receiver from the satellites, related by the speed of light. Prior to correction for the clock bias C_B, the apparent ranges of the satellites are all in error by a fixed amount and are called pseudoranges.

Two positioning services are provided by the NAVSTAR GPS. The precise positioning service (PPS) which is reserved for military use provides accuracy to within twenty-one meters (2drms). The statistical term "2drms" refers to a value that falls within two standard deviations (using the root-mean-squared method) of the sampled performance data mean. Therefore, a stated accuracy of twenty-one meters (2drms) means that the position error has an error of less than twenty-one meters approximately ninety-five percent of the time.

The standard positioning service (SPS) which is available for general use provides accuracy to within thirty meters (2drms). However, the SPS signal accuracy is intentionally degraded to protect U.S. national security interests. This process, called selective availability, degrades the accuracy of SPS position fixes to within one hundred meters (2drms). The SPS may be degraded in a number of ways, for example, by providing slightly inaccurate satellite orbital data to the receivers or by dithering the ranging information. Certain applications require better accuracy than provided by degraded SPS, SPS, or even PPS.

Differential GPS technology (DGPS) may provide location accuracies to within three meters (2drms). Such accuracies allow, for example, accurate positioning of a delivery truck on a street map or precise locating for an in-vehicle navigation system. The precision of the GPS system is improved by broadcasting differential correction data to a GPS receiver. A typical DGPS positioning system, such as the one implemented by the U.S. Coast Guard, uses known position coordinates of a reference station to compute corrections to GPS parameters, error sources, and resultant positions. This correction data is transmitted to GPS receivers to refine received position signals or computed position.

Traditional DGPS positioning systems require the user to carry both a GPS receiver and an additional communications device to receive the correction data. For example, the Coast Guard implementation requires a maritime radio beacon receiver to obtain GPS correction data. This Coast Guard system is described in a document entitled "Implementation of the U.S. Coast Guard's Differential GPS Navigation Service," U.S.C.G. Headquarters, Office of Navigation Safety and Waterway Services, Radio Navigation Division, June 28, 1993. Another system, described in U.S. Patent No. 5,311,194, entitled "GPS Precision Approach and Landing System for Aircraft" and issued to Brown, describes a differential GPS implementation for use in a precision approach and landing system for aircraft. In this system, the aircraft is required to carry a broadband GPS receiver with added functionality to receive pseudolite signals that contain the correction data.

Differential positioning system 10 in FIGURE 1 implements the DGPS concept using positioning system 12 integrated with mobile communications network 14 to accurately determine the location of vehicle 16. Differential positioning system 10 utilizes components of mobile communications network 14 as reference stations that provide correction data to vehicle 16 over an existing communications link, such as the control channel, overhead message stream, or paging channel of a cellular telephone network. Mobile communications network 14 may be a cellular telephone network, specialized mobile radio (SMR), enhanced specialized mobile radio (ESMR), a personal communications service (PCS), a satellite-based or land-based paging system, a citizen's band (CB), a dedicated radio system, such as those used by police and firefighters, or any other appropriate mobile communications technology.

Differential positioning system 10 is described with reference to location of vehicle 16. The present invention contemplates location of all types of vehicles, including cars, trucks, airplanes, boats, barges, rail cars, truck trailers, or any other movable object that is desirable to locate or track. Furthermore, differential positioning system 10 can also be used to accurately locate a person carrying a portable or hand-held mobile unit 17. Potential applications of this technology may include delivery service dispatch, less-than-full-load (LTL) trucking applications, in-vehicle navigation systems, surveying applications, collision avoidance, emergency location using mobile 911 services, or any other application requiring accurate positioning information of a vehicle, object, or person.

Differential positioning system 10 provides a more accurate position fix than currently available navigation services, and may provide these fixes near instantaneously or "on the fly." In some applications, low frequency and low accuracy updates are sufficient, but other applications may need better accuracy and higher frequency updates in near real-time. For example, a delivery truck may require accurate, high frequency position fixes for in-vehicle navigation to locate a specific delivery address or to provide real-time directions to the driver. Differential positioning system 10 may provide these high frequency updates without relying on off-vehicle computations prevalent in previous DGPS implementations. In addition, the same delivery truck may send lower frequency position reports to a remote location. These position reports may be sent at fixed time intervals, on-demand, or as a result of a predetermined reporting event. Differential positioning system 10 may provide both low and high frequency position fixes and reports in such a hybrid navigation and position reporting system.

Satellite-based positioning system 12 is a navigation system using NAVSTAR GPS, GLONASS, or other satellite-based or land-based radio navigation system to provide ranging data to mobile unit 17. Satellites 18, 20, 22 maintain accurate and synchronized time and simultaneously transmit position signals that contain satellite specific and system information required by mobile unit 17 to generate position fixes. The position signals transmitted by satellites 18, 20, 22 may include high precision clock and ephemeris data for a particular satellite, low precision clock and ephemeris (called "almanac") data for every satellite in the constellation, health and configuration status for all satellites, user text messages, and parameters describing the offset between GPS system time and UTC.

Mobile unit 17 receives position signals over message data streams 26, 28, 30 from satellites 18, 20, 22, respectively. Additional satellites (not shown) may also communicate message data streams to mobile unit 17. Typically, mobile unit 17 receives at least four satellite message data streams to solve for position information independent of inherent clock bias (C_B) between positioning system 12 and mobile unit 17. Currently the NAVSTAR GPS system has twenty-one active satellites at 11,000 mile orbits of fifty-five degrees inclination with the equator. In normal conditions, mobile unit 17 may receive position signals from seven satellites.

Using information from position signals 26, 28, 30 and optionally additional message data streams, mobile unit 17 may determine its position using accurate satellite position information transmitted by satellites 18, 20, 22 and pseudorange data represented by the time of arrival of message data streams 26, 28, 30 to mobile unit 17. Using SPS this position fix may be accurate to within 30 meters (2drms) or 100 meters (2drms) when selective availability degradation is activated. If mobile unit 17 is allowed to operate using PPS, then the position fix may be accurate to within 21 meters (2drms).

To provide a more accurate position fix for mobile unit 17, satellites 18, 20, 22 also transmit message data streams 32, 34, 36, respectively, to a reference positioning receiver 38 on or in proximity to a transmitter site 40 of mobile communications network 14. Reference positioning receiver 38 performs similar calculations to determine a position fix from position signals received from satellites 18, 20, 22. Reference positioning receiver 38 compares the computed position fix to known position coordinates and generates correction data for transmission over correction data stream 44 to mobile unit 17 for further refinements of position fix provided by mobile positioning receiver 24 (FIGURE 4).

The known position coordinates of transmitter site 40 may be determined by traditional surveying techniques. In addition, reference positioning receiver 38 may perform position fixes over a statistically significant period of time to determine the known position coordinates. Filtering or averaging position fixes by reference positioning receiver 38 over time removes or substantially reduces the effect of selective availability degradation and may provide a more accurate position determination than uncorrupted SPS or even PPS.

One type of correction data generated by reference positioning receiver 38 is a position correction which is applied to the position fix of mobile positioning receiver 24 (FIGURE 4) of mobile unit 17 to achieve a more accurate position fix. The position correction may be in latitude/longitude, compass direction and distance, or any other appropriate coordinate system. When using a

GPS positioning system 12, this technique provides accurate correction data when mobile unit 17 and reference positioning receiver 38 are located in a satellite common view area of approximately thirty square miles. In the satellite common view area all receivers operating in positioning system 12 receive approximately the same pseudorange errors assuming they are all listening to the same group of satellites 18, 20, 22. This correction method places less correction data in correction data stream 44 than other methods, but the validity of those correction terms decreases rapidly as the distance between mobile unit 17 and reference positioning receiver 38 increases. The usefulness of this correction method is impaired when mobile unit 17 and reference positioning receiver 38 compute their position fixes using position signals from different satellites. Furthermore, this method requires that both mobile unit 17 and reference positioning receiver 38 compute a navigation solution.

In an alternative correction method, reference positioning receiver 38 computes pseudorange corrections (PRCs) to each satellite 18, 20, 22, which are then transmitted over correction data stream 44 to mobile unit 17 to refine its navigation solution. The PRCs for satellites 18, 20, 22 in view of reference positioning receiver 38 are the difference between the pseudorange and the computed range to each satellite 18, 20, 22 based on the known position coordinates of reference positioning receiver 38. Each PRC message includes an identification of the satellite 18, 20, 22 and a linear measure of the PRC. Although this method may include more transmission of data, it may result in a more accurate position fix. Furthermore, such a scheme provides additional flexibility to allow mobile unit 17 to use navigation data from any of the satellites that reference positioning receiver 38 has furnished PRCs.

An additional correction method generates position corrections based on possible combinations of satellites 18, 20, 22 currently in view of reference positioning receiver 38. This approach may be computationally intensive at reference positioning receiver 38, but would allow for a simple adjustment of the solution computed by mobile unit 17. The number of position corrections (PCs) may be computed using the following formula:

$$No.\ of\ PCs = \frac{n!}{r!\,(n-r)!}$$

where n is the number of satellites in the common view area and r is the number of satellites used in the position correction calculation. For example, for a position fix using four satellites and with six satellites in the satellite common view area, reference positioning receiver 38 would have to generate fifteen PCs corresponding to fifteen combinations of four satellites each.

Each satellite 18, 20, 22 sends an identifier in its respective message data stream. Both mobile unit 17 and reference positioning receiver 38 may use these identifiers to generate satellite group IDs (SGIDs) that identify the specific combination of satellites used for a position fix. Reference receiver 38 may generate the position correction for fifteen combinations (four satellites chosen from a total of six), and tag the position corrections with the appropriate SGIDs. Mobile unit 17, having determined an SGID for its position fix, may then choose the proper position correction identified by the same SGID to ensure that mobile unit 17 and reference positioning receiver 38 use the same combination of satellites. Using this scheme with the NAVSTAR GPS, there would be 10,626 unique SGIDs for satellite combinations of four out of twenty-four satellites in the planned constellation.

The size and structure of a correction data message generated by reference positioning receiver 38 and transmitter over correction data stream 44 depends on the correction method employed and the precision required. A single pseudorange correction (PRC) message for a satellite in the satellite common view area may include a satellite ID, the range correction in a selected precision, and other associated portions of the message, such as a header, delimiter, and checksum. A typical PRC message for six satellites described in the Motorola GPS Technical Reference Manual (October 1993) is fifty-two bytes long, including the header, delimiter, and checksum.

The size and structure of a single position correction message also depends on the precision required and the transmission protocol. A typical position correction message may include a four byte SGID (1 through 10,626), a one byte latitude correction, and a one byte longitude correction. A multiple position correction message for fifteen satellite combinations (four satellites chosen from a total of six) may total 90 bytes of correction data. Appropriate header, delimiter and checksum bytes consistent with the communication protocol of mobile communications network 14 may be added.

The precision of pseudorange or position corrections depends on the anticipated range of error and the number of bytes allocated to the correction data. For example, one byte of eight bits may provide correction in the range of +/- 127 meters with one meter bit resolution. One byte may also provide correction in 0.25 meter bit resolution over a range of approximately +/- 32 meters. The precision, correction range, and byte allocation is a design choice that considers various factors, such as the available bandwidth in correction data stream 44, the accuracy of the unrefined position fix at mobile unit 17, the correction method employed, and the inherent inaccuracies of positioning system 12.

Correction data stream 44 allows correction data to be transmitted from reference positioning receiver 38 to mobile unit 17. In one embodiment, correction data stream 44 may be the control channel, paging channel, or overhead message stream currently implemented in cellular telephone technology. Currently, the control channel provides paging of incoming calls, hand-off instructions, and other features of the cellular telephone network, but may be modified by one skilled in the art to include transmission of correction data. Correction data stream 44 may also be implemented using any other communication link between transmitter site 40 and mobile communications device 42 (FIGURE 4) in mobile unit 17, whether or not the communication link requires seizing of a voice or data channel.

