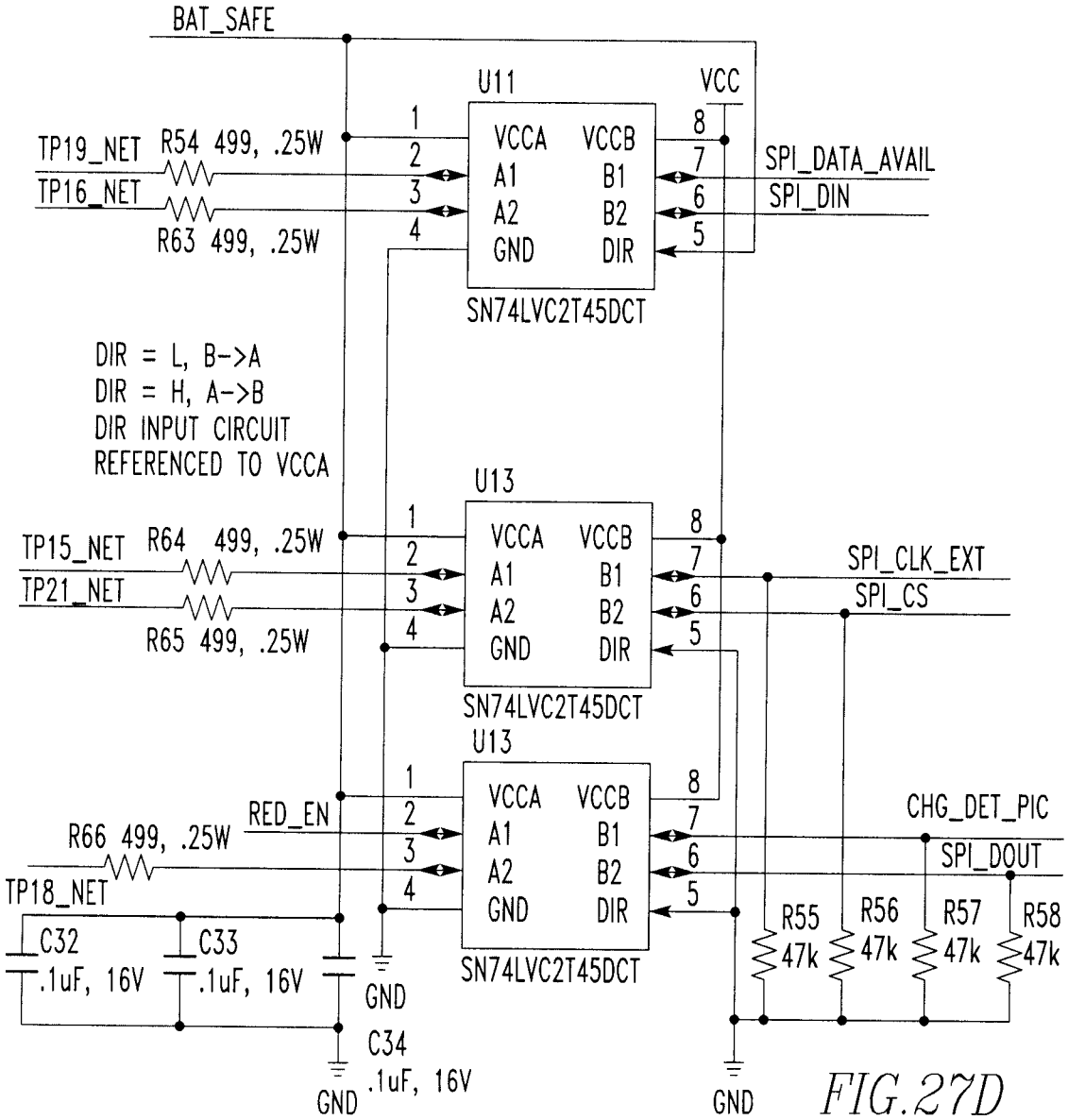


FIG.27D

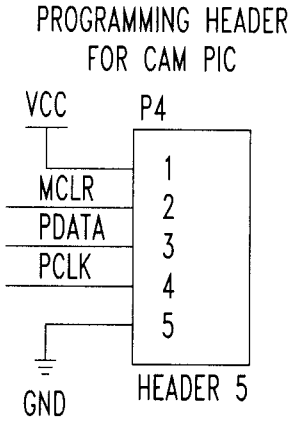


FIG.27E

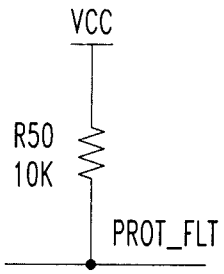


FIG.27F

