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(54) METHOD AND APPARATUS FOR REMOTE BLOOD ALCOHOL MONITORING

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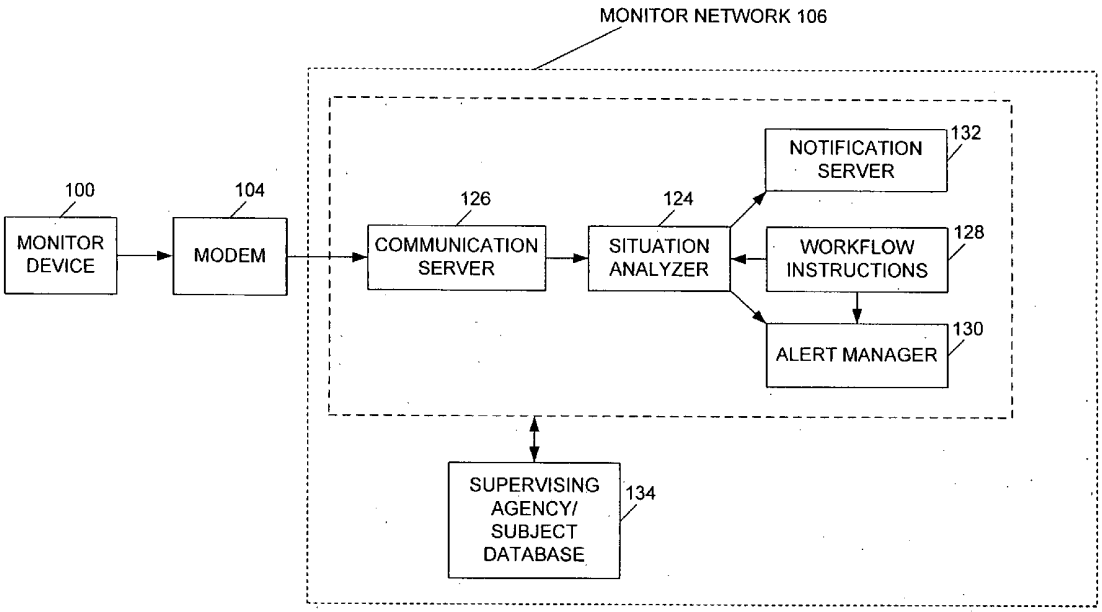
G08B 23/00 (2006.01)

(52) **U.S. Cl.** **340/573.1**

(57) **ABSTRACT**

A tamper proof transdermal alcohol content monitoring device is made up of analog and digital sides which are securely attached to the human subject to be monitored. The analog side has a sampling circuit which draws a measured insensible skin perspiration sample from the skin of the subject and measured with an electrochemical fuel cell. A distance measurement of the device from the skin of the subject and temperature of the sample are monitored along with the transdermal alcohol content, and converted to digital signals which are transmitted to a modem when the monitor is in proximity to the modem. The signals are stored in the modem and uploaded to a central monitoring station. Automatic alerts may be sent from the central monitoring station to a supervising agency. The supervising agency may also access the information through secured dedicated web-sites via the Internet.



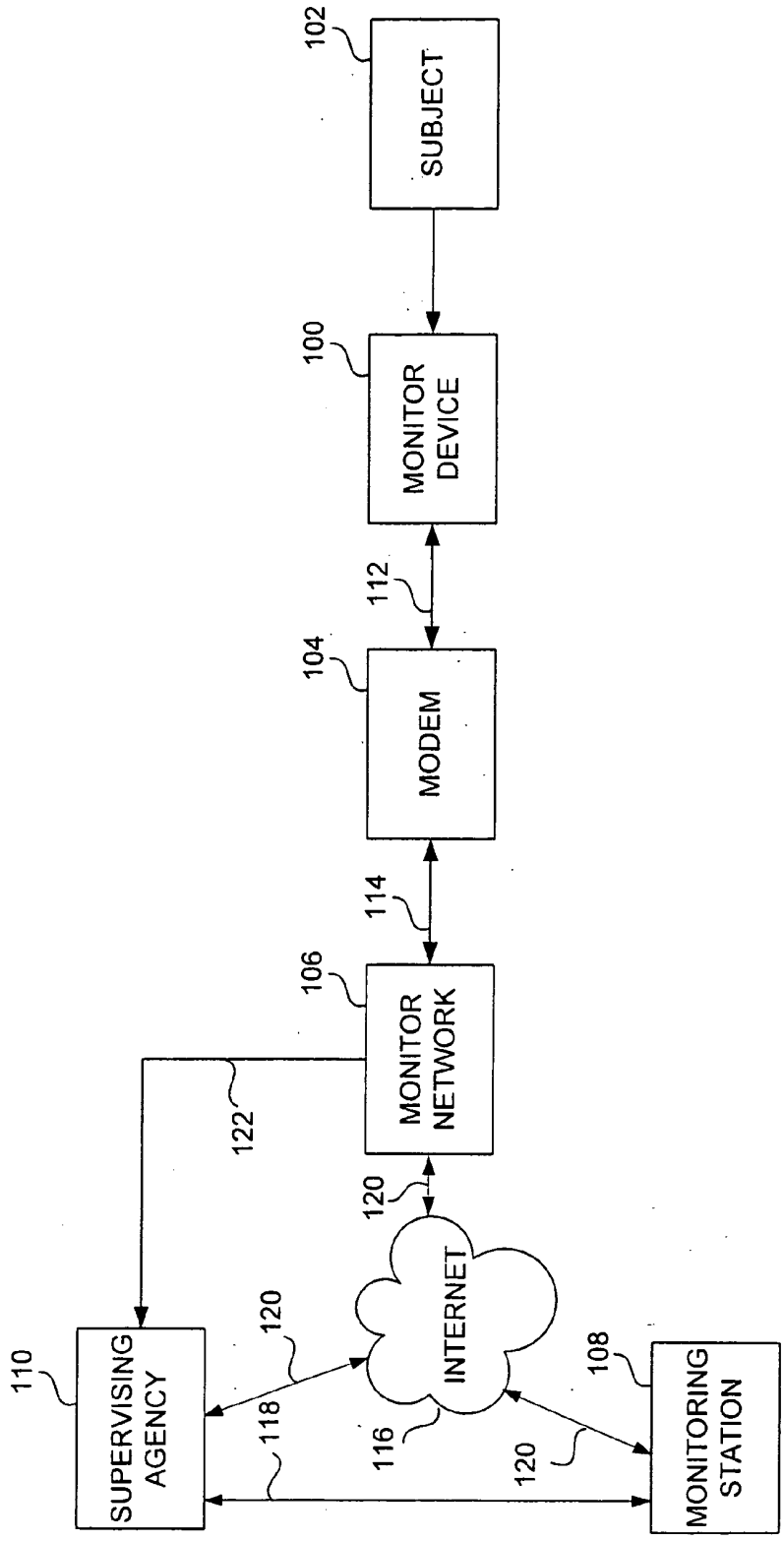

102
SUBJECT
100
MONITOR DEVICE
112
104
MODEM
114
106
MONITOR NETWORK
122
120
INTERNET
110
SUPERVISING AGENCY
120
118
116
120
108
MONITORING STATION