There are several developing technologies that may provide a convenient implementation of correction data stream 44. For example, cellular digital packet data (CDPD) technology allows integration of data and voice using the existing cellular telephone infrastructure. In a CDPD system, digital packets of data and analog voice segments share the same channel. Other developments in digital cellular communications, such as code division multiple access (CDMA) and time division multiple access (TDMA), allow digital data and digital voice signals to be interspersed on a communications channel. These technologies integrate digital data transmission in a mobile communications network 14, and therefore provide a convenient implementation scheme for correction data stream 44.

Using the technologies mentioned above or other appropriate digital communications link, transmitter site

40 may either continuously broadcast correction data over correction data stream 44, such as in the control channel of the cellular telephone network, or only send correction data to mobile unit 17 when requested by a feature code request or by any other appropriate manner. Transmitter site 40 may send correction data to mobile unit 17 in one large packet or in several smaller packets interspersed with other data used for mobile communications. The correction data may be packaged in existing, but unused, bytes of the control channel or in a dedicated protocol. One possible implementation would place correction data in the extended protocol described in the EIA/TIA-533 mobile communications standard, which provides for bidirectional communication between transmitter site 40 and mobile unit 17.

Reference positioning receiver 38 may continuously receive position updates and continuously compute correction data for transmission to mobile unit 17 over correction data stream 44. Alternatively, reference positioning receiver 38 may send correction data over correction data stream 44 at predetermined time intervals, at designated times when correction data stream 44 can accommodate the additional traffic, or when requested by mobile unit 17.

Reference positioning receiver 38 may include an additional capability to ensure that correction data transmitted to mobile unit 17 by transmitter site 40 is current. This may be accomplished by including a time stamp in the correction data message to account for latency in the system. Using GPS technology as an example, satellites 18, 20, 22 in positioning system 12 provide position navigation data each second. Reference positioning receiver 38 may include an additional byte that indicates the delay in seconds of the correction data. The mobile unit 17 may save time-stamped position signals and later synchronize and correct the position signals with the time-stamped correction data received from transmitter site 40. The post-processing to refine past position fixes may be performed by mobile positioning receiver 24 (FIGURE 4) or other separate processor in mobile unit 17.

Correction data stream 44 may be part of the control channel, part of a seized voice or data channel, or a separate channel requiring mobile unit 17 to re-tune to the correction data stream channel to receive valid corrections for the area. Mobile unit 17 may continuously monitor correction data stream 44 transmitted from transmitter site 40. Furthermore, mobile unit 17 may alternately tune between several correction data streams 44 from several transmitter sites 40 to determine the strongest signal, usually relating to the nearest transmitter site 40. This strongest channel select feature of mobile unit 17 assures that reference positioning receiver 38 and mobile unit 17 will be in close proximity and receive position signals from the same group or nearly the same group of satellites 18, 20, 22. For a typical transmitter site spacing in a cellular telephone network, the distance between mobile unit 17 and reference positioning receiver 38 may be less than five miles, well within the satellite common view area of the GPS system.

Differential positioning system 10, as illustrated in FIGURE 1, contemplates placing reference positioning receiver 38 on each transmitter site 40 within mobile communications network 14. When using GPS technology as positioning system 12 and a cellular telephone network as mobile communications network 14, the satellite common view area may be much larger than the coverage area of a single transmitter site 40, thereby obviating the need to have reference positioning receivers 38 on each transmitter site 40. For example, differential positioning system 10 may include reference positioning receivers 38 on selected transmitter sites 40 of mobile communications network 14. In this configuration, mobile unit 17, which may be capable of simultaneously monitoring correction data streams 44 from multiple transmitter sites 40, may still receive correction data from a transmitter site 40 that is currently not providing communication service to mobile unit 17. Selected transmitter sites 40 equipped with reference positioning receivers 38 may be spaced so that mobile unit 17 located anywhere in mobile communications network 14 can receive correction data of sufficient signal strength from one of the selected transmitter sites 40 equipped with reference positioning receivers 38.

FIGURE 2 shows an alternative embodiment of differential positioning system 10 that places reference receivers 38 on selected transmitter sites 40 in mobile communications network 14. As in FIGURE 1, transmitter site 40 is associated with reference positioning receiver 38, which receives position signals in message data streams 32, 34, 36 from satellites 18, 20, 22, respectively. However, mobile unit 17 is located in an area serviced by transmitter site 46, which is not equipped with reference positioning receiver 38. Furthermore, mobile unit 17 is unable to receive correction data directly from transmitter site 40 due to the inability to monitor communications from transmitter sites 40 and 46, the distance from transmitter site 40, or other reasons. However, mobile unit 17 is close enough to reference positioning receiver 38 to receive navigation data from at least a subset of satellites 18, 20, 22 serving reference positioning receiver 38. Using any of the correction methods described above with reference to FIGURE 1, reference positioning receiver 38 generates correction data and transmits this correction data through link 48 to transmitter site 46. Transmitter site 46 transmits correction data generated by reference positioning receiver 38 over correction data stream 44 to mobile unit 17. Mobile unit 17 uses the correction data to refine a position fix derived from position signals received from satellites 18, 20, 22 over message data streams 26, 28, 30.

Differential positioning system 10, illustrated in FIGURE 2, reduces the number of reference positioning receivers 38 required by networking correction data through link 48 between transmitter sites 40, 46. Link 48 between transmitter sites 40, 46 may include microwave communications, bidirectional paging or control channels, direct land-line connections, switching stations such as MTSOs, or any other appropriate communications device to send correction data from transmitter site 40 to transmitter site 46.

FIGURE 3 is a schematic representation of transmitter site 40 associated with reference positioning receiver 38. Reference positioning receiver 38 may be mounted directly on transmitter site 40 or on a separate structure or mounting. Reference positioning receiver 38 includes an antenna 50, receiver 51, controller 52, and memory 54. The following description relates to the operation of reference positioning receiver 38 with a GPS positioning system, however, the same concepts apply to other land-based and satellite-based positioning systems.

Reference positioning receiver 38 receives position signals in message data streams 32, 34, 36 from satellites 18, 20, 22, respectively. The position signals include navigation data, such as ephemeris, almanac, and clock correction data. Ephemeris data includes detailed information about the specific satellite course over the next two hours, the almanac data includes less detailed information about the complete satellite constellation for a longer period, and the clock correction data includes information to correct for clock errors. The satellite transmissions received by antenna 50 consist of a direct sequence spread spectrum signal containing the ephemeris, almanac, and clock correction data at a rate of fifty bits per second. In the case of the SPS, a pseudorandom noise signal with a chip rate of 1.023 MHz that is unique to each satellite is used to spread the spectrum of the information which is then transmitted on a center frequency of 1575.42 MHz.

Receiver 51 receives satellite position signals having a bandwidth of approximately 2 MHz and a signal-to-noise ratio of approximately -20 dB. The relative movement between satellites 18, 20, 22 and reference positioning receiver 38 causes an additional Doppler frequency offset from the GPS center frequency. To recover the navigation data and measure the propagation time of the satellite position signals, receiver 51 must cancel or allow for the Doppler frequency offset and generate the proper coarse/acquisition code associated with each satellite 18, 20, 22 to despread the signal. Once synchronization with the pseudorandom noise signal is achieved, receiver 51 may extract the ephemeris, almanac, and clock correction data and pass this information to controller 52.

Controller 52 receives navigation data from at least three satellites and uses this information to determine a navigation solution based on well-known triangulation techniques. In a four satellite fix, with each satellite position represented by coordinates (X_n, Y_n, Z_n) with the indice n equal to one through four, the position coordinates (X, Y, Z) of reference positioning receiver 38 may be determined by solving the following equations:

$$(X_1 - X)^2 + (Y_1 - Y)^2 + (Z_1 - Z)^2 = (R_1 - C_B)^2$$
$$(X_2 - X)^2 + (Y_2 - Y)^2 + (Z_2 - Z)^2 = (R_2 - C_B)^2$$
$$(X_3 - X)^2 + (Y_3 - Y)^2 + (Z_3 - Z)^2 = (R_3 - C_B)^2$$
$$(X_4 - X)^2 + (Y_4 - Y)^2 + (Z_4 - Z)^2 = (R_4 - C_B)^2$$

where R_1, R_2, R_3, R_4 are pseudorange measurements from the satellites and C_B is a common clock bias. Controller 52 may use certain data stored in memory 54 to arrive at a navigation solution. Controller 52 may then compare the instantaneous navigation solution (X, Y, Z) to known position coordinates (X_0, Y_0, Z_0) stored in memory 54 to generate position correction data in latitude/longitude, compass direction and distance, or other appropriate coordinate system.

In an alternative embodiment, controller 52 may receive ephemeris, almanac, and clock correction data from satellites 18, 20, 22 and compute a pseudorange (R_N) for each satellite. Since the satellite signal contains information on the precise satellite orbits and controller 52 has known position coordinates (X_0, Y_0, Z_0) stored in memory 54, the true range to each satellite 18, 20, 22 can be calculated. By comparing the true range and the measured pseudorange, a pseudorange correction (PRC) for each satellite 18, 20, 22 may be computed and sent as correction data. As described above with reference to FIGURE 1, controller 52 may also provide position correction data based on navigation solutions using all possible combinations of satellites 18, 20, 22 currently in view of reference positioning receiver 38.

Correction data in any of the various forms described above is sent by controller 52 to channel controller 56 of transmitter site 40 over communication link 58. Communication link 58 may be a direct wire connection, a radio communication link, a connection through a switched telephone system, or other appropriate communication link. Depending on the configuration of differential positioning system 10, channel controller 56 may send correction data to radio duplexer 60 for transmission over transmitter site antenna 62 to mobile unit 17. Alternatively, channel controller 56 may pass correction data through link 48 to transmitter site 46 currently serving mobile unit 17.

Also shown in FIGURE 3 as part of transmitter site 40 are time-of-arrival (TOA) data generator 64 and clock 66 that may be used in an alternative positioning system 200 described with reference to FIGURE 6. TOA data generator 64 generates a TOA data message and sends this message to channel controller 56 for transmission to mobile unit 17 over transmitter site antenna 62. The TOA data message may include a precise time of transmission based on information maintained by clock 66. Clock 66 and TOA data generator 64 are shown as elements of transmitter site 40, but it should be understood that their functions may also be implemented in a central or distributed device accessible by transmitter sites 40, 46 of mobile communications network 14.

FIGURE 4 is a schematic representation of a mobile unit 17 that includes mobile positioning receiver 24, mobile communications device 42, and other associated hardware and software, described below. Mobile positioning receiver 24 is similar in construction and function to reference positioning receiver 38 and includes an antenna 82, receiver 84, controller 86, and memory 88. In operation, mobile positioning receiver 24 receives position signals from satellites 18, 20, 22 over message data streams 26, 28, 30 at antenna 82. Receiver 84 processes these signals to extract ephemeris, almanac, and clock correction data. Controller 86 receives this information and computes a navigation solution or pseudorange measurements. These calculations performed by controller 86 may use data stored in memory 88.

Mobile communications device 42 includes an antenna 90, transceiver 92, and hand set 94. In operation, mobile communications device 42 receives correction data at antenna 90 over correction data stream 44. The correction data may be transmitted directly from transmitter site 40 equipped with reference positioning receiver 38 as described with reference to FIGURE 1, or indirectly through link 48 and transmitter site 46 as described with reference to FIGURE 2. As described above, the correction data may be in a variety of forms, including single or multiple position corrections, or pseudorange corrections to each satellite. Correction data is then stripped from correction data stream 44 by transceiver 92. Correction data may be passed to processor 100 over link 95 or over any other appropriate path, such as through bus drivers 112 and modem or dual tone multifrequency (DTMF) coder/decoder 110. Hand set 94 provides traditional voice or data communication using mobile communications device 42.