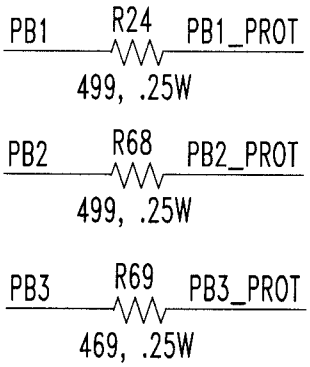


FIG.27G

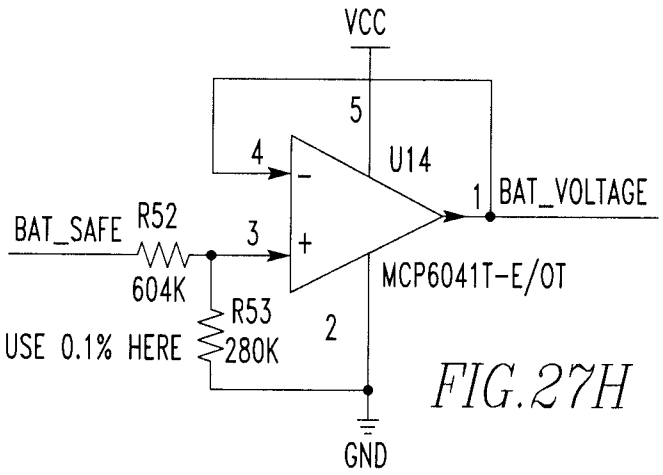


FIG.27H

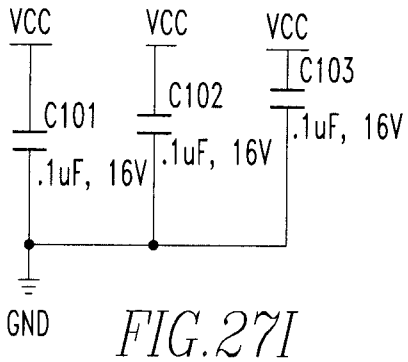


FIG.27I