FIG. 1

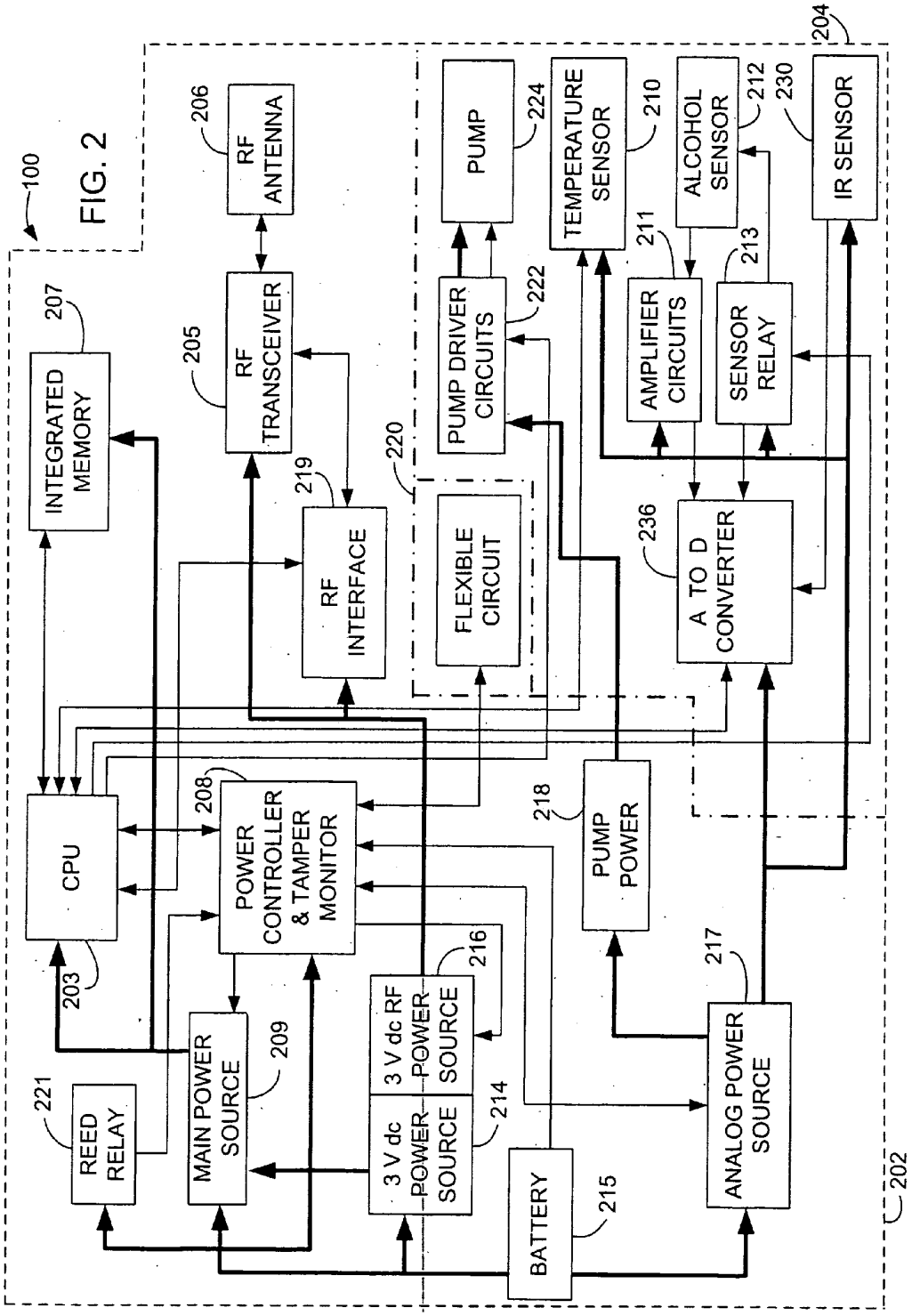


FIG. 2
100
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
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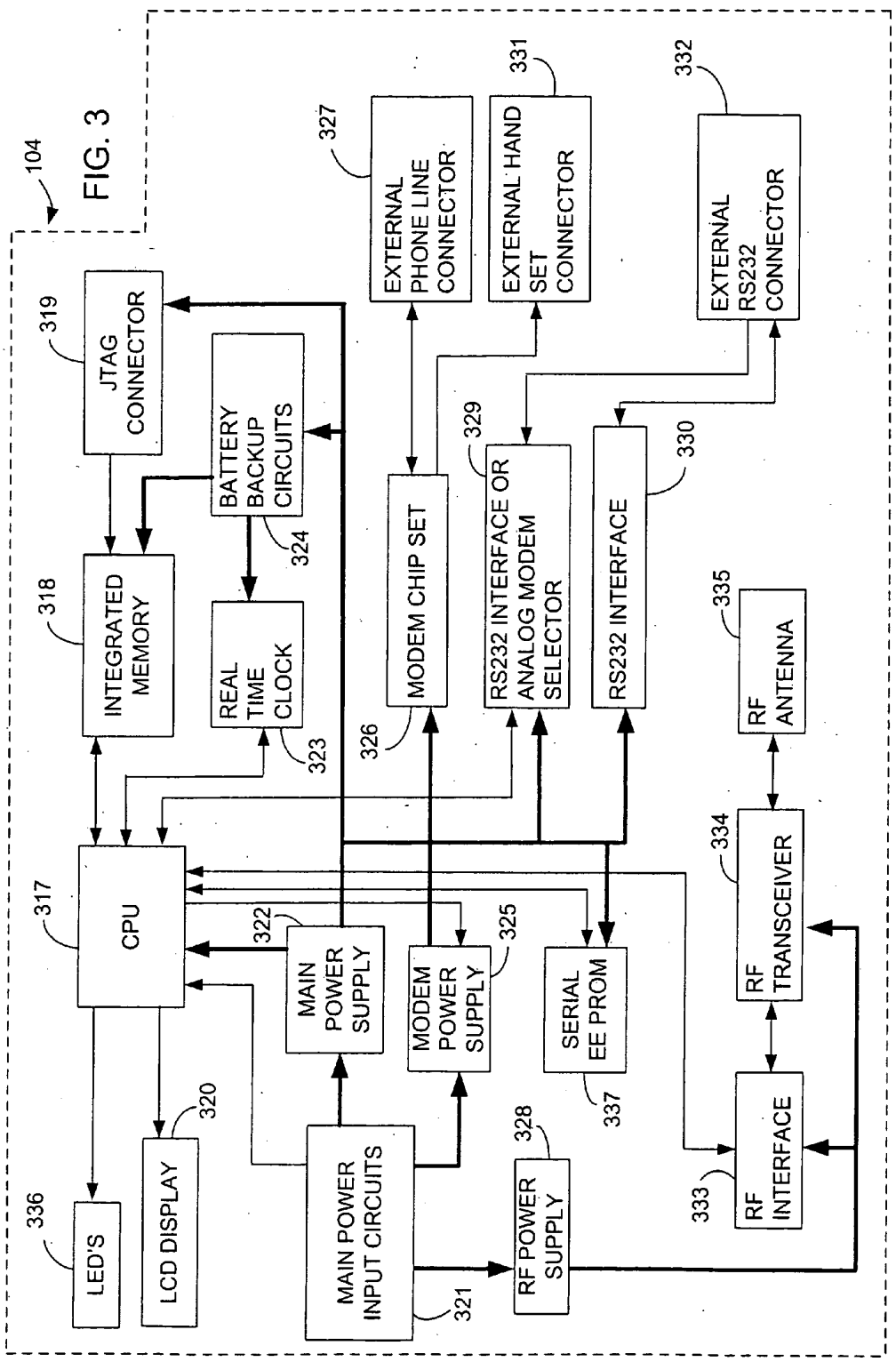
218
219
220
221
222
224
230
236
CPU
INTEGRATED MEMORY
RF ANTENNA
RF TRANSCEIVER
RF INTERFACE
POWER CONTROLLER & TAMPER MONITOR
MAIN POWER SOURCE
REED RELAY
3 V dc RF POWER SOURCE
3 V dc POWER SOURCE
BATTERY
FLEXIBLE CIRCUIT
PUMP DRIVER CIRCUITS
PUMP
PUMP POWER
TEMPERATURE SENSOR
AMPLIFIER CIRCUITS
ALCOHOL SENSOR
SENSOR RELAY
IR SENSOR
A TO D CONVERTER
ANALOG POWER SOURCE


104
FIG. 3
JTAG CONNECTOR
319
BATTERY BACKUP CIRCUITS
324
INTEGRATED MEMORY
318
REAL TIME CLOCK
323
CPU
317
MAIN POWER SUPPLY
322
MODEM POWER SUPPLY
325
MAIN POWER INPUT CIRCUITS
321
LED'S
336
LCD DISPLAY
320
EXTERNAL PHONE LINE CONNECTOR
327
MODEM CHIP SET
326
EXTERNAL HAND SET CONNECTOR
331
RS232 INTERFACE OR ANALOG MODEM SELECTOR
329
RS232 INTERFACE
330
EXTERNAL RS232 CONNECTOR
332
SERIAL EE PROM
337
RF POWER SUPPLY
328
RF ANTENNA
335
RF TRANSCEIVER
334
RF INTERFACE
333

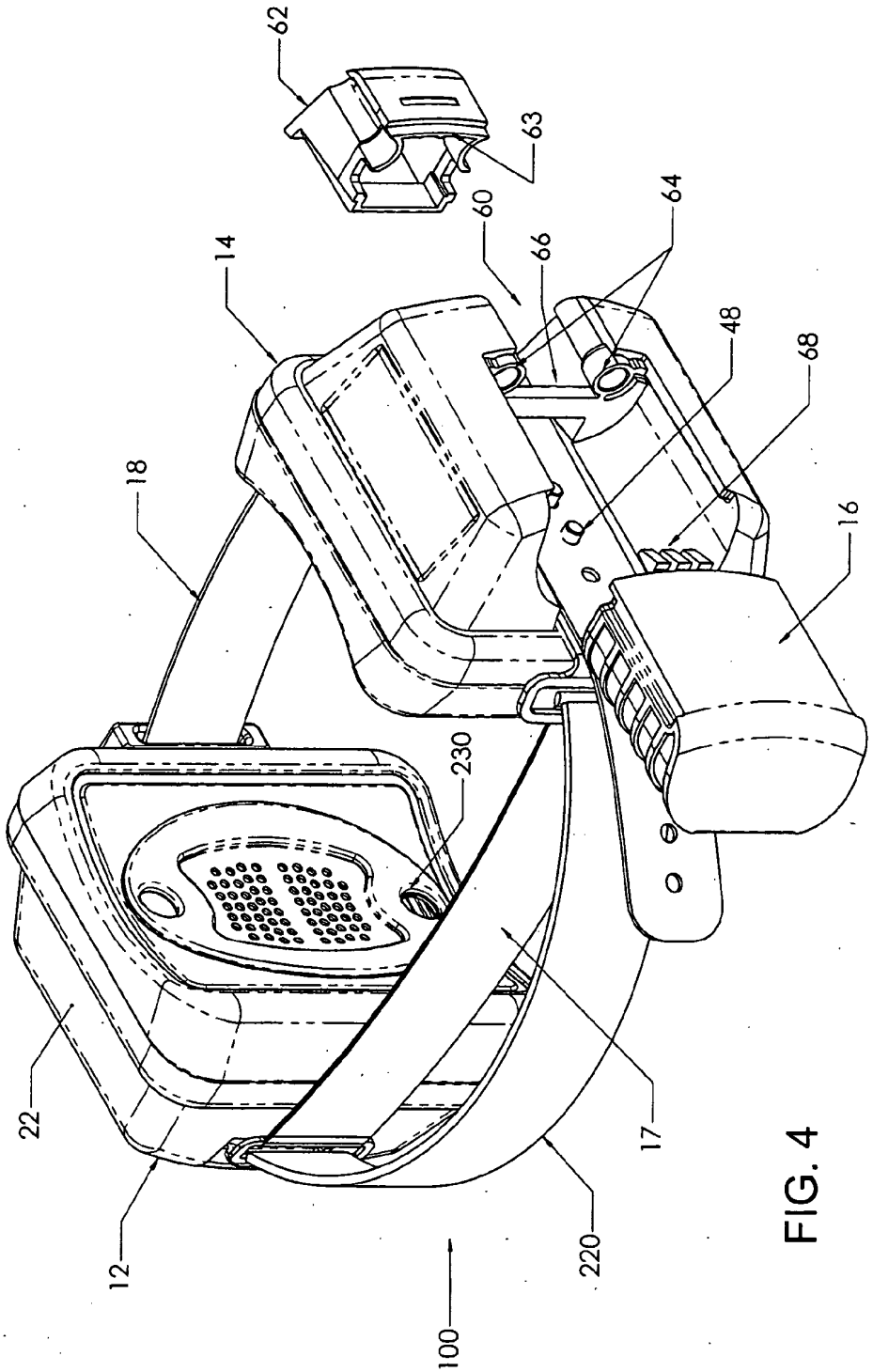
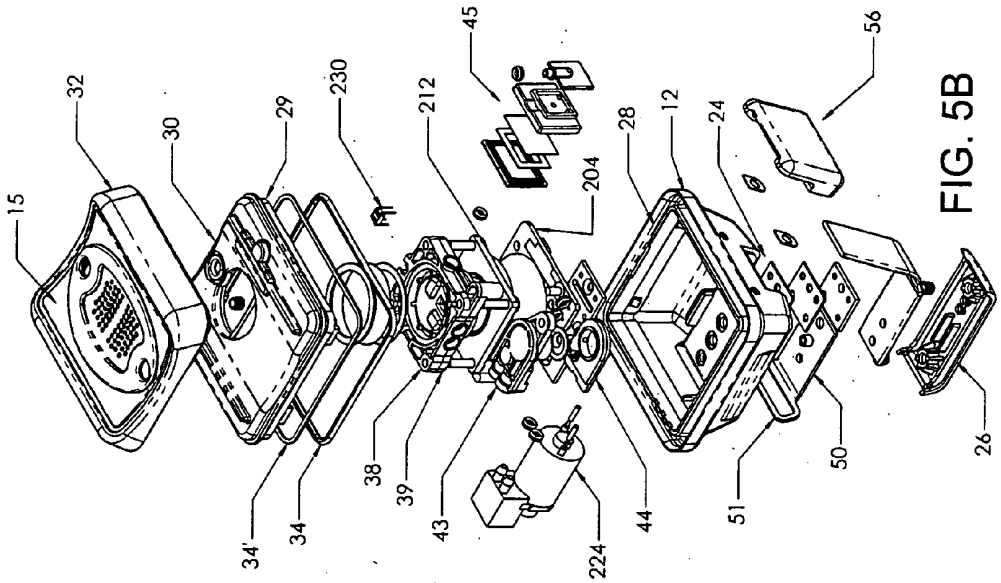


FIG. 4


15
32
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230
212
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204
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34'
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224
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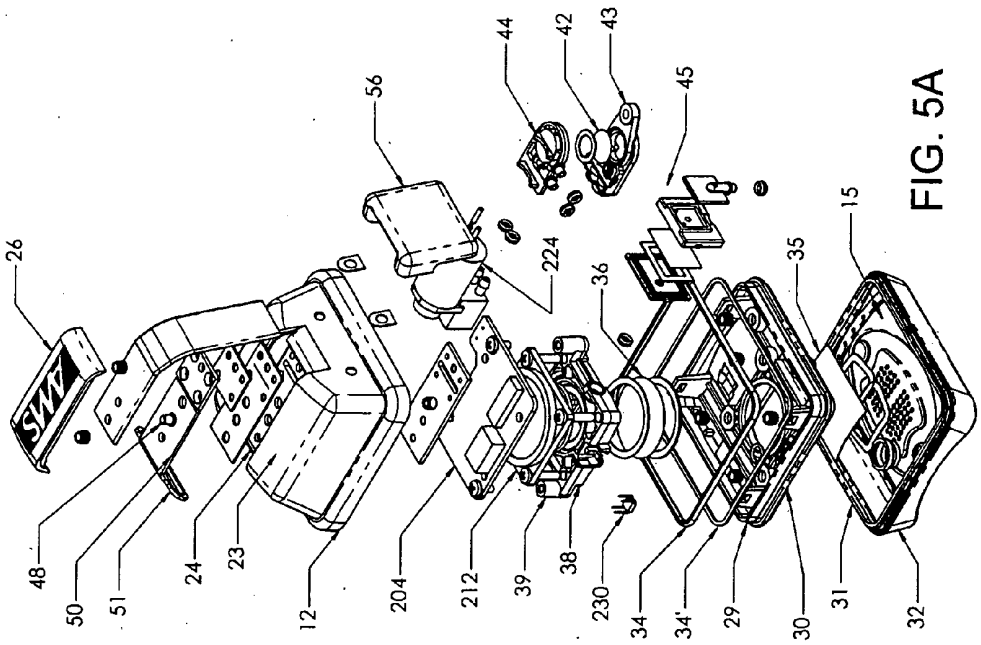
50
26

FIG. 5B


26
56
44
42
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224
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FIG. 5A