Processor 100 manages the communicating, locating, and reporting features of mobile unit 17. Processor 100 receives a navigation solution or pseudorange measurements from controller 86 and correction data from transceiver 92. Coupled to processor 100 is memory 102 which may contain programs, databases, and other information required by processor 100 to perform its functions. For example, memory 102 may contain a table of known position coordinates of transmitter sites 40 for use in computing the position of mobile unit 17 in the alternative positioning system 200 described with reference to FIGURE 6. Memory 102 may be random access memory (RAM), read-only memory (ROM), CD-ROM, removable memory devices, or any other device that allows storage or retrieval of data.

Processor 100 and controller 86, as well as memory 102 and memory 88, may be separate or integral components of mobile unit 17. For example, controller 86 may include a port that directly receives correction data and allows mobile positioning receiver 24 to output a refined position fix. Mobile unit 17 contemplates any arrangement, processing capability, or task assignment between controller 86 and processor 100.

In operation, processor 100 generates a refined position fix for mobile unit 17 based on the navigation solution or pseudorange measurements from controller 86 and the correction data from transceiver 92. This refined position fix may be sent to output device 104 to generate a moving or static display of vehicle 16 on a map represented by map data stored in memory 102. Alternatively, output device 104 may produce audible information, such as directions or location updates, to the operator of vehicle 16.

Processor 100 is also coupled to input device 106 that allows operation of mobile unit 17. Input device 106 may be a keypad or touch screen, as well as voice recognition software and hardware that can accept audible commands and information. Furthermore, both output device 104 and input device 106 may include fixed or removable storage media, such as magnetic computer discs, CD-ROM, or other suitable media to both receive output and provide input to processor 100.

Processor 100 may also generate data messages for transmission to a remote location using mobile communications device 42. The data messages may include the refined position fix of mobile unit 17, the time of reporting, or information input by the vehicle operator, as well as any other information collected by processor 100 from various sensors 108. For example, sensors 108 may include various engine sensors, truck trailer sensors, security monitors, or other devices generating information on the status or condition of mobile unit 17, vehicle 16, or its operator. The generation and transmission of a data message may be based on elapsed time, movement of mobile unit 17, sensor readings, or any other piece of information that may necessitate reporting to a remote location. The data messages are sent from processor 100 through modem or DTMF coder/decoder 110 to bus drivers 112, and then to transceiver 92 for transmission over antenna 90 to a remote location, such as central host 120 (FIGURE 5). Data messages may also be sent directly to transceiver 92 over link 95.

Mobile unit 17 may also include a clock 116 coupled to processor 100 that may be used to synchronize the navigation solutions or pseudorange measurements received from controller 86 with latent correction data received from transceiver 92. Clock 116 may also be used in alternative positioning system 200 described with reference to FIGURE 6. In operation, clock 116 provides accurate time to processor 100, and may receive clock correction updates from mobile positioning receiver 24 or through correction data from mobile communications device 42.

Components of mobile unit 17 shown in FIGURE 4 may be packaged into one or more housings. Mobile unit 17 may be mounted to vehicle 16 or an object to be tracked. Mobile unit 17 may also be packaged as a portable, hand-held device that provides personal locating, communicating, and reporting functions. For example, a portable, hand-held mobile unit 17 may be used by surveyors, rescue teams, individuals that may change forms of transportation, or any other application requiring portability of mobile unit 17.

FIGURE 5 is a schematic representation of a central host 120. Central host 120 receives communications from mobile unit 17, such as reports generated by processor 100, through link 122. Link 122 may be one or a combination of dedicated telephone lines, switched telephone lines, microwave communications links, satellite-based communications links, or any other suitable communication link that allows mobile unit 17 to transmit data to or receive data from central host 120.

A data message from mobile unit 17 enters central host 120 through a modem or DTMF coder/decoder 124 and passes to central controller 126. Coupled to central controller 126 is memory 128 and input/output device 130. Memory 128 may be RAM, ROM, CD-ROM, removable memory devices, or any other device that allows storage or retrieval of data. Input/output 130 includes any variety of output devices, such as a display, a speaker to provide audible information, removable storage media, or any other appropriate output device. Input/output device 130 may also include a variety of input devices, such as a keyboard, mouse, touch screen, removable storage media, or any other appropriate input device.

Central controller 126 receives data messages from mobile unit 17 and processes this information to locate, track, dispatch, and communicate with mobile unit 17. For example, central controller 126 can maintain a database in memory 128 of all mobile units 17 with their current location, status, and relevant sensor readings. This database can also be used to initiate communication with mobile unit 17. Furthermore, central controller 126 may perform a call delivery function that routes incoming calls to mobile unit 17 through link 122. This aspect of call delivery is fully described in Application Serial No. 08/095,166, entitled "Method and Apparatus for a Nation-Wide Cellular Telephone Network" filed July 20, 1993, and Application Serial No. 08/175,256 entitled "Data Messaging in a Communications Network" filed December 28, 1993, both applications commonly owned by the assignee of the present application, and both applications hereby incorporated by reference.

FIGURE 6 illustrates an alternative positioning system 200 that utilizes equipment of the existing mobile communications network 14 to locate vehicle 16 equipped with a modified mobile unit 17. Mobile unit 17 communicates with transmitter sites 202, 204, 206 over communications links 208, 210, 212, respectively. Communication links 208, 210, 212 may be the control channel, overhead message stream, or paging channel of a cellular telephone network, a portion or all of a seized voice or data channel, or a dedicated channel. Transmitter sites 202, 204, 206 may be coupled to a network in a variety of ways. For example, transmitter site 202 is coupled to transmitter site 204 over land-line connections through MTSO 214. Transmitter site 202 is coupled to transmitter site 206 over a microwave or other radio link 216. Transmitter site 204 is coupled to transmitter site 206 over a direct or dedicated connection 218.

Positioning system 200 operates in a similar fashion to an aspect of differential positioning system 10 described with reference to FIGUREs 1 and 2, but does not rely on a positioning system 12 to transmit navigation data. Instead, transmitter sites 202, 204, 206 transmit time-of-arrival (TOA) data over respective communications links 208, 210, 212. Mobile unit 17 receives TOA data and computes the position of mobile unit 17 using the TOA data and known position coordinates of transmitter sites 202, 204, 206.

The TOA data from transmitter sites 202, 204, 206 may be transmitted in a variety of ways. In one method, a network clock 220 synchronizes the instantaneous transmission of TOA data from transmitter sites 202, 204, 206. Using this method, the time of reception at mobile unit 17 provides pseudorange measurements to transmitter sites 202, 204, 206. As in differential positioning system 10 of FIGUREs 1 and 2, a fourth transmitter site allows the position of mobile unit 17 to be computed without regard for a clock bias (C_B) between network clock 220 and clock 116 (FIGURE 4) maintained on mobile unit 17.

In another embodiment, transmitter sites 202, 204, 206 transmit TOA data at different times, but include the time of transmission in the message to mobile unit 17. Assuming cellular transmitter sites 202, 204, 206 maintain synchronized time through network clock 220, mobile unit 17 can generate pseudorange measurements by comparing the message time of arrival to the time of transmission.

Transmitter sites 202, 204, 206 and mobile unit 17 may have different configurations when operating in positioning system 200. Referring to FIGURE 3, transmitter site 40 does not need an associated reference positioning receiver 38 to provide location information in positioning system 200. Transmitter site 40, however, does include TOA data generator 64 and clock 66 to generate the TOA data for transmission to mobile unit 17. Referring now to FIGURE 4, mobile unit 17 does not require mobile positioning receiver 24 for operation within positioning system 200. TOA data is received by transceiver 92 and sent to processor 100, which uses the TOA data to compute pseudoranges to cellular transmitter sites 202, 204, 206. Using well-known triangulation techniques described with reference to FIGURE 3, processor 100 may then compute a position fix of mobile unit 17 using the pseudoranges and known position coordinates of transmitter sites 202, 204, 206 stored in memory 102.

Although the present invention has been described with several embodiments, various changes and modifications may be suggested to one skilled in the art, and it is intended that the present invention encompass such changes and modifications as fall within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A locating system using a cellular telephone network and a positioning system, comprising:

a reference positioning receiver having known position coordinates and operable to receive first position signals from the positioning system, the reference positioning receiver further operable to generate correction data in response to the first position signals and the known position coordinates;

a transmitter site of the cellular telephone network coupled to the reference positioning receiver, the transmitter site operable to transmit the correction data generated by the reference positioning receiver; and

a mobile unit in communication with the cellular telephone network and the positioning system, the mobile unit operable to receive correction data transmitted by the transmitter site, the mobile unit further operable to receive second position signals from the positioning system and to determine the location of the mobile unit in response to the second position signals and the correction data.

2. The system of Claim 1, wherein the transmitter site transmits the correction data in a control channel.

3. The system of Claim 1, wherein the reference positioning receiver is mounted on the transmitter site.

4. The system of Claim 1, wherein the known position coordinates of the reference positioning receiver are based on data received by the reference positioning receiver over a statistically significant period of time.

5. The system of Claim 1, wherein the correction data comprises a position correction representing a comparison between a position fix based on the first position signals and the known position coordinates of the reference positioning receiver.

6. The system of Claim 1, wherein:

the first position signals comprise time-of-arrival data received by the reference positioning receiver from a plurality of satellites; and

the correction data comprises pseudorange corrections for each satellite.

7. The system of Claim 1, further comprising:

a memory coupled to the mobile unit, the memory operable to store map data; and

a display coupled to the mobile unit, the display operable to display the location of the mobile unit and the map data.

8. The system of Claim 1, further comprising a central controller coupled to the mobile unit, the central controller operable to receive the location of the mobile unit.

9. The system of Claim 1, wherein the mobile unit is mounted on a vehicle.

10. The system of Claim 1, wherein the mobile unit is housed in a portable, hand-held housing.

11. The system of Claim 1, wherein the mobile unit further comprises:

a mobile communications device in communication with the cellular telephone network, the mobile communications device operable to receive correction data transmitted by the transmitter site;

a mobile positioning receiver coupled to the mobile communications device, the mobile positioning receiver operable to receive second position signals from the positioning system; and

a processor coupled to the mobile communications device and the mobile positioning receiver, the processor operable to determine the location of the mobile unit in response to the second position signals received from the mobile positioning receiver and the correction data received from the mobile communications device.

12. A locating system using a mobile communications network and a positioning system, comprising:

a reference positioning receiver having known position coordinates and operable to receive first position signals from the positioning system, the reference positioning receiver further operable to generate correction data in response to the first position signals and the known position coordinates;

a first transmitter site of the mobile communications network coupled to the reference positioning receiver;

a second transmitter site of the mobile communications network coupled to the first transmitter site, the second transmitter site operable to transmit correction data received from the first transmitter site; and

a mobile unit in communication with the second transmitter site and the positioning system, the mobile unit operable to receive correction data transmitted by the second transmitter site, the mobile unit further operable to receive second position signals from the positioning system and to determine the location of the mobile unit in response to the second position signals and the correction data.

13. The system of Claim 12, further comprising a communications link coupled to the first and second transmitter sites, the communications link operable to receive correction data from the first transmitter site and to transmit the correction data to the second transmitter site.

14. The system of Claim 12, wherein the second transmitter site transmits the correction data in a control channel.

15. The system of Claim 12, wherein the reference positioning receiver is mounted on the first transmitter site.

16. The system of Claim 12, wherein the known position coordinates of the reference positioning receiver are based on data received by the reference positioning receiver over a statistically significant period of time.

17. The system of Claim 12, wherein the correction data comprises a position correction representing a comparison between a position fix based on the first position signals and the known position coordinates of the reference positioning receiver.

18. The system of Claim 12, wherein:

the first position signals comprise time-of-arrival data received by the reference positioning receiver from a plurality of GPS satellites; and

the correction data comprises pseudorange corrections for each GPS satellite.

19. The system of Claim 12, further comprising:

a memory coupled to the mobile unit, the memory operable to store map data; and

a display coupled to the mobile unit, the display operable to display the location of the mobile unit and the map data.