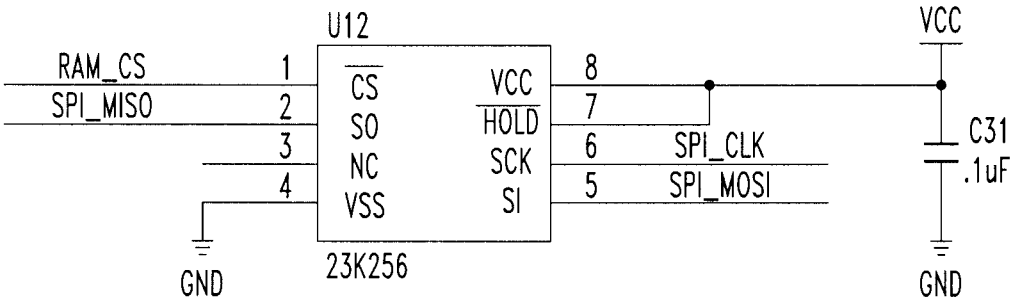


FIG.27J

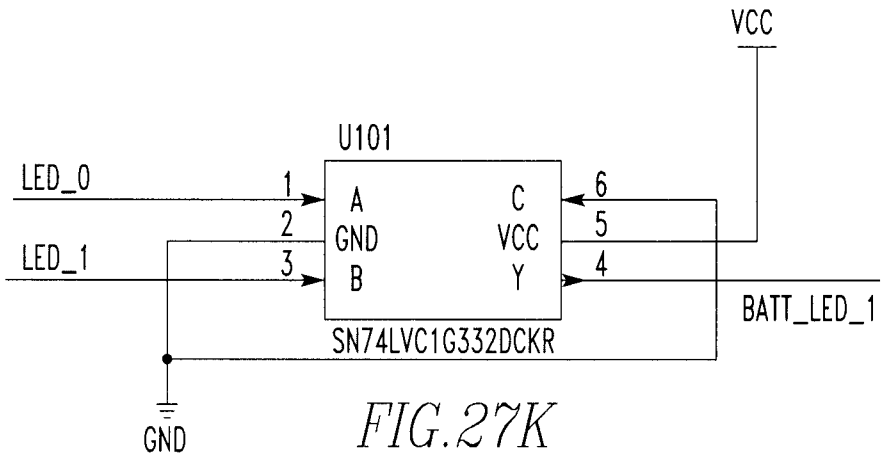


FIG.27K

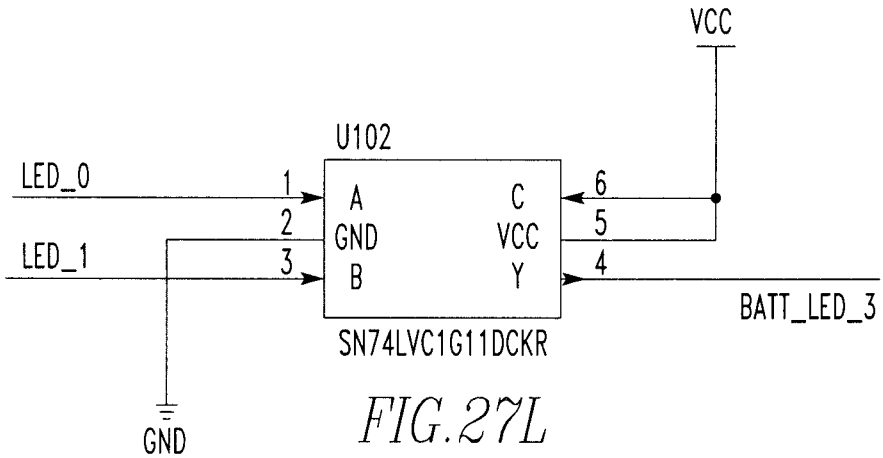
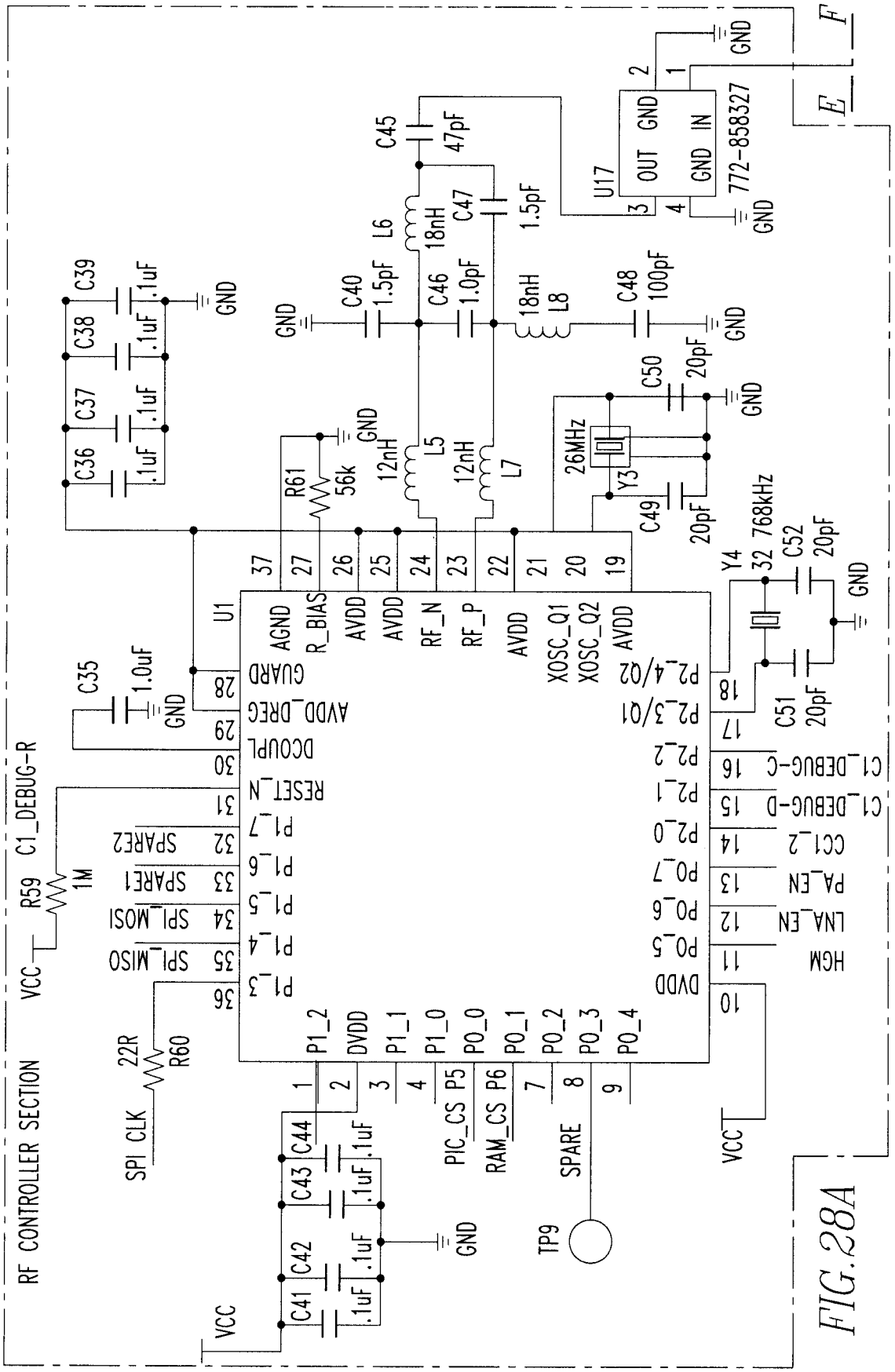