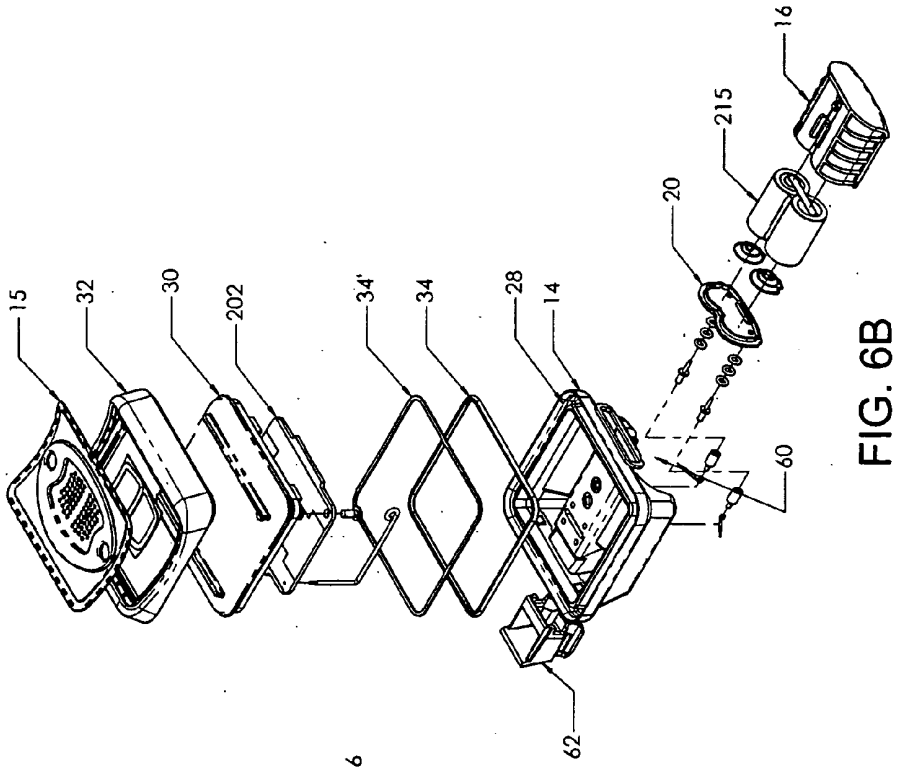
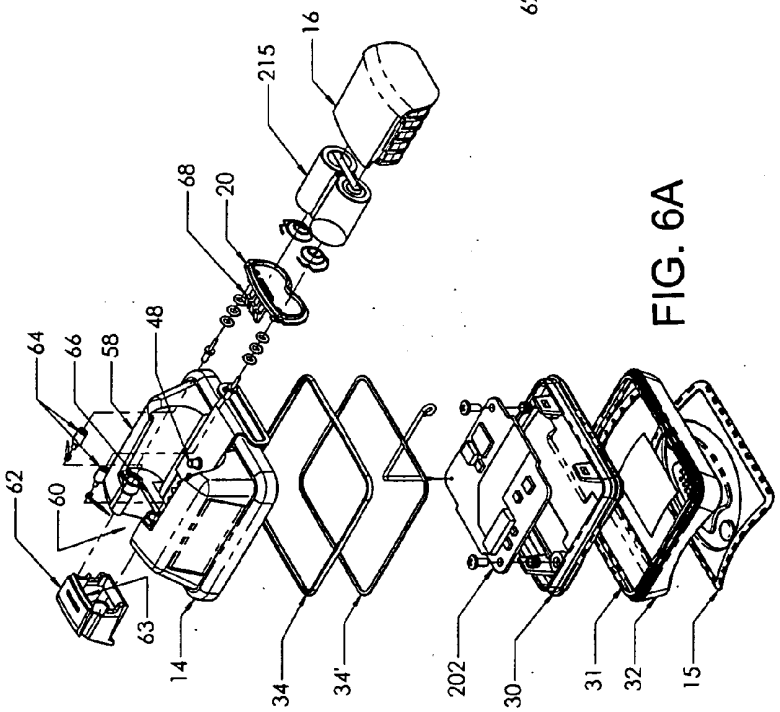

16
215
20
15
32
30
202
34'
34
28
14
60
62

FIG. 6B


16
215
68
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64
66
58
48
62
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63
14
34
34'
202
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32
15