20. The system of Claim 12, further comprising a central controller coupled to the mobile unit, the central controller operable to receive the location of the mobile unit.

21. The system of Claim 12, wherein the mobile unit is mounted on a vehicle.

22. The system of Claim 12, wherein the mobile unit is housed in a portable, hand-held housing.

23. The system of Claim 12, wherein the mobile unit further comprises:

a mobile communications device in communication with the cellular telephone network, the mobile communications device operable to receive correction data transmitted by the second transmitter site;

a mobile positioning receiver coupled to the mobile communications device, the mobile positioning receiver operable to receive second position signals from the positioning system; and

a processor coupled to the mobile communications device and the mobile positioning receiver, the processor operable to determine the location of the mobile unit in response to the second position signals received from the mobile positioning receiver and the correction data received from the mobile communications device.

24. An apparatus for locating a vehicle within the service area of a cellular telephone network and a positioning system, comprising:

a positioning receiver on the vehicle and operable to receive first position signals from the positioning system;

a mobile communications device on the vehicle and coupled to a transmitter site of the cellular telephone network, the mobile communications device operable to receive correction data transmitted by the transmitter site; and

a processor on the vehicle and coupled to the positioning receiver and the mobile communications device, the controller operable to determine the location of the vehicle in response to the first position signals and the correction data.

25. The apparatus of Claim 24, wherein the mobile communications device receives the correction data in a control channel transmitted by the transmitter site of the cellular telephone network.

26. The apparatus of Claim 24, further comprising:

a memory coupled to the processor, the memory operable to store map data; and

a display coupled to the processor, the display operable to display the location of the vehicle and the map data.

27. The apparatus of Claim 24, further comprising a central controller coupled to the mobile communications device, the central controller operable to receive the location of the vehicle.

28. The apparatus of Claim 24, wherein the correction data comprises a position correction.

29. The apparatus of Claim 24, wherein the correction data comprises pseudorange corrections from a plurality of satellites in the positioning system.

30. A method for locating a mobile unit within the service area of a cellular telephone network and a positioning system, comprising:

receiving first position signals from the positioning system at a reference positioning receiver having known position coordinates;

generating correction data in response to the first position signals and the known position coordinates;

receiving correction data at a cellular transceiver in the mobile unit;

receiving second position signals from a positioning system at a mobile positioning receiver in the mobile unit; and

determining the location of the mobile unit in response to the second position signals and the correction data.

31. The method of Claim 30, wherein the correction data is received at the cellular transceiver in a control channel.

32. The method of Claim 30, wherein the correction data comprises a position correction representing a comparison between a position fix based on the first position signals and the known position coordinates of the reference positioning receiver.

33. The method of Claim 30, wherein:

the positioning system comprises a plurality of satellites; and

the correction data comprises pseudorange corrections for each satellite.

34. The method of Claim 30, further comprising the step of displaying the location of the mobile unit on a map.

35. The method of Claim 30, further comprising the step of receiving the location of the mobile unit at a remote location.

36. The method of Claim 30, wherein the positioning system is GPS.

37. A system for locating a mobile unit within the service area of a mobile communications network, comprising:

a plurality of transmitter sites within the mobile communications network, each transmitter site operable to transmit time-of-arrival data, each transmitter site having known position coordinates;

a mobile communications device on the mobile unit and coupled to the transmitter sites, the mobile communications device operable to receive time-of-arrival data transmitted by at least three transmitter sites;

a memory on the mobile unit and operable to store known position coordinates of the transmitter sites; and

a processor on the mobile unit and coupled to the mobile communications device and the memory, the processor operable to receive time-of-arrival data from the mobile communications device, the processor further operable to determine the position of the mobile unit in response to the time-of-arrival data received from the transmitter sites and the known position coordinates of the transmitter sites stored in the memory.

38. The system of Claim 37, wherein the transmitter sites are associated with a cellular telephone system.

39. The system of Claim 37, wherein the transmitter sites simultaneously transmit time-of-arrival data.

40. The system of Claim 37, wherein the controller is operable to determine the position of the mobile unit using triangulation techniques.

41. The system of Claim 37, wherein the transmitter sites furnish time-of-arrival data in response to a request by the mobile unit.

42. The system of Claim 37, wherein time-of-arrival data contains information relating to the time of transmission of the time-of-arrival data from the transmitter sites.

43. The system of Claim 37, further comprising a clock coupled to the transmitter sites, the clock operable to synchronize the transmission of time-of-arrival data from the transmitter sites.

44. A system for locating a mobile unit within the service area of a mobile communications network, comprising:

a plurality of transmitter sites within the mobile communications network, each transmitter site operable to transmit time-of-arrival data and known position coordinates associated with each transmitter site;

a mobile communications device on the mobile unit and coupled to the transmitter sites, the mobile communications device operable to receive time-of-arrival data and known position coordinates transmitted by at least three transmitter sites; and

a processor on the mobile unit and coupled to the mobile communications device, the processor operable to receive time-of-arrival data and known position coordinates from the mobile communications device, the processor further operable to determine the position of the mobile unit in response to the time-of-arrival data and the known position coordinates.

45. The system of Claim 44, wherein the transmitter sites are associated with a cellular telephone system.

46. The system of Claim 44, wherein the transmitter sites simultaneously transmit time-of-arrival data and known position coordinates.

47. The system of Claim 44, wherein the controller is operable to determine the position of the mobile unit using triangulation techniques.

48. The system of Claim 44, wherein the transmitter sites furnish time-of-arrival data and known position coordinates in response to a request by the mobile unit.

49. The system of Claim 44, wherein time-of-arrival data contains information relating to the time of transmission of the time-of-arrival data from the transmitter sites.

50. The system of Claim 44, further comprising a clock coupled to the transmitter sites, the clock operable to synchronize the transmission of time-of-arrival data and known position coordinates from the transmitter sites.

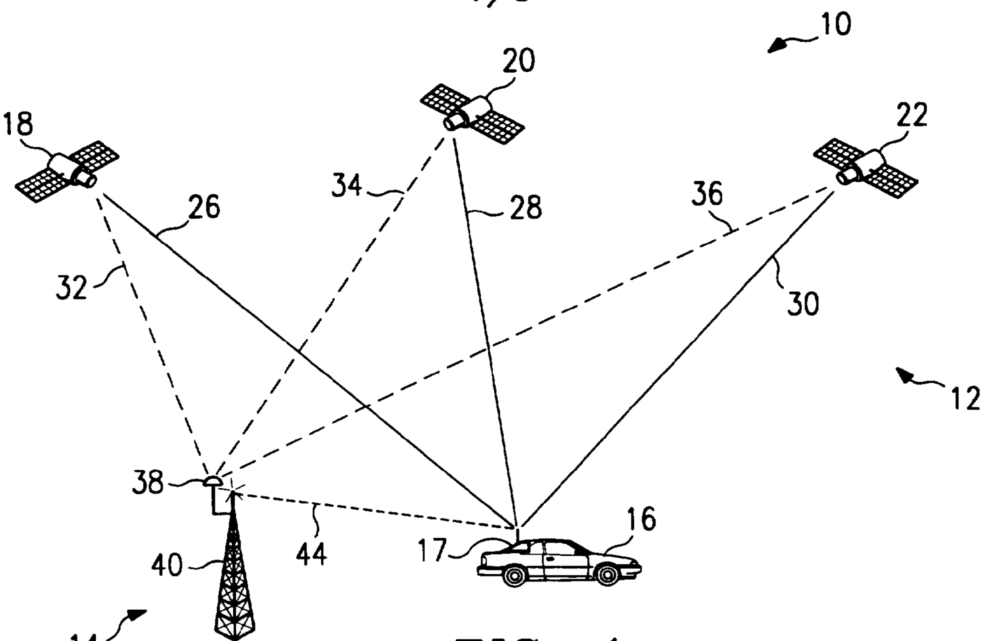
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FIG. 1

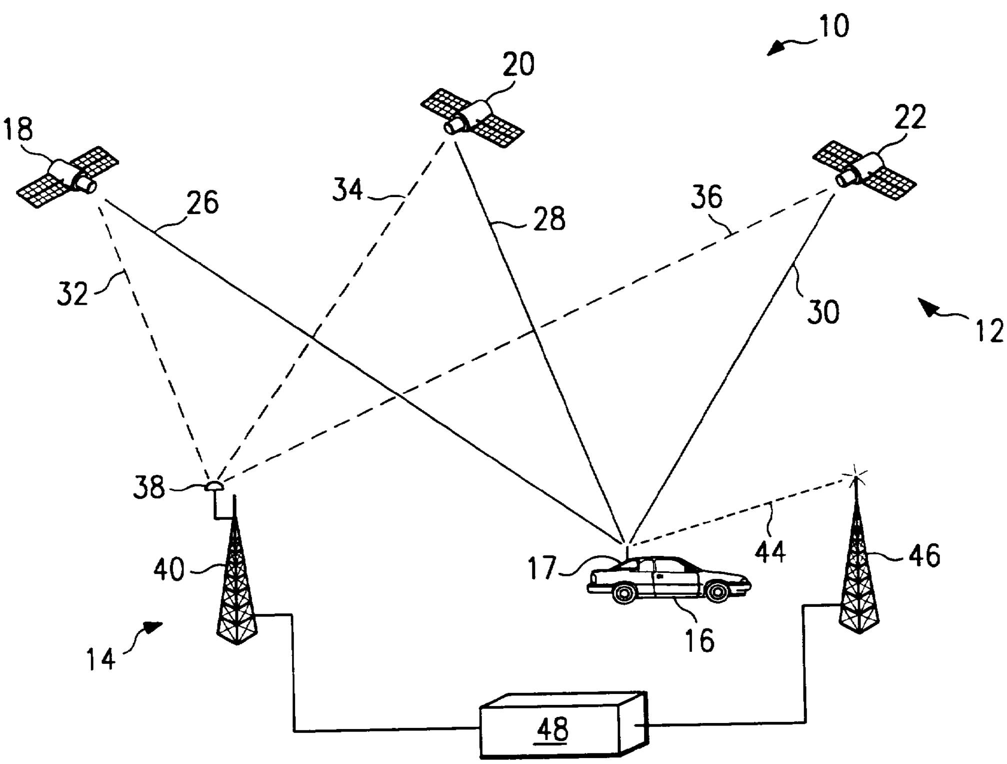
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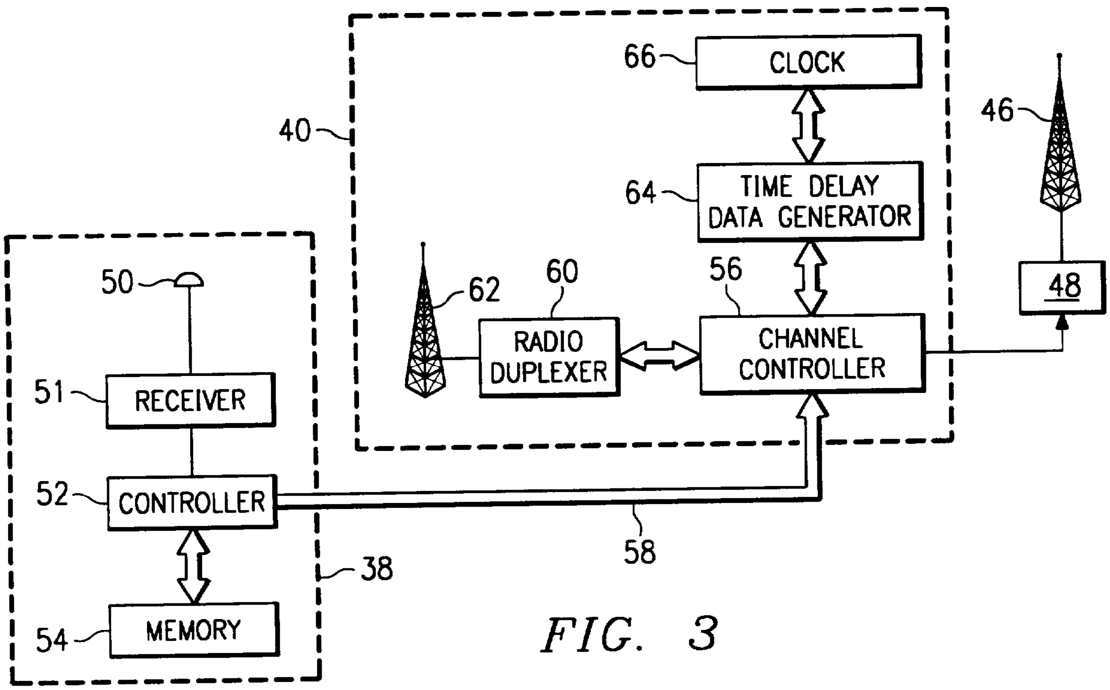
FIG. 2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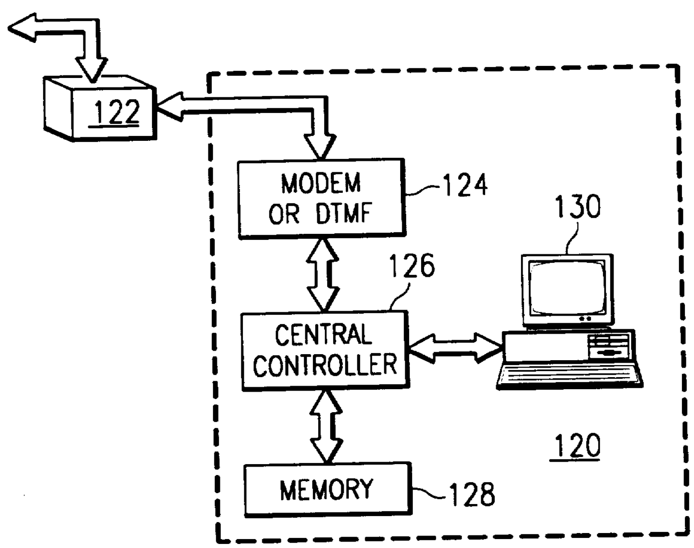
CLOCK
40
46
64
TIME DELAY
DATA GENERATOR
50
62
60
56
48
RADIO
DUPLEXER
CHANNEL
CONTROLLER
51
RECEIVER
52
CONTROLLER
38
58
54
MEMORY