FIG.27L


RF CONTROLLER SECTION
U1
AGND
R_BIAS
AVDD
AVDD
RF_N
RF_P
AVDD
XOSC_Q1
XOSC_Q2
AVDD
GUARD
AVDD_DREG
DCOUPL
RESET_N
P1_7
P1_6
P1_5
P1_4
P1_3
P1_2
DVDD
P1_1
P1_0
P0_0
P0_1
P0_2
P0_3
P0_4
P2_4/Q2
P2_3/Q1
P2_2
P2_1
P2_0
P0_7
P0_6
P0_5
DVDD
SPARE2
SPARE1
SPI_MOSI
SPI_MISO
PIC_CS
RAM_CS
SPARE
C1_DEBUG-C
C1_DEBUG-D
CC1_2
PA_EN
LNA_EN
HGM
C35 1.0uF
C36 .1uF
C37 .1uF
C38 .1uF
C39 .1uF
C40 1.5pF
C41 .1uF
C42 .1uF
C43 .1uF
C44 .1uF
C45 47pF
C46 1.0pF
C47 1.5pF
C48 100pF
C49 20pF
C50 20pF
C51 20pF
C52 20pF
L5 12nH
L6 18nH
L7 12nH
L8 18nH
R59 1M
R60 22R
R61 56k
Y3 26MHz
Y4 32.768kHz
U17 772-858327
OUT GND
GND IN
VCC
GND
SPI CLK
TP9
E
F
FIG.28A