FIG. 6A

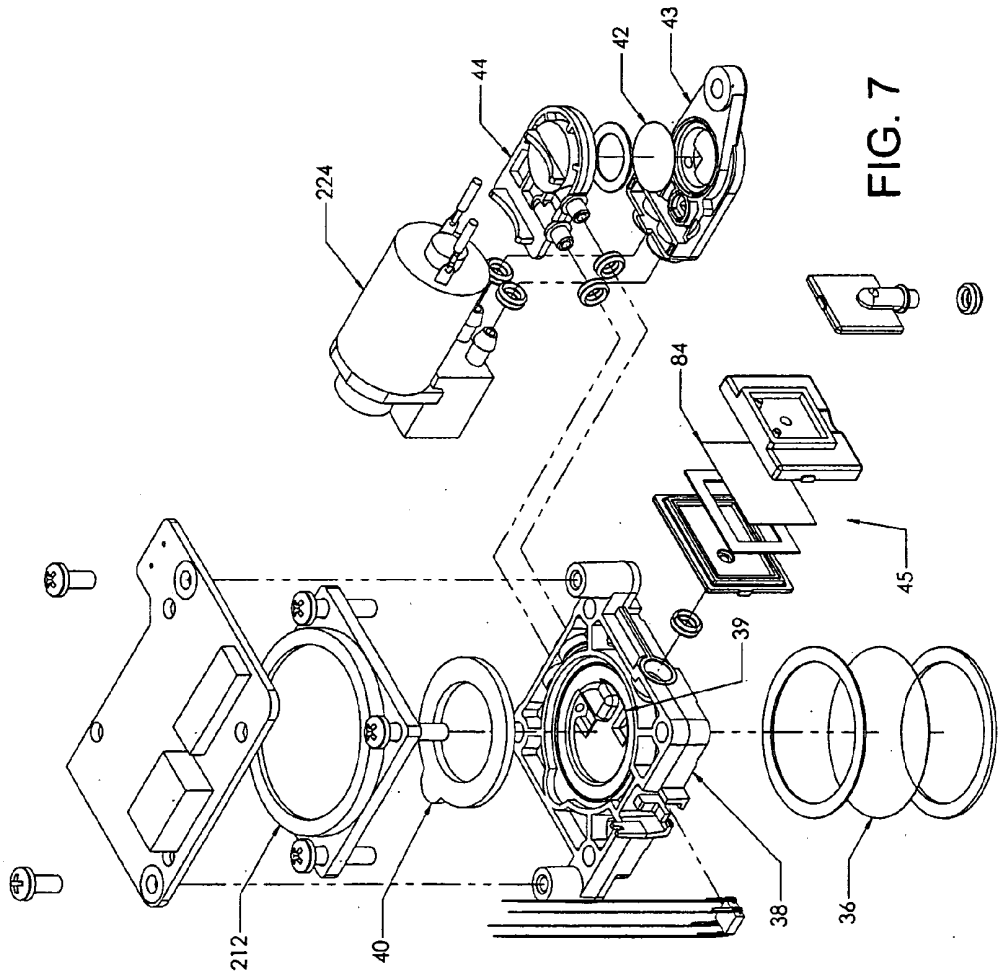

FIG. 7

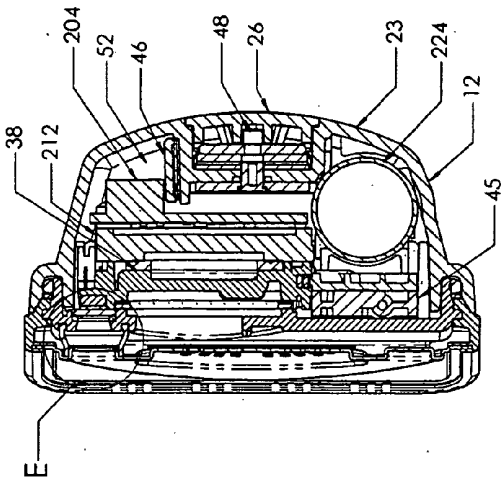

FIG. 8C

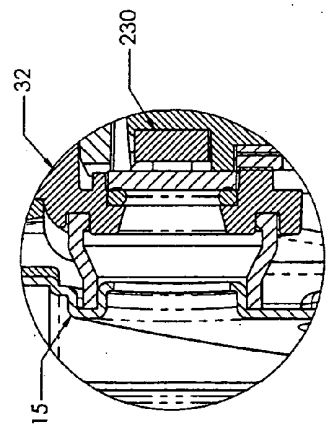

FIG. 8E

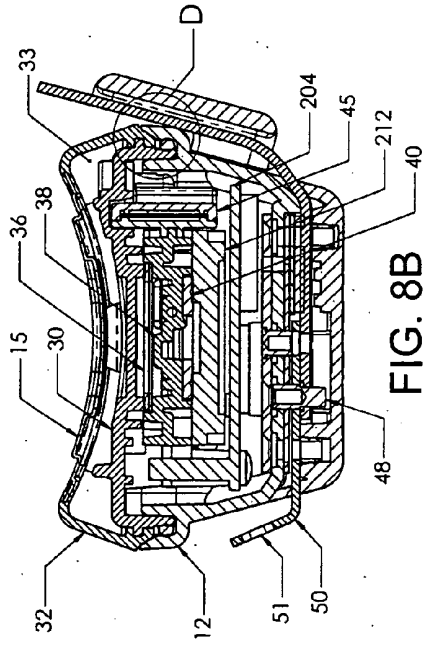

FIG. 8B

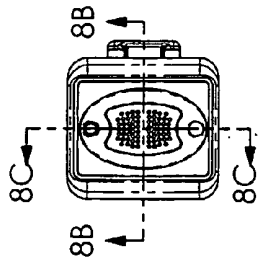

FIG. 8A

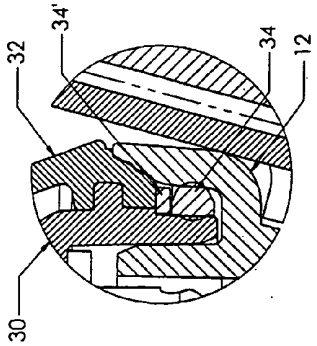

FIG. 8D

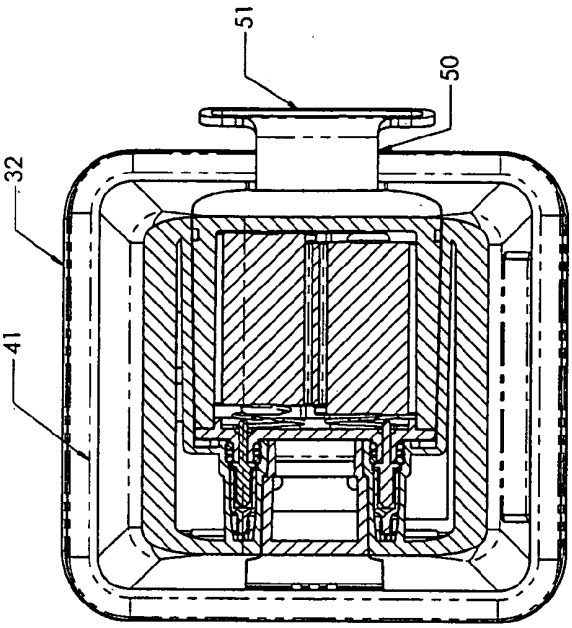

FIG. 9D

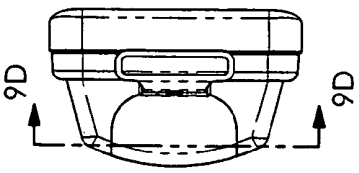

FIG. 9C

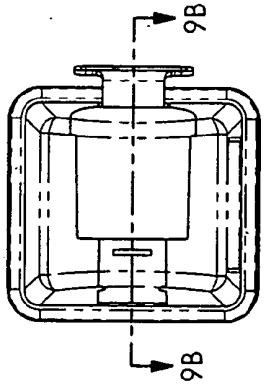

FIG. 9A

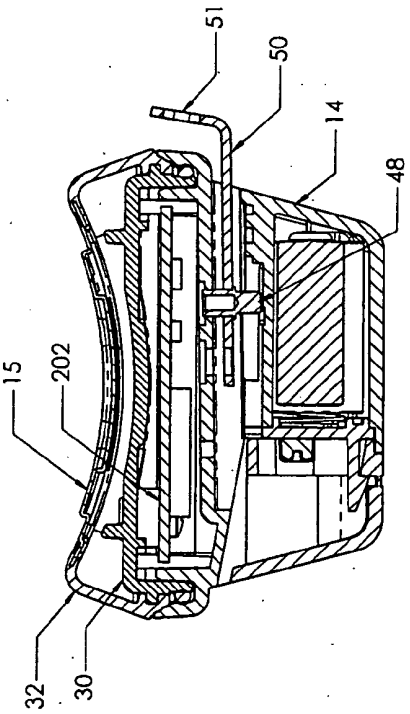

FIG. 9B

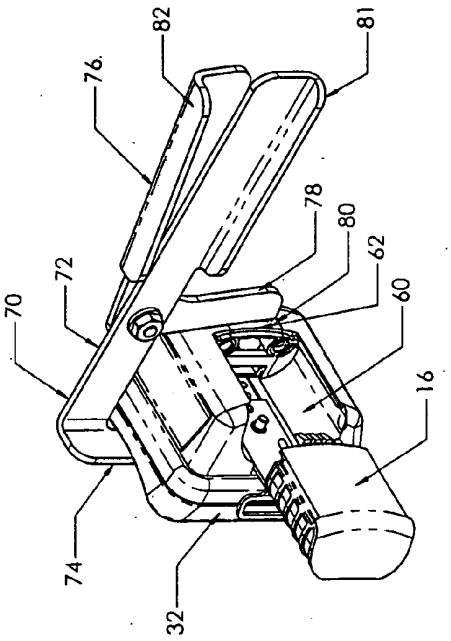

FIG. 12

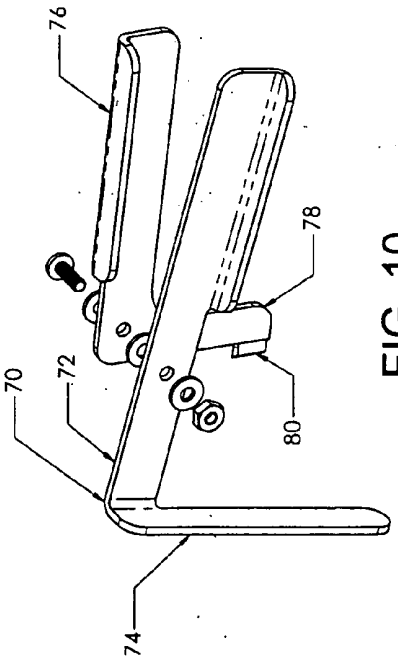

FIG. 10

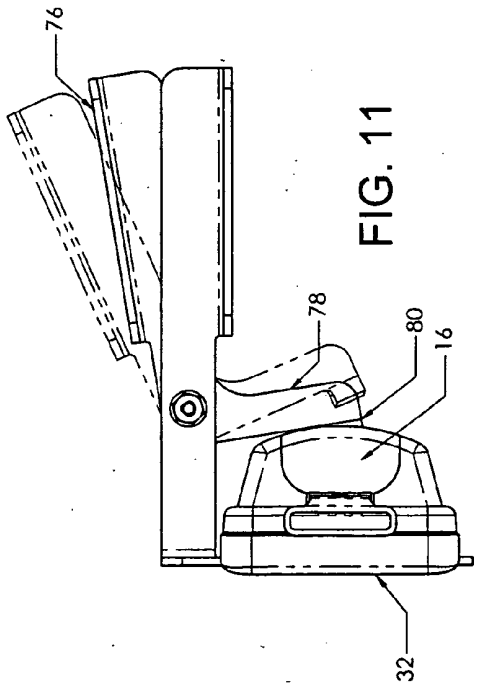

FIG. 11

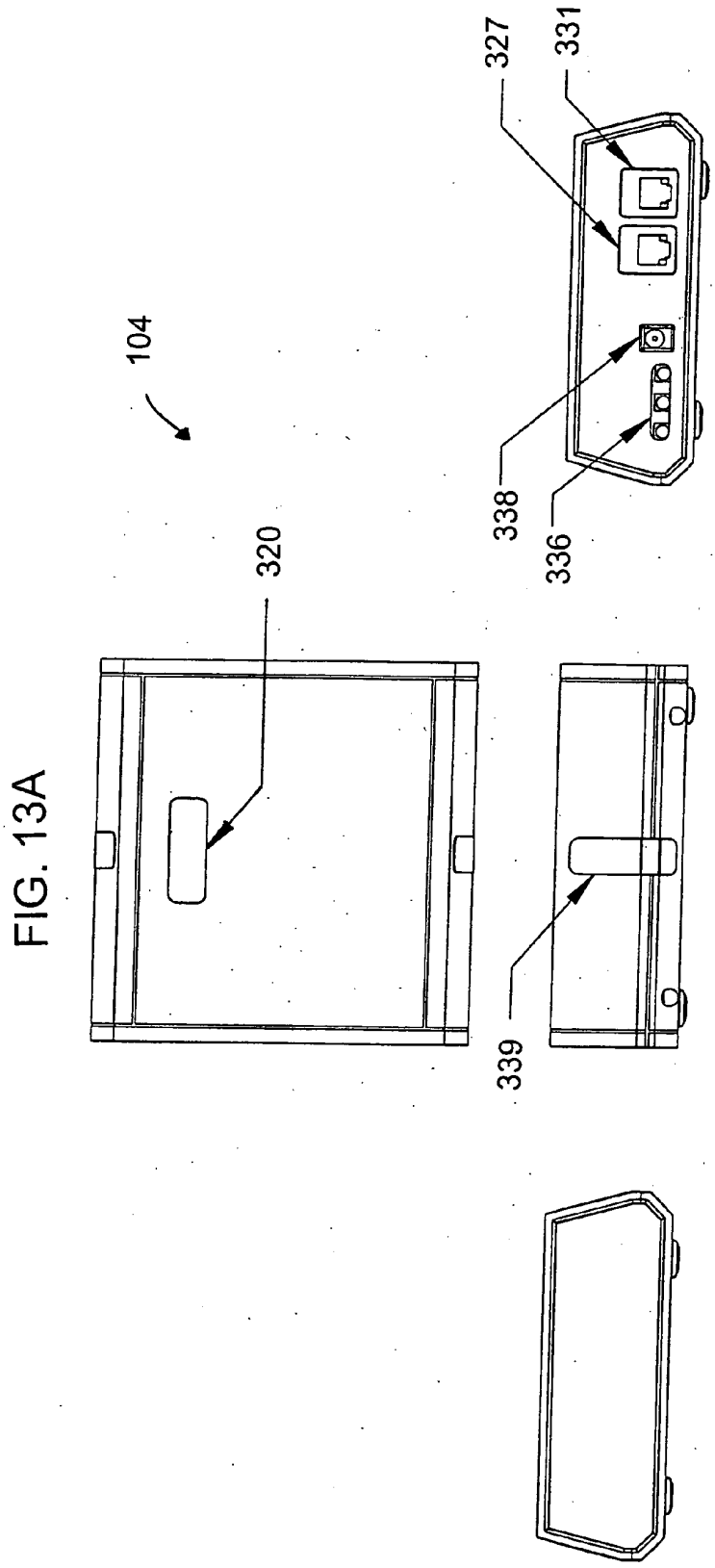

FIG. 13A

FIG. 13C

FIG. 13D

FIG. 13B

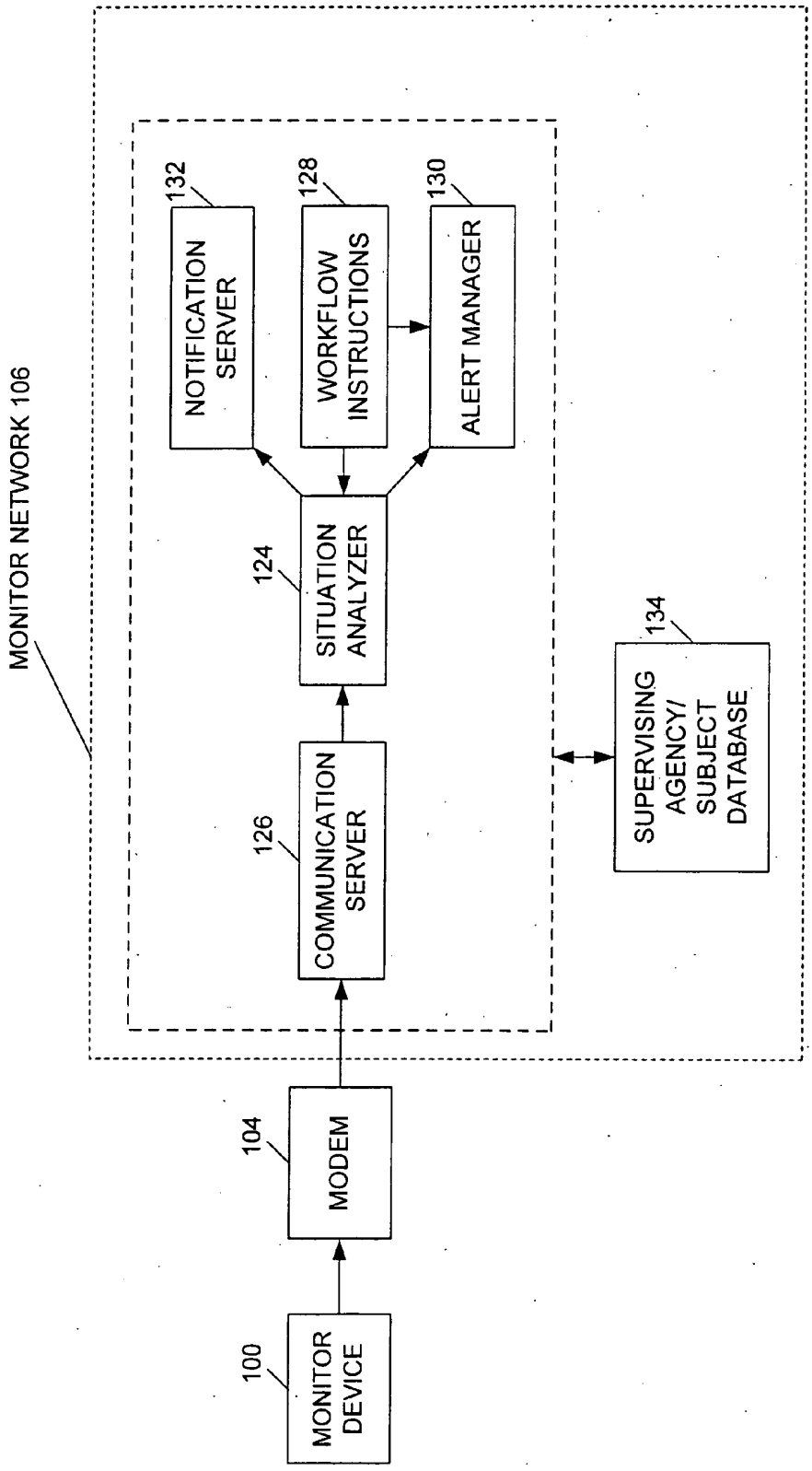
MONITOR NETWORK 106
NOTIFICATION SERVER
132
WORKFLOW INSTRUCTIONS
128
ALERT MANAGER
130
SITUATION ANALYZER
124
COMMUNICATION SERVER
126
SUPERVISING AGENCY/ SUBJECT DATABASE
134
MODEM
104
MONITOR DEVICE
100

FIG. 14

METHOD AND APPARATUS FOR REMOTE BLOOD ALCOHOL MONITORING

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a divisional application of application Ser. No. 10/441,940, filed on May 19, 2005, titled "Method And Apparatus For Remote Blood Alcohol Monitoring" which is incorporated herein by reference in its entirety, and this application is related to a co-pending patent application Ser. No. 10/441,960, filed on May 19, 2005, by Hawthorne et al. titled "BIO-INFORMATION SENSOR MONITORING SYSTEM AND METHOD" which is owned by the same assignee of this invention.

FIELD OF THE INVENTION

[0002] This invention relates to a blood alcohol monitoring system, and more particularly, relates to an improved non-invasive method and apparatus for transdermal monitoring of blood alcohol levels.

BACKGROUND OF THE INVENTION

[0003] Reference is made to U.S. Pat. No. 5,220,919 titled "BLOOD ALCOHOL MONITOR" and European Patent No. EPO 623001B1 titled "BLOOD ALCOHOL MONITOR," both owned by the assignee of this invention and both are hereby incorporated herein by reference.

[0004] Individuals on probation, parole, or in alcohol treatment programs may be prohibited from consuming alcohol, and many federal, state, and local law enforcement agencies require testing to ensure participants in court ordered programs remain alcohol free. In general, present-generation remote alcohol monitoring devices used in probation, parole, and treatment settings are fixed-location breath-testing devices that utilize voice or video identification of the participant. If a subject tests positive for alcohol, the monitoring device then sends a message alerting the monitoring center of a violation by the subject, and the monitoring center then sends an alert message to the subject's supervising agency or dedicated administrator.

[0005] As alcohol is ingested orally, it is absorbed into the body's blood and distributed throughout the body via the circulatory system. Alcohol is eliminated from the body by two mechanisms: metabolism and excretion. Metabolism accounts for the removal of greater than 90% of the alcohol consumed, removing it from the body via oxidation of the ethyl alcohol molecule to carbon dioxide and water primarily in the liver. The remaining alcohol is excreted unchanged wherever water is removed from the body—breath, urine, perspiration, and saliva. Although excretion accounts for less than 10% of the eliminated alcohol, it is significant because unaltered alcohol excretion permits an accurate measurement of alcohol concentration in the body by way of both breath analysis and insensible skin perspiration. Insensible skin perspiration is the vapor that escapes through the skin through sweating. The average person will emit approximately one liter of insensible skin perspiration each day. This perspiration can be used to obtain a transdermal measurement of blood alcohol concentration, referred to as Transdermal Alcohol Concentration ("TAC").

[0006] Transdermal monitoring of blood alcohol levels is accomplished by taking percentage measurements of alcohol contained in the air vapor that is expelled through human skin. A monitoring device is attached to the skin to capture the air and measure the alcohol. There are numerous advantages to transdermal monitoring, as opposed to breath alcohol testing, including, but not limited to, the ability to take readings at any time without the knowledge of the subject, consistent and continuous testing (unlike breath alcohol testing where a subject breathing incorrectly into the testing device can cause inaccurate results), and the ability to convert such readings into electrical signals that can be transmitted to a central monitoring station.

[0007] However, there is a continuing need for a remote alcohol monitoring system which can be conveniently placed on the subject that can carry out TAC measurements at selected time intervals as well as at random times. There is also a need for a remote alcohol monitoring system that will compensate for the effects of temperature changes on TAC readings, is tamper-proof, and virtually impossible for the subject to remove without triggering an alarm. Still further, there is also a need to be able to download the TAC measurements to a monitoring station without requiring any actions on the part of the subject being monitored, eliminating the need for the subject to personally report to a central monitoring station or probation officer, or connect the monitoring device to a telephone line to download and transmit data to a monitoring station. The present invention meets these and other needs in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** shows a block diagram of a preferred form of monitoring system in an embodiment of the present invention.

[0009] **FIG. 2** shows a block diagram of the sensing circuit of the monitor device in an embodiment of the monitoring system of the present invention.