FIG. 3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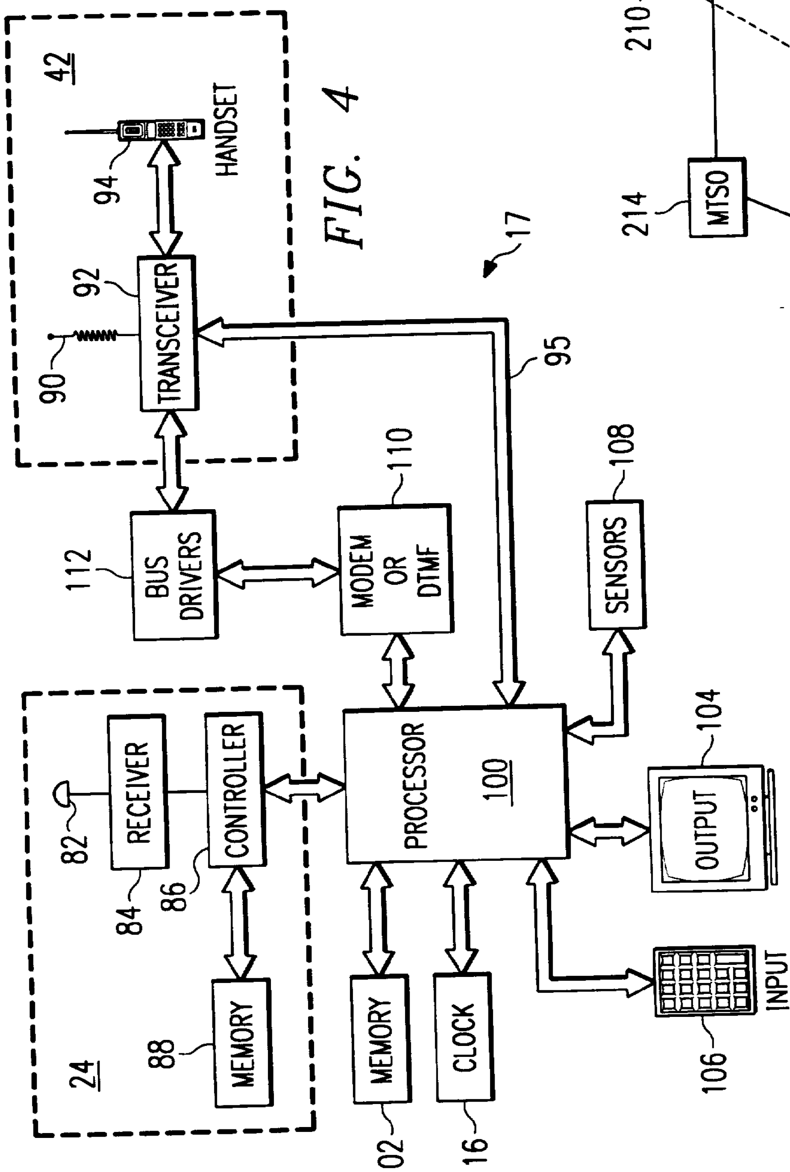
MODEM
OR DTMF
124
130
126
CENTRAL
CONTROLLER
120
MEMORY
128

FIG. 5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HANDSET
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TRANSCEIVER
95
17
112
BUS DRIVERS
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MODEM OR DTMF
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SENSORS
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82
RECEIVER
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CONTROLLER
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MEMORY
PROCESSOR
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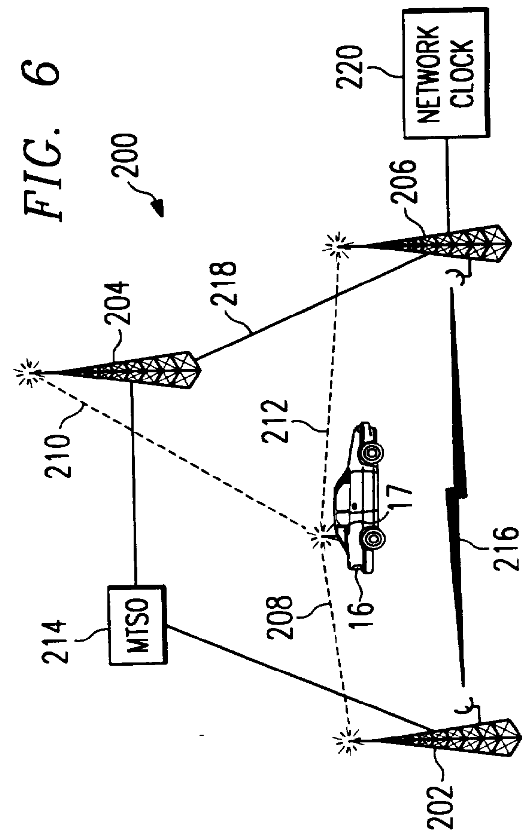
OUTPUT
102
MEMORY
116
CLOCK
106
INPUT

FIG. 4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NETWORK CLOCK
206
204
218
210
212
17
16
214
MTSO
208
216
202

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/14862

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04Q 7/00
US CL :455/33.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/33.1,89,54.1,56.1,33.4,53.1; 342/357, 379/61

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

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

APS
search terms: gps,global positioning system,cellular

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US, A, 5,389,934 (KASS) 14 February 1995, figs 1,2,col 1, line 20 - col 2, line 54)	1-50
Y	US, A, 5,225,842 (BROWN ET AL) 06 July 1993, fig 1, col 4, line 48 - col 6, line 43	1-50
Y	US, A, 5,119,102 (BARNARD) 02 June 1992, figs 1,3, col 1, line 57 - col 2, line 52.	24-29
Y	US, A, 5,155,490 (SPRADLEY, JR. ET AL) 13 October 1992, figs 1,2, col 1, line 44 - col 4, line 19.	4,6,16-18, 39, 41-43,46,48-50
A	US, A, 5,323,322 (MUELLER ET AL) 21 June 1994, fig 1, col 12, line 21-68.	1-50

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07 JANUARY 1996

Date of mailing of the international search report
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PCT

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) **International Patent Classification** 6 :
H04B 7/185, G01S 5/02

A1

(11) **International Publication Number:** **WO 97/33382**

(43) **International Publication Date:** 12 September 1997 (12.09.97)

(21) **International Application Number:** PCT/US97/03512

(22) **International Filing Date:** 7 March 1997 (07.03.97)

(30) **Priority Data:**
08/612,582 8 March 1996 (08.03.96) US
08/759,523 4 December 1996 (04.12.96) US

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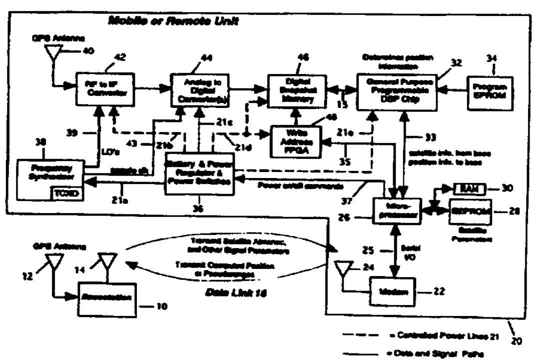
(81) **Designated States:** AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) **Title:** AN IMPROVED GPS RECEIVER UTILIZING A COMMUNICATION LINK



(57) **Abstract**

A precision carrier frequency signal for calibrating a local oscillator (56) of a GPS receiver which is used to acquire GPS signals. The precision carrier frequency signal is used to calibrate the local oscillator such that the output of the local oscillator, which is used to acquire GPS signals, is modified by a reference signal generated from the precision carrier frequency signal. The GPS receiver locks (53) to this precision carrier frequency signal and generates the reference signal. In another aspect of the invention, satellite almanac data is transmitted to a remote GPS receiver unit (20) from a base station (12) via a communication link. The remote GPS receiver unit uses this satellite almanac data to determine approximate Doppler data for satellites in view of the remote GPS receiver unit.

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AN IMPROVED GPS RECEIVER UTILIZING A COMMUNICATION LINK

BACKGROUND OF THE INVENTION

RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Patent Application Serial No. 08/612,582, filed on March 8, 1996 by Norman F. Krasner.

This application is also related to and hereby claims the benefit of the filing date of a provisional patent application by the same inventor, Norman F. Krasner, which application is entitled Low Power, Sensitive Pseudorange Measurement Apparatus and Method for Global Positioning Satellites Systems, Serial No. 60/005,318, filed October 9, 1995.

1. FIELD OF THE INVENTION

The present invention relates to receivers capable of determining position information of satellites and, in particular, relates to such receivers which find application in global positioning satellite (GPS) systems.

2. BACKGROUND ART

GPS receivers normally determine their position by computing relative times of arrival of signals transmitted simultaneously from a multiplicity of GPS (or NAVSTAR) satellites. These satellites transmit, as part of their message, both satellite positioning data as well as data on clock timing, so-called "ephemeris" data. The process of searching for and acquiring GPS signals, reading the ephemeris data for a multiplicity of satellites and computing the location of the receiver from this data is time consuming, often requiring several minutes. In many cases, this lengthy processing time is unacceptable and, furthermore, greatly limits battery life in micro-miniaturized portable applications.

Another limitation of current GPS receivers is that their operation is limited to situations in which multiple satellites are clearly in view, without obstructions, and where a good quality antenna is properly positioned to receive such signals. As such, they normally are unusable in portable, body mounted applications; in areas where there is significant foliage or building blockage; and in in-building applications.