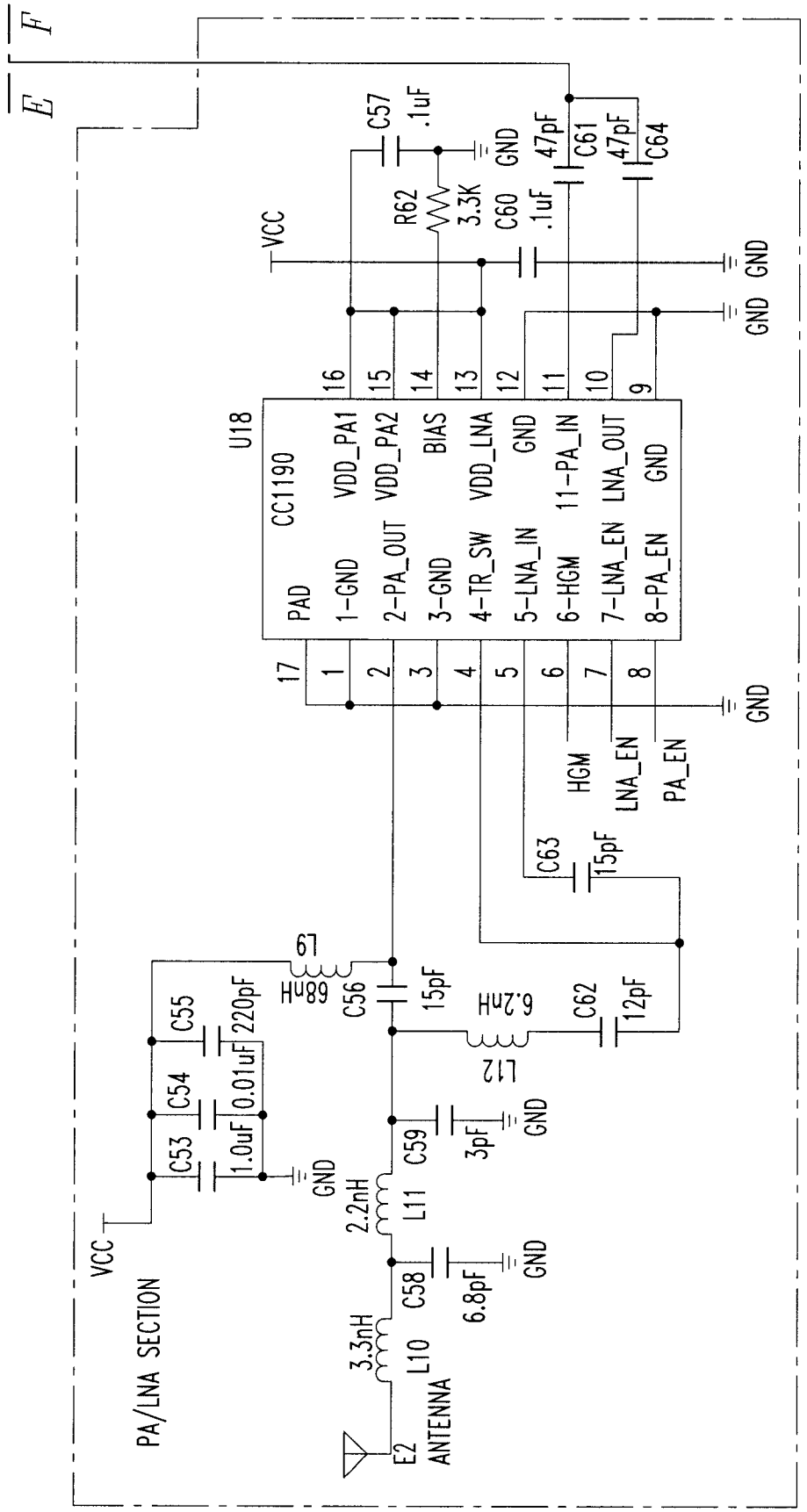

E
F
U18
CC1190
PAD
1-GND
2-PA_OUT
3-GND
4-TR_SW
5-LNA_IN
6-HGM
7-LNA_EN
8-PA_EN
VDD_PA1
VDD_PA2
BIAS
VDD_LNA
GND
11-PA_IN
LNA_OUT
GND
VCC
C57 .1uF
R62 3.3K
C60 .1uF
C61 47pF
C64 47pF
GND
HGM
LNA_EN
PA_EN
C63 15pF
C62 12pF
L12 6.2nH
L9 68nH
C56 15pF
C55 220pF
C54 0.01uF
C53 1.0uF
C59 3pF
L11 2.2nH
C58 6.8pF
L10 3.3nH
E2
ANTENNA
PA/LNA SECTION