[0010] **FIG. 3** shows a block diagram of the modem in an embodiment of the monitoring system of the present invention.

[0011] **FIG. 4** shows a perspective view of a monitor device assembly in an embodiment of the monitoring system of the present invention.

[0012] **FIG. 5A** shows an exploded perspective view of the analog side of the monitor device shown in **FIG. 4** in an embodiment of the present invention.

[0013] **FIG. 5B** shows another exploded perspective view of the analog side of the monitor device reversed 180° with respect to **FIG. 5A** in an embodiment of the present invention.

[0014] **FIG. 6A** shows an exploded perspective view of the digital side of the monitor device shown in **FIG. 4** in an embodiment of the present invention.

[0015] **FIG. 6B** shows another exploded perspective view of the digital side of the monitor device shown in **FIG. 4** but reversed 180° with respect to that shown in **FIG. 6A** in an embodiment of the present invention.

[0016] **FIG. 7** shows an exploded perspective view of the sampling system in the analog side of the monitor device shown in **FIGS. 5A and 5B** in an embodiment of the present invention.

[0017] **FIG. 8A** shows a front view in elevation of the analog side of the monitor device shown in **FIG. 4** in an embodiment of the present invention.

[0018] **FIG. 8B** shows a cross-sectional view taken about line 8B of **FIG. 8A** in an embodiment of the present invention.

[0019] **FIG. 8C** shows a cross-sectional view taken about line 8C of **FIG. 8A** in an embodiment of the present invention.

[0020] **FIG. 8D** shows a detailed view taken at D of **FIG. 8B** in an embodiment of the present invention.

[0021] **FIG. 8E** shows another detailed view taken at E of **FIG. 8C** in an embodiment of the present invention.

[0022] **FIG. 9A** shows a front view in elevation, of the digital side of the monitor device shown in **FIG. 4** in an embodiment of the present invention.

[0023] **FIG. 9B** shows a cross-sectional view taken about line 9B of **FIG. 9A** in an embodiment of the present invention.

[0024] **FIG. 9C** shows a side view in elevation of the digital side of the monitor device shown in **FIG. 4** in an embodiment of the present invention.

[0025] **FIG. 9D** shows a cross-sectional view taken about line 9D of **FIG. 9C** in an embodiment of the present invention.

[0026] **FIG. 10** shows an exploded, perspective view of the release tool in an embodiment of the present invention.

[0027] **FIG. 11** shows a side view in elevation of the digital side of the monitor device shown in **FIG. 4** and the release tool shown in **FIG. 10** engaging the battery housing of the digital side for removal and replacement in an embodiment of the present invention.

[0028] **FIG. 12** shows a perspective view of the assembly shown in **FIG. 11** after the battery housing has been released by the release tool in an embodiment of the present invention.

[0029] **FIGS. 13A-13D** show a top view and three elevation views of the modem in an embodiment of the present invention.

[0030] **FIG. 14** shows a block diagram of the monitor network in an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0031] Referring now to the Figures, in which like reference numerals refer to structurally and/or functionally similar elements thereof, **FIG. 1** shows by way of illustrative example a system block diagram of the method and apparatus for remote blood alcohol monitoring between a human Subject **102** and a Monitoring Station **108**. The preferred form of Monitor Device **100** weighs about eight ounces, is waterproof, and designed to handle the stress of everyday activity, and can be worn under any conditions, including bathing and swimming. Monitor Device **100** is attached to the Subject **102** being monitored in a manner to be described. Once Monitor Device **100** is in place, it cannot be removed without triggering a tamper alarm, which is recorded in Monitor Device **100**. In addition, there are a number of anti-tamper features designed into Monitor Device **100** to ensure that the TAC readings taken are from Subject **102**, and accurately represent the blood alcohol level of Subject **102** and not some other person. Though this discussion focuses on one Subject **102**, one skilled in the art will recognize that many Monitor Devices **100** may be attached to many Subjects **102** at the same time over a broad geographic area, and all may be monitored by Monitoring Station **108**, which is the intended purpose of the invention. Likewise, there may be multiple Monitor Networks **106** and Monitoring Stations **108** that manage additional Subjects **102** in diverse geographic locations.

[0032] Monitor Device **100** will take TAC readings that are time stamped at predetermined or random intervals twenty-four hours a day, seven days a week, 365 days a year, without active participation by Subject **102**. Testing schedules may range from as frequent as every 30 minutes or as infrequent as once per day. Monitor Device **100** collects TAC data from Subject **102** regardless of the location or activity of Subject **102**. While commuting, at work, at home, during recreation, in the shower, or sleeping, Subject **102** is passively monitored, allowing for continual, effective monitoring while Subject **102** maintains a normal routine. Subject **102** typically does not know when the sampling will occur. Typical existing alcohol monitoring programs that have used other means of testing subjects for alcohol will likely see an increase in the number of program positives utilizing the present invention. This is a result of the continuous monitoring, rather than the pre-arranged, specific testing times typical of current monitoring programs. Continuous monitoring eliminates the ability for subjects to manipulate their drinking patterns to avoid detection.

[0033] TAC readings are taken as scheduled without the participation of Subject **102**, with the data uploaded at scheduled time intervals to Modem **104**, or immediately if a positive drinking event or a tamper is detected and Modem **104** is in range. Typically, Modem **104** would be placed at the residence of Subject **102**, and Subject **102** is merely required to periodically be in proximity to Modem **104** for the purpose of allowing automatic transmission of TAC measurements taken by Monitor Device **100** over a period of time. Subject **102** comes within range of Modem **104**, typically within about ten to twenty feet, on a periodic basis, such as once per day, to allow the automatic transmission to take place. Different hardware components may increase or decrease the range at which the automatic transmission will take place. Subject **102** may rise and leave for work, return home, and remain at home until the next day when it is time to leave for work again. When Monitor Device **100** is in range and the timer indicates that it is time to communicate with Modem **104**, Monitor Device **100** will transfer is to Modem **104** through radio frequency ("RF") signals through bi-directional RF Communication Link **112** all the TAC readings, tamper indicators, error indicators, diagnostic data, and any other data stored in Monitor Device **100** regarding Subject **102**. Modem **104** also can transmit operational information, such as monitoring schedules and reporting schedules in the form of RF signals back to Monitor Device **100** over bi-directional RF Communication Link **112**.

[0034] Modem **104** stores the data contained in the RF signals received from Monitor Device **100** for transmission to Monitor Network **106**. After receiving all of the infor-

mation from Monitor Device **100**, Modem **104** will check the stored data for any TAC readings, tampers, errors, or diagnostic data. Any one of these, or a trigger from a predetermined time interval, will cause Modem **104** to establish a connection over Communication Link **114** with Monitor Network **106**. Once a connection is established, Monitor Network **106** validates the identity of Modem **104** and authenticates the data before it is stored. Once validated, Modem **104** will transfer all of the TAC readings, tampers, errors, diagnostic data, and any other data stored to a web-hosted database server at Monitor Network **106** where all data is permanently stored. Monitor Network **106** then analyzes the data received and separates and groups the data into a number of separate categories for reporting to monitoring personnel at Monitoring Station **108**. The data can then be accessed by the monitoring personnel through the use of secured dedicated websites through the Internet **116** and Internet Connection **120** to Monitor Network **106**. When Monitor Network **106** analyzes the data received, an automatic alert, based upon a rules-based database, may be sent directly from Monitor Network **106** to a call center at Supervising Agency **110** over Communication Link **122**, or to an individual previously designated by Supervising Agency **110**, when a specific alert, or combination of alerts, are received. The alert may be an e-mail, a fax, or a page to a previously provided number. Communication Link **122** may be a wire or wireless connection.

[**0035**] Monitor Network **106** may be located at Monitoring Station **108**, or in a separate location. Monitoring personnel at Monitoring Station **108** have access to all of the data gathered on all of the Subjects **102**. Supervising personnel at the call center of Supervising Agency **110**, however, only have access to those Subjects **102** that are associated with Supervising Agency **110**.

[**0036**] Monitoring Station **108** may automatically or periodically transmit data received from Modem **104** via Monitor Network **106** to one or more persons at Supervising Agency **110** who are assigned to monitor Subject **102**, such as a parole officer, probation officer, case worker, or other designated person or persons in charge of enrolling Subject **102** and monitoring the data being collected on Subject **102**. Only one Supervising Agency **110** is shown for simplicity, but one skilled in the art will recognize that many Supervising Agencies **110** may be accessing Monitor Network **106** at any given time. A connection is established with Supervising Agency **110** through Communication Link **118**. Typically this connection is accomplished via the telephone system through a wire or wireless link, and may connect to a pager or cellular phone of the designated person. Designated personnel at Supervising Agency **110** may also access Monitor Network **106** through the use of secured dedicated websites through the Internet **116** and Internet Connection **120** to Monitor Network **106**. Monitor Network **106** web software allows Supervising Agency **110** the ability to track Subject **102** compliance in a manner most feasible to them, and can be defined to fit the needs of both small and large programs. Each Supervising Agency **110** may customize the frequency of monitoring and the method of notification for alerts that they want to receive from Monitor Network **106**. Alerts may be categorized by the type and severity of alert, allowing each Supervising Agency **110** to prioritize and better categorize a response (i.e., a low battery warning versus a possible alcohol violation).

[**0037**] Each Supervising Agency **110** has its own separate data storage area on the database server at Monitor Network **106** so that representatives from each Supervising Agency **110** can retrieve the secure data they need when they need it. The method and system of the present invention will work in conjunction with existing monitoring agencies that are experienced at managing alcohol offenders.

[**0038**] The method and apparatus for remote blood alcohol monitoring of the present invention has many advantages and benefits over existing methods and apparatus, including, but not limited to, no collection of body fluids (blood, breath, urine) that require special gathering, handling, or disposal considerations; no waiting for laboratory test results; there is no need for the subject to travel to a test center; continuous 24/7/365 monitoring and data collection from any location; no subject, agency official, or laboratory intervention—only passive participation on the part of the subject; the monitoring device is light weight and can be hidden from normal view; tamper-resistant technology ensures accurate readings representative of the subject being monitored; advanced technology utilizing microprocessors, encrypted data links, and secure data storage and retrieval; the ability for monitored subjects to maintain normal daily routines, including work, counseling, community service, family obligations, and recreation; and easy, web-based, secure access for the monitoring agency to each subject's data.

[**0039**] **FIG. 2** shows a block diagram of an embodiment of Monitor Device **100**. Referring now to **FIG. 2**, thicker arrows represent power circuits, and thinner arrows represent signal circuits. Monitor Device **100** is made up of two separate circuit boards referred to as Digital Board **202** and Analog Board **204** that are connected together by a Flexible Circuit **220** which also serves as a tamper strap.

[**0040**] Digital Board **202** contains a micro-controller that functions as a Power Controller And Tamper Monitor **208**. Power Controller And Tamper Monitor **208** controls all of the power in Monitor Device **100**. When Battery **215** is inserted into Monitor Device **100**, Power Controller And Tamper Monitor **208** is activated by the 3 V dc Power Source **214**, and Monitor Device **100** operates at a 3 volt level. Once Power Controller And Tamper Monitor **208** is initialized and running it will turn on the main power to Monitor Device **100** by activating the Main Power Source **209**. Power Controller And Tamper Monitor **208** will now operate at a 5 volt level with the rest of the circuits.

[**0041**] Another function of Power Controller And Tamper Monitor **208** is to monitor the output power level of Battery **215** that operates Monitor Device **100**. This is accomplished by running the raw battery voltage through a resistive voltage divider and then connecting it directly to Power Controller And Tamper Monitor **208**. Power Controller And Tamper Monitor **208** also power controls the power to Analog Board **204** through the Analog Power Source **217**. Analog Power Source **217** in turn provides power to Pump Power **218** which powers the pump circuits, so that the pump circuits are not powered up unless Analog Board **204** is turned on.

[**0042**] Another function of Power Controller And Tamper Monitor **208** is to provide a real time clock that may set the increments of time that Monitor Device **100** is turned off before turning back on. The time and date are downloaded

to Central Processing Unit ("CPU") **203** from Modem **104** and are then communicated to Power Controller And Tamper Monitor **208**, which will then keep track of the time and date and automatically turn on Main Power Source **209** at scheduled times, which can be programmed by CPU **203**. Power Controller And Tamper Monitor **208** allows Monitor Device **100** to turn itself on and off to conserve battery life, and allows external stimulus events to turn on power to Monitor Device **100**.

[**0043**] The tamper control portion of Power Controller And Tamper Monitor **208** monitors all of the inputs that can cause Monitor Device **100** to wake up due to some kind of a tamper condition. The first condition occurs if a magnet is passed near Reed Relay **221**. Passing a magnet near Reed Relay **221** is a method that monitoring personnel employ to wake up Monitor Device **100** in order to take a TAC reading at an unscheduled time. However, Subject **102** may attempt to repeatedly pass a magnet near Reed Relay **221** in order to wear the battery down. Therefore, even when activated by monitoring personnel, any such activation of Monitor Device **100** is still processed as a tamper. Monitoring personnel can note in the records that the tamper event recorded as a result of their actions was a manual turn on, and not a tamper, and prevent any notifications from being sent to Supervising Agency **110**.