There are two principal functions of GPS receiving systems: (1) computation of the pseudoranges to the various GPS satellites, and (2) computation of the position of the receiving platform using these pseudoranges and satellite timing and ephemeris data. The pseudoranges are simply the time delays measured between the received signal from each satellite and a local clock. The satellite ephemeris and timing data is extracted from the GPS signal once it is acquired and tracked. As stated above, collecting this information normally takes a relatively long time (30 seconds to several minutes) and must be accomplished with a good received signal level in order to achieve low error rates.

Virtually all known GPS receivers utilize correlation methods to compute pseudoranges. These correlation methods are performed in real time, often with hardware correlators. GPS signals contain high rate repetitive signals called pseudorandom (PN) sequences. The codes available for civilian applications are called C/A codes, and have a binary phase-reversal rate, or "chipping" rate, of 1.023 MHz and a repetition period of 1023 chips for a code period of 1 msec. The code sequences belong to a family known as Gold codes. Each GPS satellite broadcasts a signal with a unique Gold code.

For a signal received from a given GPS satellite, following a downconversion process to baseband, a correlation receiver multiplies the received signal by a stored replica of the appropriate Gold code contained within its local memory, and then integrates, or lowpass filters, the product in order to obtain an indication of the presence of the signal. This process is termed a "correlation" operation. By sequentially adjusting the relative timing of this stored replica relative to the received signal, and observing the correlation output, the receiver can determine the time delay between the received signal and a local clock. The initial determination of the presence of such an output is termed "acquisition." Once acquisition occurs, the process enters the "tracking" phase in which the timing of the local reference is adjusted in small amounts in order to maintain a high correlation output. The correlation output during the tracking phase may be viewed as the GPS signal with the pseudorandom code removed, or, in common terminology, "despread." This signal is narrow band, with bandwidth commensurate with a 50 bit per second binary phase shift keyed data signal which is superimposed on the GPS waveform.

The correlation acquisition process is very time consuming, especially if received signals are weak. To improve acquisition time, many GPS receivers utilize a multiplicity of correlators (up to 12 typically) which allows a parallel search for correlation peaks.

Another approach to improve acquisition time is described in U.S. Patent No. 4,445,118. This approach uses the transmission of Doppler information from a control basestation to a remote GPS receiver unit in order to aid in GPS signal acquisition. While this approach does improve acquisition time, the Doppler information is accurate for only a short period of time as the GPS satellites orbit the earth at relatively high speeds. Thus, a further transmission of Doppler information will be necessary in order for a remote unit to use accurate Doppler information.

An approach for improving the accuracy of the position determination by a remote GPS receiver unit is also described in U.S. Patent No. 4,445,118, referred to as the Taylor patent. In the Taylor patent, a stable frequency reference is transmitted to a remote GPS receiver unit from a basestation in order to eliminate a source of error due to a poor quality local oscillator at the remote GPS receiver unit. This method uses a special frequency shift keyed (FSK) signal that must be situated in frequency very close to the GPS signal frequency. As shown in Figure 4 of the Taylor patent, the special FSK signal is about 20 MHz below the 1575 MHz GPS signal. Moreover, the approach described in the Taylor patent uses a common mode rejection mechanism in which any error in the local oscillator (shown as L.O. 52) of the receiver will appear in both the GPS channel and the reference channel and hence be canceled out. There is no attempt to detect or measure this error. This approach is sometimes referred to as a homodyne operation. While this approach provides some advantages, it requires that the two channels be closely matched, including closely matched in frequency. Moreover, this approach requires that both frequencies remain fixed, so frequency hopping techniques are not compatible with this approach.

SUMMARY

In one aspect of the present invention, a mobile GPS receiver receives a precision carrier frequency signal from a source providing the precision carrier frequency signal. The receiver locks to this frequency signal and provides a reference signal which is used to calibrate (e.g., stabilize or correct) a local oscillator that is used to acquire GPS signals. An apparatus which practices this aspect includes, in one embodiment, a first antenna which receives GPS signals and a downconverter coupled to the first antenna. The downconverter is coupled to a local oscillator which provides a first reference signal to the downconverter. The apparatus also includes a second antenna for receiving a precision carrier frequency signal from a source providing the precision carrier frequency signal and an automatic frequency control (AFC) circuit coupled to the second antenna. The AFC circuit provides a second reference signal to the local oscillator to calibrate the first reference signal which is used to acquire GPS signals received through the first antenna. The frequency of the precision carrier frequency signal may vary from transmission to transmission.

One embodiment of the present invention provides a method for determining the position of a remote GPS receiver by transmitting GPS satellite information, including satellite almanac data, to the remote unit or mobile GPS unit from a basestation via a data communication link. The satellite almanac data is then used to determine Doppler data for satellites in view of the remote unit. The remote unit uses this Doppler data and received GPS signals from in view satellites to subsequently compute pseudoranges to the satellites. The computed pseudoranges are then transmitted to the basestation where the position of the remote unit is calculated. Various embodiments of apparatuses which can perform this method are also described.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and not limitation in the figures of the accompanying drawings in which references indicate similar elements and in which:

Figure 1A is a block diagram of the major components of a remote or mobile GPS receiving system utilizing the methods of the present invention, and shows data links that may exist between a basestation and the remote.

Figure 1B is a block diagram of an alternative GPS mobile unit.

Figure 1C is a block diagram of another alternative GPS mobile unit.

Figures 2A and 2B provide two alternatives for the RF and IF portions of a receiver which is an embodiment of the present invention.

Figure 3 shows a flow chart of the major operations (e.g. software operations) performed by the programmable DSP processor in accordance with the methods of the present invention.

Figures 4A-4E illustrates the signal processing waveforms at various stages of processing according to the methods of the present invention.

Figure 5A illustrates a basestation system in one embodiment of the present invention.

Figure 5B illustrates a basestation system in an alternative embodiment of the present invention.

Figure 6A illustrates a GPS mobile unit having, according to one aspect of the present invention, local oscillator calibration.

Figures 6B and 6C show other embodiments of GPS mobile units having local oscillator calibration.

Figure 7 is a flow chart which shows a power management method for a mobile unit according to one embodiment of the present invention.

Figure 8 shows a method for deriving Doppler information for satellites in view from satellite almanac data provided to a mobile unit.

DETAILED DESCRIPTION OF THE INVENTION

This invention concerns apparatuses and methods for computing the position of a mobile, or remote, object in a manner that results in the remote hardware having very low power dissipation and the ability to operate with very low received signal levels and yet provide accurate measurements of position information. That is, power consumption is reduced while receiver sensitivity and accuracy is increased. This is also made possible by the receipt and use at the remote unit of a stable frequency communication signal. This is made possible by the implementation of the remote receiving functions, as shown in Figure 1A, as well as the transmission of satellite almanac information from a separately located basestation 10 to the remote or GPS mobile unit 20.

It should be noted that pseudoranges may be used to compute the remote's geographical position in many different ways. Three examples are:

1. Method 1: By re-transmitting the satellite data messages to the remote 20 from the basestation 10, the remote 20 may combine this information with the pseudorange measurements to compute its position. See, for example, U.S. patent No. 5,365,450, which is incorporated herein by reference. Typically, the remote unit 20 performs the computation of position in the remote 20.
2. Method 2: The remote 20 may gather the satellite ephemeris data from the reception of GPS signals in the normal manner that is commonly practiced in the art. This data, which typically is valid for one to two hours, may be combined with pseudorange measurements to complete, typically in the remote unit, the position calculation.
3. Method 3: The remote 20 may transmit over a communications link 16 the pseudoranges to the basestation 10 which can combine this information with the satellite ephemeris data to complete the position calculation. See, for example, U.S. Patent No. 5,225,842, which is incorporated herein by reference.

In approaches (or Methods) 1 and 3, it is assumed that the basestation 10 and remote 20 have a common view of all satellites of interest and are positioned close enough to one another to resolve a time ambiguity associated with the repetition rate of the GPS pseudorandom codes. This will be met for a range between basestation 10 and remote 20 of 1/2 times the speed of light times the PN repetition period (1 millisecond), or about 150 km.

In order to explain the current invention, it is assumed that method 3 is utilized to complete the position calculation. However, upon review of this Specification, it will be appreciated by those skilled in the art that the various aspects and embodiments of the present invention could be used with any of the above three Methods as well as other approaches. For example, in a variation of Method 1, satellite data information such as data representative of satellite ephemeris may be transmitted by a basestation to a remote unit, and this satellite data information may be combined with pseudo ranges, computed according to the present invention from buffered GPS signals, to provide a latitude and longitude (and in many cases also an altitude) for the remote unit. It will be appreciated that the position information received from the remote may be limited to latitude and longitude or may be extensive information which includes latitude, longitude, altitude, velocity and bearing of the remote. Moreover, the local oscillator correction and/or the power management aspects of the present invention may be utilized in this variation of Method 1. Furthermore, satellite almanac information may be transmitted to the remote unit 20 and utilized by the remote unit 20 in accordance with aspects of the present invention.

Under Method 3, the basestation 10 commands the remote 20 to perform a measurement via a message transmitted over a data communications link 16 as shown in Figure 1A. The message from the basestation 10 which commands the remote 20 may typically also specify an identification of the particular satellites in view or other initialization data. The basestation 10 may also send within this message (or may have previously sent) satellite almanac information, which is a form of satellite data information. This satellite almanac information typically includes a description of the approximate position versus time of all satellites in the GPS constellation. U.S. Patent No. 4,445,118 describes some of the data which may be included in satellite almanac data. This message is received by a separate modem 22 that is part of the remote unit 20, and it is stored in a memory 30 coupled to a low-power microprocessor 26. The satellite almanac information may then be used to derive Doppler information for satellites in view; this derivation is described further below. The almanac data may be valid for periods up to one month. The microprocessor 26 handles data information transfer between the remote unit processing elements 32-48 and the modem 22, and it controls power management functions within the remote receiver 20, as will be evident in the subsequent discussion. Normally, the microprocessor 26 sets most or all remote unit 20's hardware to a low power, or power down, state, except when the pseudorange and/or other GPS calculations are being performed, or when an alternative source of power is available. However, the receiver portion of the modem is at least periodically turned on (to full power) to determine if the basestation 10 has sent a command to the remote to determine the remote's position.

The use of this satellite almanac information to derive Doppler information for satellites in view of the remote eliminates the requirement for the remote 20 to search for such Doppler, thereby reducing its processing time by in excess of a factor of 10. The use of the Doppler information also allows the GPS mobile unit 20 to process more quickly a sample of GPS signals and this tends to reduce the amount of time for which the processor 32 must receive full power in order to compute a position information. This alone reduces the power consumed by the remote unit 20 and contributes to improved sensitivity. Additional information may also be sent to the remote 20, including the epochs of the data in the GPS message.

The received data link signal may utilize a precision carrier frequency. The remote receiver 20 may employ, as shown in Figure 6 which is described below, an automatic frequency control (AFC) loop to lock to this carrier and thereby further calibrate its own reference oscillator (e.g., by correcting the output frequency of the GPS L.O. which is used to acquire GPS signals). A message transmission time of 10 msec, with a received signal to noise ratio of 20 dB, will normally allow frequency measurement via an AFC to an accuracy of 10 Hz or better. This will typically be more than adequate for the requirements of the present invention. This feature will also enhance the accuracy of the position calculations which are performed, either conventionally or using the fast convolution methods of the present invention. This feature is described below in further detail.

In one embodiment of the invention, the communication link 16 is a commercially available narrow bandwidth radio frequency communication medium, such as a two-way pager system. This system may be used in embodiments where the amount of data transmitted between the remote 20 and basestation 10 is relatively small. The amount of data required for the transmission of Doppler (instead of satellite almanac data) and other data (e.g. initialization data such as the identities of the satellites in view) is relatively small and similarly the amount of data required for the position information (e.g.. pseudoranges) is relatively small. Consequently, narrowband systems are adequate for this embodiment. Satellite almanac data may be compressed such that the amount of data necessary to describe the approximate position of all satellites in the GPS constellation may be transmitted efficiently in a narrowband width communication system. Those systems which require the transmission of large amounts of data over a short period of time may require a higher bandwidth radio frequency communication medium. These higher bandwidth systems may be required in those embodiments where uncompressed satellite almanac data is transmitted.