FIG.28B

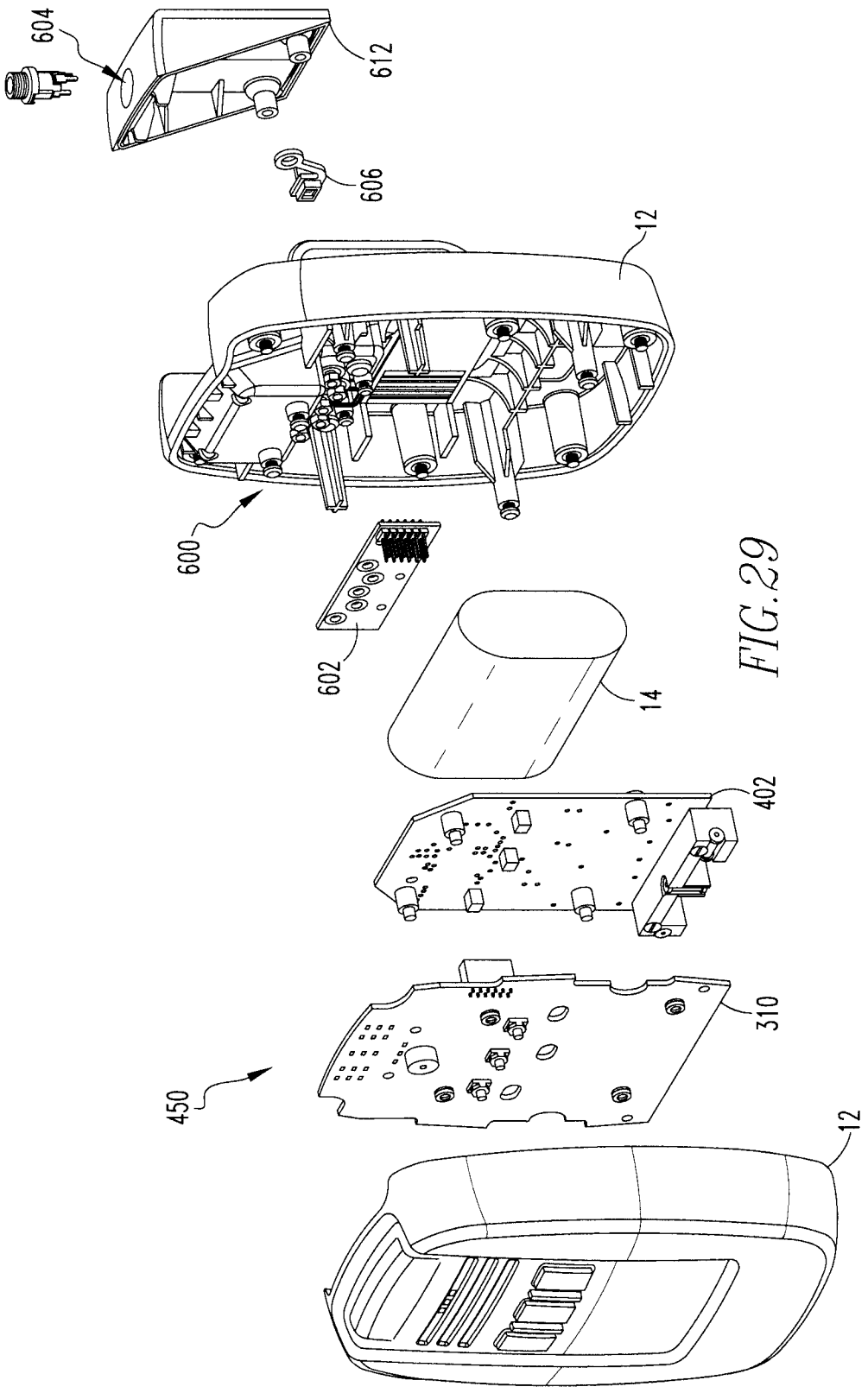


FIG. 29

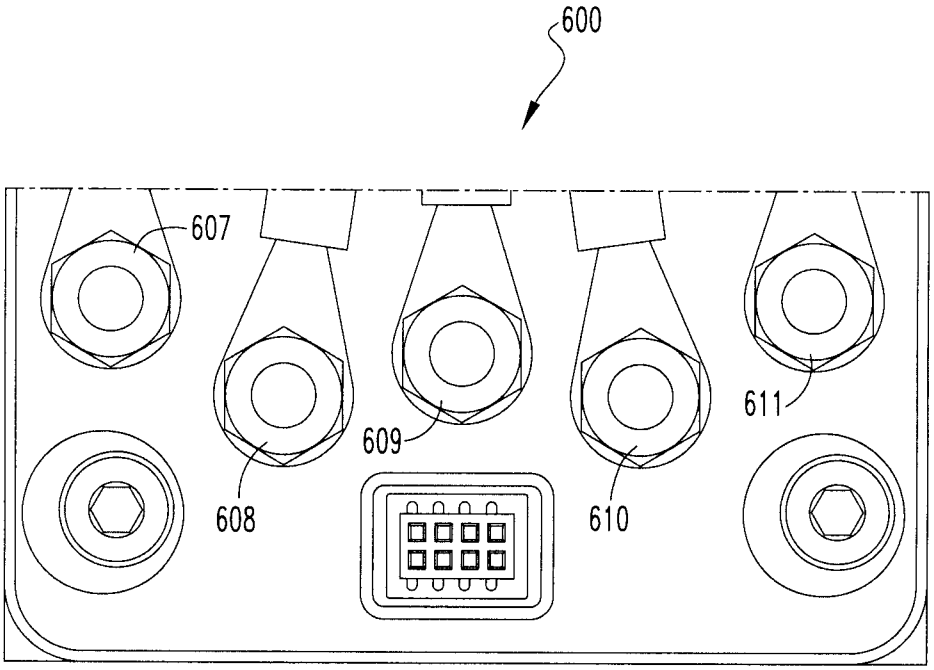
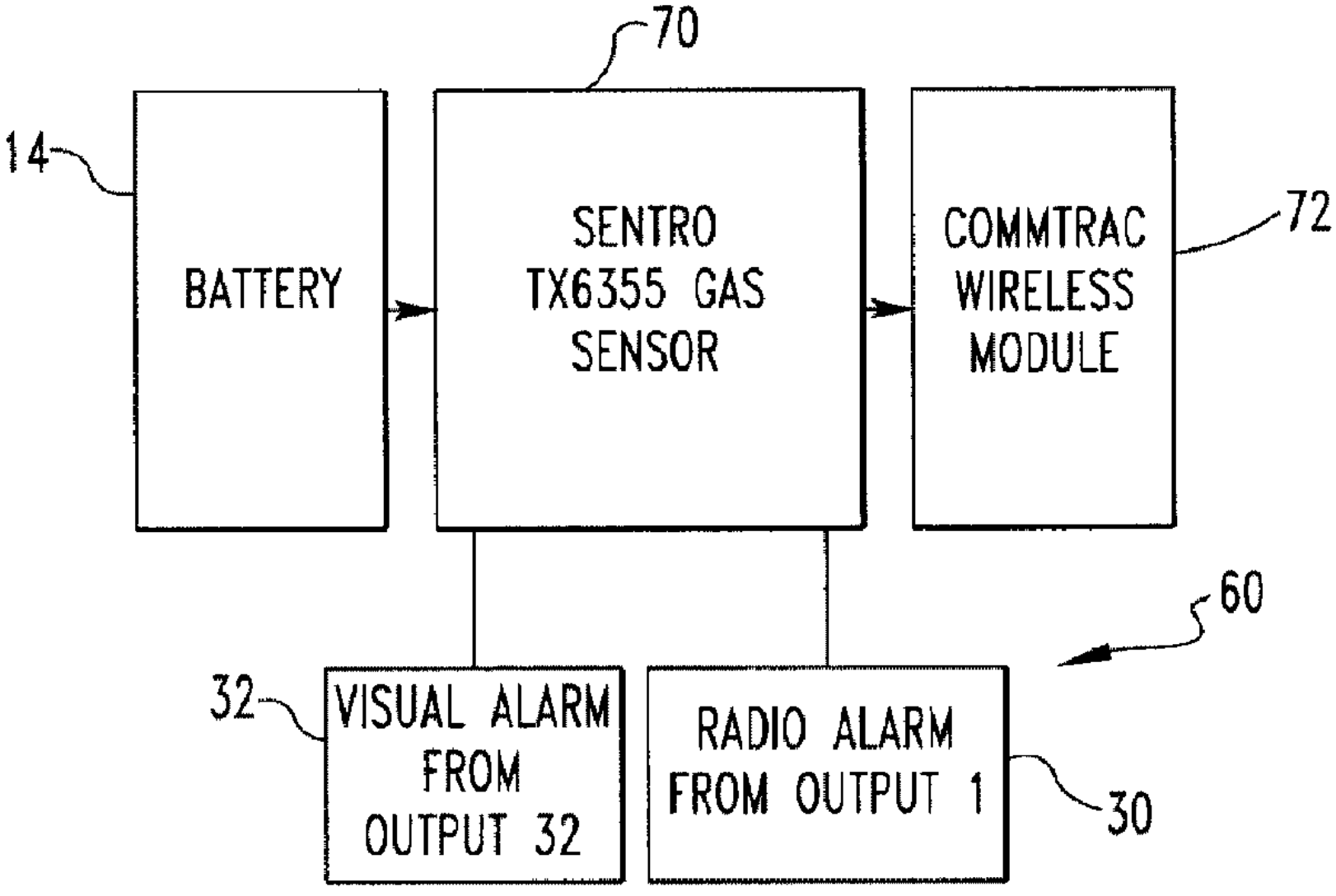


FIG.30


70
14
BATTERY
SENTRO
TX6355 GAS
SENSOR
COMMTRAC
WIRELESS
MODULE
72
60
32
VISUAL ALARM
FROM
OUTPUT 32
RADIO ALARM
FROM OUTPUT 1
30