[**0044**] Passing a magnet near Reed Relay **221** will cause it to open and close, creating a pulsing effect at the tamper monitoring input. When Power Controller And Tamper Monitor **208** detects this pulsing input it will immediately turn on Main Power Source **209** and activate Monitor Device **100**. A tamper event record is recorded, and the procedure to take a TAC reading is initiated. A temperature reading and a distance reading are also taken. Monitor Device **100** then checks to see if it is within range of Modem **104**. If so, then the communication and transmission procedure is initiated.

[**0045**] The tamper control portion of Power Controller And Tamper Monitor **208** also monitors a continuous signal that is being passed through Flexible Circuit **220** and Analog Board **204** and back to the tamper control portion. If this signal is interrupted, then Power Controller And Tamper Monitor **208** will immediately activate Main Power Source **209** and Monitor Device **100** will proceed as outlined above. As mentioned above, Digital Board **202** also contains CPU **203** which is a stand alone processor which typically has no internal memory component. In another embodiment of the invention, CPU **203** and Integrated Memory **207** may be combined together in the same chip. CPU **203** retrieves all of its instructions and data from Integrated Memory **207**, which is used for both program memory and data storage memory. Integrated Memory **207** is divided internally into several different memory segments. There is a small segment of the memory dedicated to the boot strap program. The boot strap program is used to initialize Monitor Device **100** when power is first applied. The boot strap program is a very basic program that will initialize CPU **203** and then check the validity of the main operating program that is stored in a larger section of Integrated Memory **207**. The boot strap program also has the capability of establishing communications through RF Communication Link **112** if the main program is not valid.

[**0046**] The RF link between Monitor Device **100** and Modem **104** is established through the use of a serial to RF Transceiver **205** and RF Antenna **206**. CPU **203** will command Power Controller And Tamper Monitor **208** to turn on 3 V dc RF Power Source **216**. Power Controller And Tamper Monitor **208** will then activate 3 V dc RF Power Source **216** and supply all the RF components with 3 volts. CPU **203** is connected to RF Transceiver **205** through RF Interface **219** which allows the 5 volt serial signal from CPU **203** to be converted to the proper voltage (3 volts) for the RF transceiver circuits. By establishing RF Communication Link **112** the main program can then be downloaded into Monitor Device **100** by Modem **104** if required. Once the boot strap program has verified that the main program is valid, it will then switch operation to the main program segment stored in Integrated Memory **207** instead of establishing RF Communication Link **112**.

[**0047**] Analog Board **204** contains a serial programmable chip Analog to Digital ("A to D") Converter **236**. This is a programmable chip in that it allows for amplifier gain to be applied to the signals that are being monitored thorough the use of internal Amplifier Circuits **211** and software stored in Integrated Memory **207**, instead of using external hardware to amplify the signals. CPU **203** can then use the software to change the gain of all the A to D channels at any time. A to D Converter **236** is used to convert data created by Alcohol Sensor **212**, Infrared ("IR") Sensor **230**, and Sensor Relay **213** into digital data. These signals are input to A to D Converter **236** in analog form and are then converted to a digital signal and communicated through a serial link to CPU **203**. Alcohol Sensor **212** is a passive electrochemical fuel cell. The output of Alcohol Sensor **212** is an electrical current which is proportional to the amount of alcohol present in the vapor sample. IR Sensor **230** measures the distance between Monitor Device **100** and the skin of Subject **102** to confirm that Monitor Device **100** has not been removed, or that a barrier has not been placed between the skin of Subject **102** and Monitor Device **100**, such as plastic wrap, tape, paper, aluminum foil, playing cards, and the like. Sensor Relay **213** keeps Alcohol Sensor **212** shorted, and only opens it when a reading is being taken.

[**0048**] Analog Board **204** also contains serial Temperature Sensor **210**. Temperature Sensor **210** measures temperature in degrees Celsius and transmits temperature readings through a serial link to CPU **203**. A low temperature reading may indicate that Monitor Device **100** has been removed from the limb of Subject **102**. Normally, the skin temperature of Subject **102** will constantly fluctuate up and down over time. A period of fairly constant temperature readings my be an indication that a barrier has been placed between the skin and Monitor Device **100**. Temperature readings from Temperature Sensor **210** combined with distance readings from IR Sensor **230** are evaluated together to determine a tamper condition. Temperature readings are also used to adjust the TAC readings as discussed immediately below.

[**0049**] The last items on Analog Board **204** are Pump Driver Circuits **222** and Pump **224**. CPU **203** will activate Pump **224** in the process of taking a reading. Pump **224** draws a consistent and predetermined amount of air across Alcohol Sensor **212**, which measures the amount of alcohol present in the air sample. The amount of time that Pump **224** is activated is strictly controlled by CPU **203** in order to control the consistency of each sample taken. When the predetermined amount of time has expired, CPU **203** will turn off Pump **224**. CPU **203** will then monitor Alcohol

Sensor **212**. Once the peak voltage from the alcohol sensor has been recorded, CPU **203** will then calculate the approximate TAC reading for the peak voltage recorded and store that information in Integrated Memory **207** for later retrieval by Modem **104**.

[**0050**] Each Monitor Device **100** must be calibrated through a characterization process before it can be used to monitor a Subject **102**. The characterization process takes several hours. In a controlled environment, air samples of known alcohol concentrations are introduced into the sample chambers of each Monitor Device **100** at six different temperatures. The voltage generated by Alcohol Sensor **212** is then recorded. Alcohol concentrations of 0.00%, 0.02%, 0.05%, and 0.08% are used in the characterization process. Thus, a table is created for each Monitor Device **100** having 24 separate values. An example of a characterization data table for a particular Monitor Device **100** is shown below. No two Monitor Devices **100** will have the same characterization table due to the variances of all of the assembled components. In the table below, the temperatures are listed across the top row of the table and the alcohol concentrations supplied are shown in the far left column. The resulting voltages from the Monitor Device **100** being characterized are shown in the table matrix corresponding to each sample and temperature.

[**0051**] The gain shown is the software gain that CPU **203** will use for each reading when Monitor Device **100** is operating on Subject **102**. The gain is determined for each Monitor Device **100** during the characterization process, and will also vary from device to device. The first step in the characterization process is to heat Monitor Device **100** to the maximum temperature and allow it to settle in at that temperature. The gain is then set to a default value of 8. The maximum allowable sample (0.08%) is then introduced to Monitor Device **100**. The resulting Alcohol Sensor **212** voltage is measured, and this voltage must be less than the maximum allowable voltage for Monitor Device **100**. If it is, then the gain is increased and the test is repeated until the maximum allowable voltage is exceeded. Once the maximum allowable voltage has been exceeded, the gain is set back one level to ensure that the maximum allowable voltage will not be exceeded.

Characterization Table

%/Celsius	15	21	27	33	39	45
0.00	0.18	0.36	0.34	0.36	0.40	0.52
0.02	0.54	0.82	1.08	1.04	1.14	1.24
0.05	1.10	1.98	2.14	2.20	2.26	2.32
0.08	2.12	3.22	3.46	3.54	3.56	3.70

Gain = 8

[**0052**] The characterization table for each Monitor Device **100** is stored in Integrated Memory **207**, and CPU **203** will extrapolate the TAC reading based upon the temperature reading and the voltage reading and the gain applied.

[**0053**] After Monitor Device **100** has completed the reading, it will then activate the RF circuits and wait to see if an RF signal is received from Modem **104**. If a signal is received from Modem **104**, Modem **104** will then retrieve all of the information stored in Integrated Memory **207** and transmit it to Modem **104**. If no signal is received, then Modem **104** will turn off.

[**0054**] **FIG. 3** shows a block diagram of an embodiment of Modem **104** where thicker arrows represent power circuits, and thinner arrows represent signal circuits. **FIGS. 13A-13D** show a top and three elevation views of an embodiment of Modem **104**. Referring now to **FIG. 3** and **FIGS. 13A-13D**, Modem **104** is powered by an external dc power supply (not shown in **FIG. 3** or **FIGS. 13A-13D**). The dc power supply can be configured to plug into either an 115V AC supply or an international type power outlet. The dc power supply is plugged into an external power source and then plugged into the back of Modem **104** at Main Power Input **338**. Main Power Input **338** is connected to Main Power Input Circuits **321**. These circuits filter the power and make sure that the polarity of the power is correct and then distribute the power to Main Power Supply **322**, Modem Power Supply **325**, and RF Power Supply **328**. Main Power Input Circuits **321** also monitor the power for AC power failures. This is accomplished by running the DC power input through a resistive divider and then into CPU **317**.

[**0055**] Main Power Supply **322** supplies the power to CPU **317**, RS232 Interface or Analog Modem Selector **329**, RS232 Interface **330**, Serial EE Prom **337**, Battery Backup Circuits **324** and JTAG Connector **319**. Battery Backup Circuits **324** supply the power to Integrated Memory **318** and Real Time Clock **323**. The main power is applied as soon as Modem **104** is plugged in. The fact that Modem **104** is on is reflected by at least one LED that is illuminated in LED's **336**. LCD Display **320** will also display various status messages regarding the current status of Modem **104**. Tamper Tape Strip **339** is applied to a side of Modem **104** where the top half and bottom half come together as a tamper indicator. Any attempt by Subject **102** to gain access to the internal portion of Modem **104** will be evident from the altered state of Tamper Tape Strip **339**.

[**0056**] Integrated Memory **318** is divided internally into several different memory segments. There is a small segment of the memory dedicated to the boot strap program. The boot strap program is used to initialize Modem **104** when power is first applied. The boot strap is a very basic program that will initialize CPU **317** and then check the validity of the main operating program that is stored in a larger section of Integrated Memory **318**. There is also an additional RAM component that supplies extra data storage capabilities. Serial EE Prom **337** is used to store all of the critical information for Modem **104** such as the serial number, device identification information and the phone numbers that should be called to connect to Monitor Network **106**. Modem **104** will retrieve and validate all of the critical information and will then validate the main operational program. If the main operational program is valid, Modem **104** will switch operation from the bootstrap program to the main operational program. Once the switch is made Modem **104** will contact Monitor Network **106** and report the latest power fail. If Subject **102** unplugs Modem **104** and moves it to a different location, or if the electricity is cut off for any reason, such as a power outage, a power fail event is recorded. If the main operational program is not valid then Modem **104** will try to contact Monitor Network **106** and get the main operational program downloaded to

itself. The JTAG Connector **319** also provides a means of programming both the modem boot strap program and the main operational program into Integrated Memory **318**.

[**0057**] To connect to Monitor Network **106**, Modem **104** will check the input from the RS232 Interface or Analog Modem Selector **329** and see if there is a serial cable attached to Modem **104** at External RS232 Connector **332**, which is accessible by opening up the cover of Modem **104**. If there is, then Modem **104** will go into slave mode waiting for serial communications to come in through RS232 Interface **330**. This mode provides a means of manually issuing commands and loading programs and or data to Modem **104**. If there is no serial cable attached to Modem **104**, then CPU **317** will turn on Modem Power Supply **325**. After allowing Modem Chip Set **326** to power up and stabilize, CPU **317** will check for a dial tone. If no dial tone is identified, then CPU **317** will hang up and generate an alarm to indicate that the phone line is not connected at External Phone Line Connector **327**. Modem **104** will then try again after a predefined delay period. External Hand Set Connector **331** receives the telephone wire that comes from the telephone hand set.

[**0058**] Once a dial tone has been established, CPU **317** will dial the phone number for Monitor Network **106**. CPU **317** will then monitor Modem Chip Set **326** for an indication that a connection has been established with Monitor Network **106**. If CPU **317** determines that the phone line is busy, or that there is no answer, then CPU **317** will hang up and log an alarm indicating that a connection could not be established. Modem **104** will then wait a predefined delay period and try to make the connection again. Once the connection is established, Monitor Network **106** becomes the master and Modem **104** becomes the slave. Monitor Network **106** will then extract all of the pertinent information that it needs to validate Modem **104** and to update its status. It will then update Real Time Clock **323** so that Modem **104** is set to the proper time for the time zone where Modem **104** is currently located. Monitor Network **106** will then upload all data that has been stored in Modem **104** since the last upload. Monitor Network **106** then has the ability to download any number of specific monitoring instructions that need to be sent to Monitor Device **100**, along with all of the schedule information for Modem **104** and Monitor Device **100**. Monitor Network **106** will then tell Modem **104** to hang up and start operations.