It will be appreciated that it may nevertheless be efficient to use a narrowband system even when uncompressed satellite almanac information is transmitted because the almanac information has good accuracy for long periods of time (e.g., a month, typically). Thus, this information may be transmitted once a month and then stored in the GPS mobile unit (e.g., in flash EEPROM memory) and used for the entire month; typically, in this case, this information is stored with a time stamp which indicates the date of receipt of the satellite almanac data. The remote unit may then, when receiving a command to provide its position information, determine whether the satellite almanac data is stale and receive or not receive the transmission of almanac data provided by the basestation. If the data is not stale (e.g. the almanac data, as indicated by its time stamp, is less than a month old or some other predetermined period of time), then the data may be used from storage and receipt of "fresh" satellite almanac data is not necessary and the automatic transmission of such data is ignored. Alternatively, the basestation may determine whether to transmit satellite almanac data by keeping a list of the remote units which have been sent satellite almanac data and a time stamp indicating the last transmission of satellite almanac data for each such remote unit. The basestation can then determine whether to transmit satellite almanac data with a position fix command based upon the staleness of the last satellite almanac data stored at the particular remote. If the almanac data at the particular remote is not stale (e.g., it is less than one month old) then the position fix command without the almanac data is transmitted from the basestation to the remote. If the almanac data is stale, then current satellite almanac data is transmitted to the remote unit.

Once the remote 20 receives a command (e.g., from the basestation 10) for GPS processing together with the satellite almanac information (or determines it may use a locally stored version of satellite almanac data), the microprocessor 26 activates the RF to IF Converter 42, Analog to Digital Converter 44 and Digital Snapshot Memory 46 via a Battery and Power Regulator and Power Switches circuit 36 (and controlled power lines 21a, 21b, 21c and 21d) thereby providing full power to these components. This causes the signal from the GPS satellite which is received via antenna 40 to be downconverted to an IF frequency, where it subsequently undergoes digitization. A set of such data, typically corresponding to a duration of 100 milliseconds to 1 second (or even longer), is then stored in a Snapshot Memory 46. The amount of data stored may be controlled by the microprocessor 26 such that more data may be stored in the memory 46 (to obtain better sensitivity) in those situations when conserving power is not as important as obtaining better sensitivity, and less data may be stored in those situations when conservation of power is more important than sensitivity. Typically, sensitivity is more important when the GPS signals may be obstructed partially, and power conservation is less important when a copious power supply (e.g. a car battery) is available. The addressing of this memory 46 to store this data is controlled by a Field Programmable Gate Array integrated circuit 48. Downconversion of the GPS signal is accomplished using a frequency synthesizer 38 which provides local oscillator signal 39 to the converter 42 as discussed further below.

Note that all this time (while the snapshot memory 46 is being filled with the digitized GPS signals from the in view satellites) the DSP microprocessor 32 may be kept in a low power state. The RF to IF

Converter 42 and Analog to Digital Converter 44 are typically only turned on for a short period of time, sufficient to collect and store the data required for pseudorange calculation. After the data collection is complete, these converter circuits are turned off or power is otherwise reduced via controlled power lines 21b and 21c (while the memory 46 continues to receive full power), thus not contributing to additional power dissipation during the actual pseudorange calculation. The pseudorange calculation is then performed using, in one embodiment, a general purpose, programmable digital signal processing IC 32 (DSP), as exemplified by a TMS320C30 integrated circuit from Texas Instruments. This DSP 32 is placed in an active power state by the microprocessor 26 and the circuit 36 via controlled power line 21e prior to performing such calculations.

This DSP 32 differs from others used in some remote GPS units in that it is general purpose and programmable, as compared to specialized custom digital signal processing IC's. Furthermore, the DSP 32 makes possible the use of a Fast Fourier Transform (FFT) algorithm, which permits very rapid computation of the pseudoranges by performing rapidly a large number of correlation operations between a locally generated reference and the received signals. Typically, 2046 such correlations are required to complete the search for the epochs of each received GPS signal. The Fast Fourier Transform algorithm permits a simultaneous and parallel search of all such positions, thus speeding the required computation process by a factor of 10 to 100 over conventional approaches.

Once the DSP 32 completes its computation of pseudoranges for each of the in view satellites, it transmits, in one embodiment of the invention, this information to the microprocessor 26 via interconnect bus 33. At this time the microprocessor 26 may cause the DSP 32 and memory 46 to again enter a low power state by sending an appropriate control signal to the Battery and Power Regulator circuit 36. Then, the microprocessor 26 utilizes a modem 22 to transmit the pseudorange data over a data link 16 to the basestation 10 for final position computation. In addition to the pseudorange data, a time tag may simultaneously be transmitted to the basestation 10 that indicates the elapsed time from the initial data collection in the buffer 46 to the time of transmission of the data over the data link 16. This time tag improves the capability of the basestation to compute position calculation, since it allows the computation of the GPS satellite positions at the time of data collection. As an alternative, in accordance with Method 1 above, the DSP 32 may compute the position (e.g. latitude, longitude or latitude, longitude and altitude) of the remote unit and send this data to the microprocessor 26, which similarly relays this data to the basestation 10 via the modem 22. In this case the position computation is eased by the DSP maintaining the elapsed time from the reception of satellite data messages to the time at which the buffer data collection begins. This improves the capability of the remote unit to compute position calculation, since it allows the computation of the GPS satellite positions at the time of data collection.

As shown in Figure 1A, modem 22, in one embodiment, utilizes a separate antenna 24 to transmit and receive messages over data link 16. It will be appreciated that the modem 22 includes a communication receiver and a communication transmitter which are alternatively coupled to the antenna 24. Similarly, basestation 10 may use a separate antenna 14 to transmit and receive data link messages, thus allowing continuous reception of GPS signals via GPS antenna 12 at the basestation 10.

It is expected, in a typical example, that the position calculations in the DSP 32 will require less than a few seconds of time, depending upon the amount of data stored in the digital snapshot memory 46 and the speed of the DSP or several DSPs.

It should be clear from the above discussion that the remote unit 20 need only activate its high power consumption circuits for a small fraction of time, if position calculation commands from the basestation 10 are infrequent. It is anticipated, in at least many situations, that such commands will result in the remote equipment being activated to its high power dissipation state only about 1% of the time or less.

This then allows battery operation for 100 times the length of time that would otherwise be possible. The program commands necessary for the performance of the power management operation are stored in EEPROM 28 or other suitable storage media. This power management strategy may be adaptable to different power availability situations. For example, when prime power is available the determination of position may occur on a continuing basis.

As indicated above, the digital snapshot memory 46 captures a record corresponding to a relatively long period of time. The efficient processing of this large block of data using fast convolution methods contributes to the ability of the present invention to process signals at low received levels (e.g., when reception is poor due to partial blockage from buildings, trees, etc.). All pseudoranges for visible GPS satellites are computed using this same buffered data. This provides improved performance relative to continuous tracking GPS receivers in situations (such as urban blockage conditions) in which the signal amplitude is rapidly changing.

A slightly different implementation exhibited in Figure 1B dispenses with the microprocessor 26 and its peripherals (RAM 30 and EEPROM 28) and replaces its functionality with additional circuitry contained within a more complex FPGA (field programmable gate array) 49. The structure and operation of the remote unit shown in Figure 1B is described in further detail in U.S. Patent Application Serial No. 08/612,669, filed March 8, 1996 by Norman F. Krasner, now U.S. Patent No._________, which application is hereby incorporated herein by reference. The remote unit of Figure 1B uses the DSP 32a to selectively power on or reduce power to different components according to a power management method such as that shown in Figure 7.

Figure 1C shows another embodiment according to the present invention of a GPS mobile unit which contains many of the same components as the GPS mobile units shown in Figures 1A and 1B.

Figure 1C shows a feature of the present invention which allows the GPS mobile unit to trade off sensitivity for power conservation. As described herein sensitivity of the GPS mobile unit may be increased by increasing the amount of buffered GPS signals which are stored in the memory 46. This is done by acquiring and digitizing more GPS signals and storing this data in the memory 46. While this increased buffering causes more power consumption, it does improve the sensitivity of the

GPS mobile unit. The structure and operation of the remote unit shown in Figure 1C is described in further detail in the above noted U.S. Patent Application Serial No. 08/612,669, filed March 8, 1996.

Representative examples of an RF to IF frequency converter and digitizing system for the mobile GPS unit are shown in Figure 2A and 2B. The structure and operation of these examples shown in Figure 2A and 2B are described in further detail in the above noted U.S. Patent Application Serial No. 08/612,669, filed March 8, 1996.

Details of the GPS signal processing performed in the DSP 32 may be understood with the aid of the flow chart of Figure 3 and the pictorial of Figures 4A, 4B, 4C, 4D and 4E. It will be apparent to those skilled in the art that the machine code, or other suitable code, for performing the signal processing to be described is stored in EPROM 34. Other non-volatile storage devices could also be used. The following assumes that the I/Q sampling of Figure 2A is employed and that the snapshot memory 46 contains two channels of digitized data at 2.048 MHz. The objective of the processing is to determine the timing of the received waveform with respect to a locally generated waveform. Furthermore, in order to achieve high sensitivity, a very long portion of such a waveform, typically 100 milliseconds to 1 second, is processed. It will also be appreciated that the Doppler information which is used in this signal processing may be Doppler information which was derived from stored or recently transmitted satellite almanac data (or may be Doppler information directly transmitted along with the position command to the remote unit so that no Doppler derivation in the remote unit is required). The derivation of Doppler information from satellite almanac data is described further herein in conjunction with Figure 8. Further details concerning the signal processing shown in Figures 3 and 4A-4E are described in the above noted U.S. Patent Application Serial No. 08/612,669, filed March 8, 1996.

A summary of the signal processing described above and shown in Figure 3 and in Figures 4A-4E will now be provided. The GPS signals from one or more in view GPS satellites are received at the remote GPS unit using an antenna on the remote GPS unit. These signals are digitized and stored in a buffer in the remote GPS unit. After storing these signals, a processor performs in one embodiment preprocessing, fast convolution processing, and post processing operations. These processing operations involve:

a) breaking the stored data into a series of blocks whose durations are equal to a multiple of the frame period of the pseudorandom (PN) codes contained within the GPS signals.

b) for each block performing a preprocessing step which creates a compressed block of data with length equal to the duration of a pseudorandom code period by coherently adding together successive subblocks of data, the subblocks having a duration equal to one PN frame; this addition step will mean that the corresponding sample numbers of each of the subblocks are added to one another.

c) for each compressed block, performing a matched filtering operation, which utilizes fast convolution techniques, to determine the relative timing between the received PN code contained within the block of data and a locally generated PN reference signal (e.g. the pseudorandom sequence of the GPS satellite being processed).

d) determining a pseudorange by performing a magnitude-squared operation on the products created from said matched filtering operation and post processing this by combining the magnitude-squared data for all blocks into a single block of data by adding together the blocks of magnitude-squared data to produce a peak.

and e) finding the location of the peak of said single block of data to high precision using digital interpolation methods, where the location is the distance from the beginning of the data block to the said peak, and the location represents a pseudorange to a GPS satellite corresponding to the pseudorandom sequence being processed.

Typically, the fast convolution technique used in processing the buffered GPS signals is a Fast Fourier Transform (FFT) and the result of the convolution is produced by computing the product of the forward transform of the compressed block and a prestored representation of the forward transform of the pseudorandom sequence to produce a first result and then performing an inverse transformation of the first result to recover the result. Also, the effects the Doppler induced time delays and local oscillator induced time errors are compensated for on each compressed block of data by inserting between the forward and inverse Fast Fourier Transform operations, the multiplication of the forward FFT of the compressed blocks by a complex exponential whose phase versus sample number is adjusted to correspond to the delay compensation required for the block.