[**0059**] CPU **317** will hang up and turn off the power to Modem Chip Set **326**. CPU **317** will then activate the RF circuits and try to establish an RF link. The RF link is established through the use of a serial to RF Transceiver **334** and the RF antenna **335**. CPU **317** is connected to RF transceiver **334** through RF Interface **333** which allows the serial signal from CPU **317** to be converted to the proper voltage for the RF transceiver circuits. CPU **317** will start sending a standard message out over the RF link. This message is addressed to Monitor Device **100**, so if Monitor Device **100** is within range of Modem **104** and Monitor Device **100** is active, then Monitor Device **100** will answer the message with a status message indicating that Monitor Device **100** is active and operating. Modem **104** will then become the master and Monitor Device **100** will become the slave. Modem **104** will extract all of the status information from Monitor Device **100** and will validate the operating program and any pertinent operating data needed by Monitor Device **100**. Modem **104** will then update the real time clock in Monitor Device **100** so that Monitor Device **100** and Modem **104** are on the same time. Modem **104** will then extract any TAC reading information as well as any tamper or error information from Monitor Device **100**. Modem **104** will then turn off the RF signal. When the RF signal is turned off, Monitor Device **100** will turn itself off and return to normal monitoring mode.

[**0060**] CPU **317** will then scan through the data just received and determine if any of the data needs to be sent immediately to Monitor Network **106**. If not, then CPU **317** will wait a predefined delay period and then start the polling sequence again. If there is data that needs to be transmitted to Monitor Network **106** immediately, or if the time clock indicates that it is a scheduled time to call Monitor Network **106**, then Modem **104** will go through the connection process and connect to Monitor Network **106**.

[**0061**] **FIG. 14** shows a more detailed block diagram of Monitor Network **106**. Alert/tamper information is constantly being generated and monitored by the system components of the present invention. The following description will describe how and why the information is generated and how the information is handled and processed once it is generated.

[**0062**] Passive identification of Subject **102** is achieved by securely attaching Monitor Device **100** to Subject **102** in such a manner that it cannot be removed without physically damaging Monitor Device **100** and leaving evidence that Monitor Device **100** has been removed. Once Conductive Strap **18** has been adjusted and secured over Securing Pins **48**, Battery Housing **16** and Battery Clip **62** are inserted into Enlarged Channel **60** securing Monitor Device **100** to Subject **102**. The only way Monitor Device **100** can now be removed from Subject **102** is by cutting Conductive Strap **18** or Flexible Circuit **220**, or by breaking or cutting one of Housing **12**, Housing **14**, Battery Housing **16**, or Battery Clip **62**.

[**0063**] When Battery **215** makes electrical contact upon being inserted in Monitor Device **100**, an alert is generated indicating that power has been applied to Monitor Device **100** and the last known time and date are logged with the alert so that the duration Monitor Device **100** went without power can be determined. Normal occurrences of these alerts are generated each time Monitor Device **100** is attached to Subject **102**, or each time that Battery **215** is changed in Monitor Device **100**. There should never be an alert of this type generated when Monitor Device **100** is in normal operation on Subject **102**. Another type of removal alarm is generated if Flexible Circuit **220** or Conductive Strap **18** are cut or disconnected at any time after Battery **215** is secured in Monitor Device **100**. Monitor Device **100** will generate a Strap Alert, along with the time and date the Strap Alert was generated.

[**0064**] Monitor Device **100** monitors the data from Alcohol Sensor **212** and Infrared Sensor **230** combined with Temperature Sensor **210**, which are mounted on Analog Board **204**, to determine if there has been some type of obstruction placed between Monitor Device **100** and the skin of Subject **102**. If the output of these three sensors indicates that there is an obstruction, Monitor Device **100** will log the alert along with the time and date that the alert occurred. This alert will be generated as long as the sensor data indicates that the condition is present.

[0065] All of the alerts described previously will cause Monitor Device **100** to attempt to communicate with Modem **104** as soon as possible, overriding the normal scheduled communication programmed into Modem **104** and Monitor Device **100**. The system of the present invention uses the scheduled communication times to ensure that all equipment is operational under normal conditions. During normal operation there should be no reason for the equipment to override the schedules, and it will only communicate when scheduled. If no schedules were used, there would be no communication and no validation that readings were being taken and stored by Monitor Device **100**. If Monitor Device **100** does not communicate at a scheduled communication time, Modem **104** will generate an alert that Monitor Device **100** failed to communicate on schedule, along with the present time and date. This alert will be labeled as a Communication Alert by Situation Analyzer **124**. If Monitor Device **100** does not communicate with Modem **104** for a period of 24 hours, Modem **104** will generate a No Monitor Communication Alert, along with the present time and date. This will also be labeled as a Communication Alert by Situation Analyzer **124**. Thus, the normal flow of communication between Monitor Device **100** and Modem **104** must exist or there will be alerts generated to inform the monitoring personnel that something is wrong with the system.

[0066] Modem **104** communicates with the Monitor Network **106** through Communication Server **126**. The normal communication between these two devices is controlled by schedules programmed into the particular Modem **104** that is assigned to a particular Monitor Device **100**. Monitor Network **106** also monitors these schedules. If Modem **104** fails to communicate when scheduled, Monitor Network **106** will generate a Communication Alert indicating that Modem **104** failed to communicate when scheduled. Thus if the normal communications cycle between Modem **104** and Communication Server **126** is broken, then alerts will be generated to inform the monitoring personnel that something is wrong with the system. This type of system architecture provides the means for equipment at each level of the communication chain to generate alarms. This guarantees that if a piece of equipment anywhere in the chain of communication fails, there will be an alarm to report it.

[0067] Data input and data management are handled by Supervising Agency/Subject Database **134**. Supervising Agency/Subject Database **134** is actually a combination of databases that support all of the processes of Monitor Network **106**. Supervising Agency/Subject Database **134** includes input and management of the call center data, the Supervising Agency/Subject data, and any specific information relating to a treatment center associated with the Supervising Agency **110**, and the offender or patient data for all Subjects **102**, including their individual monitoring and communication schedules and the device information for Modems **104** and Monitor Devices **100** assigned to them. Supervising Agency/Subject Database **134** stores all of the readings and tampers/alerts information that is received from all Modems **104** and Monitor Devices **100**, as well as any device information that needs to be stored and monitored. Supervising Agency/Subject Database **134** provides a complete historical record of all readings and tampers/alerts for all Subjects **102** being monitored in the system.

[0068] Situation Analyzer **124** is used to parse the data and apply a known set of rules and instructions for handling the raw data and parsing it into a limited number of categories. These categories can be broken down as follows:

[0069] Positive TAC: Includes all positive readings and any type of positive readings that involve an interferant. An interferant is defined as a reading indicating a positive TAC, where the positive TAC is caused by some sort of topical ethanol applied to the skin or spilled/poured onto the Monitoring Device **100**, but not ingested into the body by drinking.

[0070] Equipment Tamper: Includes Obstruction alarms received from Monitor Device **100**. Power up alarms received from Monitor Device **100**, and distance and temperature alarms that are received from Monitor Device **100**. Also included are Equipment Failures.

[0071] Communication Alerts: Includes No Modem Communication, No Monitor Device Communication, Modem missed scheduled call-in time alerts, and Monitor Device missed scheduled call-in time alerts.

[0072] Equipment Maintenance: Includes alerts for scheduled maintenance, non-scheduled maintenance, and software downloads.

[0073] Equipment Assignment: Includes alerts for equipment now assigned to a client and equipment removed from a client.

[0074] Situation Analyzer **124** will make inquires to Workflow Instructions **128** to get direction on what is the default or specific action that should be applied to the message that was just received. Situation Analyzer **124** will then use those instructions and any historical data relating to similar messages to make a decision as to what to do with the message just received. Situation Analyzer **124** can also monitor historical data and escalate the severity of alert messages if there is a pattern emerging in the data that would require more immediate attention. Once Situation Analyzer **124** has made its decision, it will pass the message to Alert Manager **130**. Alert Manager **130** will inquire to Workflow Instructions **128** for direction on what should be done with this message. Alert Manager **130** will then present the alert information to the monitoring personnel upon request and prompt them for some type of action required to address the alert. The main categories of alert management can be broken down as:

[0075] Review/Report the information.

[0076] Take Action: By monitoring personnel or some other person in a monitoring role.

[0077] Snooze the alert.

[0078] Log all action that is required for the alert.

[0079] Change the Status of the Alert: By taking the appropriate action the alert can now be resolved. Once resolved, the database will reflect this status and remove the Alert from the new information screens.

[0080] Situation Analyzer **124** will then check to see if the message that is being dealt with requires any type of immediate notification of a monitoring person. If it does, then Situation Analyzer **124** will send the message to Notification Server **132**. Notification Server **132** will then

inquire to Supervising Agency/Subject Database **134** to see what method of notification is preferred by the monitoring person, and then execute the notification method, such as sending an e-mail, sending a fax, or sending a page to the appropriate person.

[**0081**] Thus, the method and system of the present invention offers multiple levels of alert ranging from alerts generated by Monitor Device **100**, from Modem **104**, and from Monitor Network **106**. The flexible and changeable scheduling at the Subject **102** level allows for more timely intervention for all of the Subjects **102** being monitored who are demonstrating problems.

[**0082**] Referring now to **FIGS. 4 and 5**, a preferred form of Monitor Device **100** is illustrated for attachment to a human Subject **102**, the Monitor Device **100** being in the form of a bracelet broadly comprised of an analog side having Housing **12**, digital side having Housing **14** and Battery Housing **16**, and Elastic Strap **17** with Flexible Circuit **220** connected to Conductive Strap **18** between the Housing **12** and Housing **14**, all of which enable the bracelet to encircle the limb of a human Subject **102**, such as an arm or a leg. Flexible Circuit **220** contains the circuit connections between Analog Board **204** in Housing **12** and Digital Board **202** in Housing **14**. One end of Conductive Strap **18** is connected to Flexible Circuit **220**, and the other end of Conductive Strap **18** has a series of holes punched there through which are designed to fit in cooperation with Securing Pins **48** in Enlarged Channel **60** in Housing **14** so that Monitor Device **100** may be adjustably tightened to fit securely to the limb of Subject **102**. Strap Securing Bracket **56** attaches to Housing **12** and channels Conductive Strap **18** towards Housing **14**. Strap Securing Bracket **56** prevents Subject **102** from being able to manipulate and rotate Housing **12** and Housing **14** inside out so that Cover Plates **15** are facing outward from the skin of Subject **102**. The extra rigidity provided by Strap Securing Bracket **56** along its length over a portion of Conductive Strap **18** prevents Subject **102** from being able to turn the bracelet inside out after being secured to a limb.

[**0083**] Housing **12** is preferably a rigid casing generally rectangular in cross-section with a concave-shaped open interior with Side Walls **22** and Back Wall **23** having a Channel **24** for mounting Elastic Strap **17**, Conductive Strap **18**, and Flexible Circuit **220** in a manner to be described. Cover Plate **26** is attached to Back Wall **23** so as to hold the straps permanently in place. Housing **12** is open opposite Back Wall **23** and has an outer continuous peripheral edge having Groove **28** for insertion of a Surrounding Edge **29** of an analog Base Plate **30** together with Surrounding Edge **31** of a Flexible Boot **32** in outer spaced relation to Base Plate **30**. Flexible Boot **32** is of generally concave configuration, as best seen from **FIG. 5B**, and the same is true of a rigid metal Cover Plate **15** which is mounted centrally of Flexible Boot **32**. Cover Plate **15** is curved to conform to the curvature of the leg or arm of human Subject **102** to which it is attached, and is perforated to permit the passage of air into the interior of Housing **12**. Cover Plate **15** is made from surgical stainless steel so as not to cause skin irritation to Subject **102** during the duration of time of continuous wear. A D-Ring **34** and D-ring Retainer **34'** are inserted into Groove **28** along with the Surrounding Edge **29** of Base Plate **30** to establish a press fit, waterproof engagement between Flexible Boot **32**, Base Plate **30**, and the peripheral edge of Housing **12**. In this way, the assembled Base Plate **30** and Flexible Boot **32** define a Collection Chamber **33** (see **FIG. 8B**) for retention of each air sample recovered from the skin of Subject **102**. By virtue of the flexing of Flexible Boot **32** in relation to the skin of the limb of Subject **102**, a suction/vacuum created thereby helps induce the drawing of insensible skin perspiration into Collection Chamber **33** through Cover Plate **15**. In this relation, a Boot Filter **35** underlies Cover Plate **15** to selectively remove any moisture from each sample as it is drawn into Collection Chamber **33**. Material for Boot Filter **35** is selected to allow air to pass through but trap moisture to maintain the waterproof requirement, but allow enough air to pass through to work effectively with Pump **224**.

[**0084**] Referring now to **FIGS. 7 and 8**, a Sample Chamber Filter **36** is mounted in the bottom of a First Sample Chamber **38** which is divided from a Second Sample Chamber **39** and is located directly in the path of air sample flow from Collection Chamber **33** through Base Plate **30**. A Gasket **40** is mounted between Second Sample Chamber **39** and Alcohol Sensor **212**. Pump **224** causes the air sample to flow from First Sample Chamber **38** through a manifold having Manifold Lower Half **43** and Manifold Upper Half **44** separated by a Moisture Filter **42**, into Second Sample Chamber **39**. A Check Valve Assembly **45** permits the air sample to be exhausted from Second Sample Chamber **39** into Space **52** in Housing **12**. Analog Board **204** is mounted on top of Alcohol Sensor **212** and forms the bottom of Space **52**. The top of Space **52** is bounded by Vent Cover **46** and Back Wall **23** in which Restraining Bracket **50** is mounted (See **FIG. 5A**) which has a Looped End **51** (See **FIG. 5A**) and Securing Pins **48**. Looped End **51** has affixed to it a looped end of Elastic Strap **17**. Flexible Circuit **220** is affixed to Securing Pins **48**, and then extends through Restraining Bracket **50**, Back Wall **23** and is electrically connected to Analog Board **204**. Conductive Strap **18** is also affixed to Securing Pins **48** and then secured by Cover Plate **26**.

[**0085**] In order to reliably measure blood alcohol content, the insensible skin perspiration which is emitted from the body in the form of vapors will migrate away from the skin and through Boot Filter **35** located on Cover Plate **15** of the analog side of Monitor Device **100**. These vapors collect in Collection Chamber **33** between the Cover Plate **15** and the Base Plate **30**. As this space fills with vapors from the body of Subject **102**, the vapors will start to migrate through the Sample Chamber Filter **36** and collect in First Sample Chamber **38** in Housing **12**. Pump **224** is activated to draw the sample from Collection Chamber **33** as well as First Sample Chamber **38** to exit into Manifold Upper Half **44** and pass through Moisture Filter **42** into Manifold Lower Half **43** and Pump **224**. The sample is then forced out of Pump **224** into Manifold Lower Half **43** where it passes back into Manifold Upper Half **44** and the upper portion of Second Sample Chamber **39** and passes across Alcohol Sensor **212** where the sample will of course displace any existing air from the upper portion of Second Sample Chamber **39** through Check Valve Assembly **45**. In exiting through Check Valve Assembly **45** the air is forced through another Moisture Filter **84** into Space **52** in the interior area between Second Sample Chamber **39** and Back Wall **23** of Housing **12**. The sample discharged into Space **52** will in turn cause any existing air in Space **52** to migrate through Vent Cover **46** in Back Wall **23** and escape into the atmosphere.

[0086] In order to avoid false readings, it is important that the sampling system not only be waterproof to prevent the entry of moisture from the atmosphere but that any moisture in the sample itself be removed including any condensation resulting from temperature changes between the point where the sample is collected and the measuring area. From the foregoing, the filters referred to in the preceding paragraph and specifically in relation to the analog side of Monitor Device **100** are hydrophobic filters which will remove moisture from each sample while permitting the gas and entrained alcohol to pass through the air flow path as described. Thus, any moisture contained within the vapors migrating through Flexible Boot **32** will be removed by Boot Filter **35**. However, as the sample undergoes cooling as it is advanced from Collection Chamber **33** through First Sample Chamber **38**, Manifold Upper Half **44**, and Pump **224**, there will be additional condensation of moisture which must be removed in order to obtain the most accurate readings at Alcohol Sensor **212**. It is equally important that Housing **12** itself be water-tight to prevent the entry of any moisture through the juncture of Flexible Boot **32** with Housing **12** as well as through the interface between Flexible Circuit **220** and Back Wall **23**, and particularly from the flex circuit connection into Analog Board **204** located in the region of Vent Cover **46**.

[0087] Referring now to **FIGS. 6A, 6B**, 9A and 9B, the digital Housing **14** is constructed in a manner closely similar to the analog Housing **12**, and like parts are correspondingly enumerated. However, the interior of the housing essentially contains only a digital printed circuit, Digital Board **202**, which receives the output signals of A to D Converter **236**. Reed Relay **221** on Digital Board **202** can be magnetically activated to awaken the analog circuit for taking a measurement. Back Wall **58** of digital Housing **14** includes Enlarged Channel **60** for insertion of Battery Housing **16** through one end of Enlarged Channel **60** into secure engagement with Battery Clip **62**, which is mounted in the opposite end of Enlarged Channel **60** between a pair of Battery Contact Sockets **64**. A Cross-Member **66** is permanently mounted in Enlarged Channel **60** between Battery Contact Sockets **64** to support Housing **14**. Battery Housing **16** and Battery Clip **62** are hollow and of generally rectangular configuration and correspondingly sized so that projecting catches on the ends of Tangs **68** on Battery Cover **20** will move into engagement with a molded breakaway on an off-set portion of Lip **63**, on an outer end wall of Battery Clip **62** when Battery Housing **16** and Battery Clip **62** are inserted into opposite ends of Enlarged Channel **60**.

[0088] In the preferred form, the Battery Housing **16** is designed to be permanently affixed in the Back Wall **58** of Housing **14**. When thus fixed in place, it is impossible to remove Monitor Device **100** from the limb of Subject **102** without cutting Flexible Circuit **220** or Conductive Strap **18**, or otherwise breaking Housing **12**, Housing **14**, or Battery Clip **62**. Nevertheless, when it does become necessary to replace Battery **215**, or simply to remove Monitor Device **100** from Subject **102**, Battery Housing **16** must be removed. To this end a Release Tool **70** is provided as illustrated in **FIGS. 10-12**. Release Tool **70** is made up of an Elongated Handle **72** having a Stationary Arm **74** extending from one end of said arm and at right angles thereto. A tang-engaging Lever Arm **76** is pivotally connected to an intermediate portion of Elongated Handle **72** and has a Blade Member **78** with a Blade Edge **80** at its free end. Lever Arm **76** is pivotally connected to Elongated Handle **72** at a location such that when Stationary Arm **74** bears against Flexible Boot **32**, Blade Edge **80** is pivoted into engagement with the molded breakaway portion of Battery Clip **62**. Blade Edge **80** is movable to bear against Tangs **68** so as to release them from engagement from Battery Clip **62** and allow removal of Battery Housing **16** and enclosed Battery **215** from Housing **14** for replacement of Battery **215**. It is necessary to break the breakaway portion of Battery Clip **62** in order to release Tangs **68**. Battery Clip **62** must be replaced to permit reattachment of Battery Housing **16** with a new Battery **215**.

[0089] In order to facilitate manual gripping of Release Tool **70**, Elongated Handle **72** is provided with a Rounded Portion **81** along one edge, and Lever Arm **76** is provided with a Rounded Portion **82** along one edge which will move into engagement with an edge of Elongated Handle **72** when Lever Arm **76** is squeezed to force Blade Edge **80** into engagement with the breakaway portion of Battery Clip **62**.

[0090] Having described the present invention, it will be understood by those skilled in the art that many changes in construction and circuitry and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the present invention.

What is claimed is:

1. A monitor network for use with a modem and a continuous remote blood alcohol monitoring device attached to a human subject, the monitor network comprising:

a communication server, wherein said communication server receives raw data over a communication link from the modem, wherein said raw data is gathered by the continuous remote blood alcohol monitoring device attached to the subject and transmitted to the modem;

a situation analyzer connectable to said communication server, wherein said situation analyzer parses said raw data through a predetermined set of rules into a plurality of messages;

a workflow instructions connectable to said situation analyzer, wherein said situation analyzer queries said workflow instructions for an action to be applied to each of said plurality of messages;

a supervising agency/subject database connectable to said situation analyzer for storing said raw data, for storing information on the human subject, supervising agency, and a supervising person monitoring the human subject, and for storing a method of notification predetermined by said supervising person; and

a notification server connectable to said situation analyzer, wherein when said situation analyzer determines that said action to be applied to a one of said plurality of messages requires an immediate notification of said supervising person, said situation analyzer will communicate said one of said plurality of messages to said notification server, and further wherein said notification server queries said supervising agency/subject database to determine a predetermined notification method, and executes said predetermined notification method to communicate a one of said plurality of messages to said supervising person.

2. The monitor network according to claim 1 further comprising:

an alert manager connectable to said situation analyzer and to said workflow instructions, wherein said situation analyzer passes each of said plurality of messages to said alert manager, and further wherein said alert manager categorizes each of said plurality of messages

into a one of a plurality of alert management categories for presentation to a monitoring person at a monitoring station.

3. The monitor network according to claim 2 wherein said plurality of alert management categories further comprises:

a review/report;

a take action;

a snooze alert;

a log action required; and

a change the status of alert.

4. The monitor network according to claim 1 wherein said supervising agency/subject database further comprises:

a call center data for a supervising agency associated with the human subject;

a treatment center information for a treatment center associated with said supervising agency;

a historical record of all previously received raw data; and

a patient data for the human subject, said patient data further comprising a monitoring schedule, a communication schedule, a device information for the continuous remote blood alcohol monitoring device, and a device information for the modem in communication with the continuous remote blood alcohol monitoring device.

5. The monitor network according to claim 1 wherein said situation analyzer categories said plurality of messages into a plurality of categories, said plurality of categories further comprising:

a positive transdermal alcohol content reading, including a positive reading caused by an interferant;

an equipment tamper, including an obstruction alarm, a power up alarm, a distance alarm, and a temperature alarm;

a communication alert, including a no modem communication, a no continuous remote blood alcohol monitoring device communication, a modem missed scheduled communication, and a continuous remote blood alcohol monitoring device missed scheduled communication;

an equipment maintenance, including a scheduled maintenance, a non-scheduled maintenance, and a software download maintenance; and

an equipment assignment, including an equipment assigned and an equipment removed.

6. The monitor network according to claim 1 wherein the continuous remote blood alcohol monitoring of a human subject is done twenty-four hours a day, seven days a week, 365 days a year.

7. A method for using a monitor network to process raw data received via a modem from a continuous remote blood alcohol monitoring device attached to a human subject, the method comprising the steps of:

(a) receiving in a communication server in the monitor network the raw data over a communication link from the modem, wherein the raw data is gathered by the continuous remote blood alcohol monitoring device attached to the subject and is transmitted to the modem;

(b) parsing with a situation analyzer said raw data through a predetermined set of rules into a plurality of messages;

(c) determining with a workflow instructions an action to be applied to each of said plurality of messages;

(d) storing in a supervising agency/subject database said raw data, an information on the human subject, an information on a supervising agency associated with the human subject, a predetermined notification method for notifying a supervising person of said supervising agency associated with the human subject; and

(e) when said action to be applied to a one of said messages requires an immediate notification of said supervising person, executing with a notification server said predetermined notification method to communicate a one of said plurality of messages to said supervising person.

8. The method according to claim 7 wherein said predetermined notification method is a one of an e-mail message, a facsimile transmission, a page to a pager, a text message, a call to a telephone, and a call to a cellular telephone.

9. The method according to claim 7 further comprising the step of:

categorizing by an alert manager each of said plurality of messages into a one of a plurality of alert management categories for presentation to a monitoring person at a monitoring station, wherein said plurality of alert management categories is a one of a review/report, a take action, a snooze alert, a log action required, and a change the status of alert.

10. The method according to claim 9 further comprising the steps of:

analyzing by said situation analyzer a current message together with a historical raw data related to said current message; and

escalating said current message to a higher one of said plurality of alert management categories when a pattern is detected by said analyzing step that would require more immediate attention.

11. The method according to claim 9 further comprising the steps of:

downloading by the monitor network said monitoring schedule and said communication schedule to said modem;

downloading by said modem said monitoring schedule and said communication schedule to the continuous remote blood alcohol monitoring device;

when a scheduled communication between said communication server and said modem fails to occur, generating by said communication server a communication alert; and

communicating said communication alert to said monitoring station.

12. The method according to claim 7 further comprising the step of:

storing in said supervising agency/subject database a call center data for a supervising agency associated with the human subject, a treatment center information for a treatment center associated with said supervising

agency, a historical record of all previously received raw data, and a patient data for the human subject, said patient data further comprising a monitoring schedule, a communication schedule, a device information for the continuous remote blood alcohol monitoring device, and a device information for the modem in communication with the continuous remote blood alcohol monitoring device.

13. The method according to claim 7 wherein said parsing with a situation analyzer step further comprises the step of:

categorizing each of said plurality of messages into a one of a plurality of categories, wherein said plurality of categories is a one of a positive transdermal alcohol content reading, including a positive reading caused by an interferant; an equipment tamper, including an obstruction alarm, a power up alarm, a distance alarm, and a temperature alarm; a communication alert, including a no modem communication, a no continuous remote blood alcohol monitoring device communication, a modem missed scheduled communication, and a continuous remote blood alcohol monitoring device missed scheduled communication; an equipment maintenance, including a scheduled maintenance, a non-scheduled maintenance, and a software download maintenance; and an equipment assignment, including an equipment assigned and an equipment removed.

14. The method according to claim 7 wherein steps (a) through (e) may be performed twenty-four hours a day, seven days a week, 365 days a year.

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专利名称(译)	用于远程血液酒精监测的方法和设备		
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摘要(译)

防篡改透皮酒精含量监测装置由模拟和数字侧面组成，其牢固地附着于待监测的人体。模拟侧具有采样电路，其从受试者的皮肤吸取测量的不敏感皮肤出汗样品并用电化学燃料电池测量。从受试者皮肤和样品温度的装置的距离测量与透皮酒精含量一起被监测，并且被转换成数字信号，当监视器接近调制解调器时，该数字信号被发送到调制解调器。信号存储在调制解调器中并上传到中央监控站。可以从中央监控站向监管机构发送自动警报。监管机构还可以通过互联网通过安全的专用网站访问信息。