In the foregoing embodiment the processing of GPS signals from each satellite occurs sequentially over time, rather than in parallel. In an alternative embodiment, the GPS signals from all in view satellites may be processed together in a parallel fashion in time.

It is assumed here that the basestation 10 has a common view of all satellites of interest and that it is sufficiently close in range to remote unit 20 in order to avoid ambiguities associated with the repetition period of the C/A PN code. A range of 90 miles will satisfy this criteria. The basestation 10 is also assumed to have a GPS receiver and a good geographical location such that all satellites in view are continuously tracked to high precision.

While several described embodiments of the basestation 10 show the use of a data processing component, such as a computer at the basestation in order to compute position information such as a latitude and a longitude for the mobile GPS unit, it will be appreciated that each basestation 10 may merely relay the information received, such as pseudoranges from a mobile GPS unit, to a central location or several central locations which actually perform the computation of latitude and longitude. In this manner the cost and complexity of these relaying basestations may be reduced by eliminating a data processing unit and its associated components from each relaying basestation. A central location, would include receivers (e.g. telecommunication receivers) and a data processing unit and associated components. Moreover, in certain embodiments, the basestation may be virtual in that it may be a satellite which transmits Doppler information or satellite almanac data to remote units, thereby emulating a basestation in a transmission cell.

Figures 5A and 5B show two embodiments of a basestation according to the present invention. In the basestation shown in Figure 5A, a GPS receiver 501 receives GPS signals through a GPS antenna 501a. The GPS receiver 501, which may be a conventional GPS receiver, provides a timed reference signal which typically is timed relative to GPS signals and also provides satellite almanac data for all the satellites in the constellation of GPS satellites and may provide Doppler information relative to the satellites in view. This GPS receiver 501 is coupled to a disciplined local oscillator 505 which receives the time reference signal 510 and phase locks itself to this reference. This disciplined local oscillator 505 has an output which is provided to a modulator 506. The modulator 506 also receives the satellite almanac data (or alternatively, Doppler data information signals for each satellite in view of the GPS mobile unit) and/or other satellite data information signals 511. The modulator 506 modulates the satellite almanac data (or alternatively, the Doppler) and/or other satellite data information onto the local oscillator signal received from the discipline local oscillator 505 in order to provide a modulated signal 513 to the transmitter 503. The transmitter 503 is coupled to the data processing unit 502 via interconnect 514 such that the data processing unit may control the operation of the transmitter 503 in order to cause the transmission of satellite data information, such as the satellite almanac information to a GPS mobile unit via the transmitter's antenna 503a. In this manner, a GPS mobile unit may receive the satellite almanac information, the source of which is the GPS receiver 501 and may also receive a high precision local oscillator carrier signal which may be used to calibrate the local oscillator in the GPS mobile unit as shown in Figure 6. It will be appreciated that the basestation may transmit the current satellite almanac data automatically with each transmission of a position fix command to the remote unit. Alternatively the basestation may, as described above, determine whether the remote's stored version of the satellite almanac data is stale and transmit the current almanac data only if the remote's stored version is stale. If a high bandwidth communication system is being used as the communication link (e.g., a cellular telephone system) then the former approach is preferred. If a narrow bandwidth communication system is being used, then the latter approach may be preferred.

The basestation as shown in Figure 5A also includes a receiver 504 which is coupled to receive communication signals from the remote or GPS mobile unit via a communication antenna 504a. It will be appreciated that the antenna 504a may be the same antenna as the transmitter's antenna 503a such that a single antenna serves both the transmitter and the receiver in the conventional fashion. The receiver 504 is coupled to the data processing unit 502 which may be a conventional computer system. The processing unit 502 may also include an interconnect 512 to receive the Doppler and/or other satellite data information from the GPS receiver 511. This information may be utilized in processing the pseudorange information or other information received from the mobile unit via the receiver 504. This data processing unit 502 is coupled to a display device 508, which may be a conventional CRT. The data processing unit 502 is also coupled to a mass storage device 507 which includes GIS (Geographical Information System) software (e.g. Atlas GIS from Strategic Mapping, Inc. of Santa Clara, California) which is used to display maps on the display 508. Using the display maps, the position of the mobile GPS unit may be indicated on the display relative to a displayed map.

An alternative basestation shown in Figure 5B includes many of the same components shown in Figure 5A. However, rather than obtaining the satellite almanac data or Doppler and/or other satellite data information from a GPS receiver, the basestation of Figure 5B includes a source of satellite almanac data or Doppler and/or other satellite data information 552 which is obtained from a telecommunication link or a radio link in a conventional matter. For example, this information may be obtained from a server site on the Internet. This Doppler and/or satellite information is conveyed over an interconnect 553 to the modulator 506. The other input the modulator 506 shown in Figure 5B is the oscillator output signal from a reference quality local oscillator such as a cesium standard local oscillator. This reference local oscillator 551 provides a precision carrier frequency onto which is modulated the Doppler and/or other satellite data information which is then transmitted via transmitter 503 to the mobile GPS unit.

Although the preceding discussion illustrates a basestation which integrates all functions of satellite data transmission and frequency reference information, in most practical situations this may be partially performed using commercial telecommunication systems, such as cellular or paging systems. For example, most digital cellular systems utilize a very stable local oscillator in their transmitted signals. In this case, a basestation need only gather the satellite data, as in blocks 501 or 552 and send this data over such a cellular system using a conventional wireline modem. The actual modulation functions, including the precision frequency reference transmission, are then performed by the cell site transmitter. This approach results in a very low cost basestation with no special RF circuitry. Similarly, on the remote to basestation link, the cellular system provides the receiving and demodulation functions of block 504 and the basestation need only utilize a modem to receive such data over normal wirelines.

It is an important characteristic of this invention that the transmission frequency and format of the data signals are unimportant, as long as the carrier frequency is very stable. It should also be noted that this carrier frequency may vary from one transmission to the next, as it commonly does in cellular systems, which utilize a large number of frequency channels to service a large number of users. In some cases the carrier frequency may also vary within one call. For example, frequency hopping is utilized in some digital cellular systems. Again, this invention can utilize such signaling, as long as the remote receiver can frequency lock to the stable transmitted frequencies.

Figure 6A shows an embodiment of a GPS mobile unit of the present invention which utilizes the precision carrier frequency signal received through the communication channel antenna 601 which is similar to the antenna 24 shown in Figure 1A. The antenna 601 is coupled to the modem 602, which is similar to the modem 22 in Figure 1A, and this modem 602 is coupled to an automatic frequency control circuit 603 which locks to the precision carrier frequency signal sent by the basestation (which may be considered to be or include a cellular telephone cell site transmitter) described herein according to one embodiment of the present invention. The automatic frequency control circuit 603 provides an output 604, which is typically locked in frequency to the precision carrier frequency. This signal 604 is compared by the comparator 605 to the output of the GPS local oscillator 606, via interconnect 608. The result of the comparison performed by the comparator 605 is an error correction signal 610 which is provided as a correction signal to the GPS local oscillator 606. In this manner, the frequency synthesizer 609 provides a higher quality, calibrated local oscillation signal over interconnect 612 to the GPS down converter 614. It will be appreciated that the GPS local oscillator 606 and the frequency synthesizer 609 may together be considered a local oscillator which provides a GPS clock signal that is inputted to the downconverter to acquire the GPS signals received through the GPS antenna 613. As used herein, "calibrated", "calibrate" or "calibration" refers to either a system which measures and corrects a local oscillator (by using a reference signal derived from a measurement of an error in a local oscillator) or a system which stabilizes a local oscillator signal (e.g., by feeding a local oscillator signal from the communication receiver to frequency synthesizing circuits that generate GPS clock signals which are used to downconvert/acquire GPS signals).

It will be appreciated that the signal provided over interconnect 612 is similar to the local oscillator signal provided by interconnect 39 on Figure 1A to the converter 42; also, the converter 42 is similar to the GPS down converter 614 which is coupled to the GPS antenna 613 to receive GPS signals.

In an alternative embodiment the signal 604 provided by the AFC unit in the communication receiver is an LO which at the proper frequency serves as a reference for the frequency synthesizer 609. In this case no GPS local oscillator is required (shown in Figure 6A as optional for this reason) and this signal 604 will be fed directly to the synthesizer 609 in substitution for the signal 607 from the GPS local oscillator. In this manner, a precise, stable local oscillator clock signal is provided to the GPS downconverter for the downconverter to acquire GPS signals received through a GPS antenna.

In another alternative embodiment, the result of the comparison performed by comparator 605 may be output via interconnect 610a as an error correction to the DSP component 620 which is similar to the DSP chip 32 shown in Figure 1A. In this instance, no error correction signal 610 will be provided indirectly to the frequency synthesizer 609. The automatic frequency control circuit may be implemented using a number of conventional techniques including a phase lock loop or a frequency lock loop or a block phase estimator.

Figure 6B shows another embodiment of a mobile GPS unit for calibrating the GPS local oscillator used to acquire (e.g., downconvert) the GPS signals in the mobile unit of the present invention. The approach is to derive a stable frequency from the receiving circuitry of a communication receiver. Many communication signals, such as digital cellular and PCS signals have carrier frequencies stable to as good as 0.1 parts per million. The receivers for such signals provide, as part of their operation, a phase locking procedure applied to the receiver signal carrier so that such a carrier may be removed allowing the demodulation of the digital data imposed upon the carrier. The phase locking procedure normally produces as part of its process a stable local oscillator which can then be utilized to separately stabilize the local oscillators of a GPS receiver, thereby eliminating expensive components on this receiver.

The communication signal received by the communication receiver 640 may have one of a multiplicity of possible carrier frequencies, depending upon which channel it is tuned to. The first stage (converter 642) of the receiver downconverts the input signal to a single IF frequency, for example 140 MHz. This downconversion is controlled by the oscillator VCO1 643 which provides an oscillator signal input to the downconverter 642. The output of VCO1 is in turn controlled by the frequency synthesizer 644 which provides an input to oscillators VCO1 643 and VCO2 647. The mixer 646 forms a second stage RF to IF downconverter which is controlled by an input oscillator signal from oscillator 647. The following stage (Costas Loop Demodulator 648 and Temperature Compensated Voltage Controlled Oscillator (TCVCXO) 645) of the communication receiver is a phaselocking circuit whose purpose is to construct a local oscillator signal which is phaselocked to the incoming signal's carrier frequency. For a signal that is phase-shift keyed, a common circuit well known in the art to perform this circuit is the Costas Loop (e.g. see Gardner, Phaselock Techniques, 2nd Edition, John Wiley & Sons, 1979). In Figure 6B the Costas Loop provides a frequency correction voltage to the reference frequency generator TCVCXO 645 which causes the output of TCVCXO 645 to be phase and frequency aligned with the carrier frequency of the IF signal.

The VCO output 645a (from TCVCXO 645) may then be supplied as a reference frequency to a frequency synthesizer 654 used with the GPS downconverter 652 of the GPS receiver portion 650. In this manner the frequency synthesizer produces inputs for local oscillators (VCO3 653 and VCO4 655) for use in the GPS system that has the same frequency stability as that of the received communication signal. The oscillator 653 controls the first stage of the RF to IF downconversion, and the oscillator 655 controls the second stage of the RF to IF downconversion. The mixer 656 forms a second stage RF to IF downconverter which receives a first intermediate frequency from downconverter 652 and provides a second intermediate frequency to the digitizer circuits (shown together with the buffer and GPS processor in block 657).

Note that the above approach is applicable even though the frequency of the received communication signal may vary from one reception time to the next, if the signal is assigned to a different frequency channel.

An alternative to the above approach is shown in Figure 6C. Here a Direct Digital Synthesizer (DDS) 677 integrated circuit is provided with a digital tuning word from the Costas Loop 679, which is also implemented as a digital circuit. This tuning word can also then be supplied to the frequency synthesizer 689 that is part of the GPS receiver in order to stabilize its local oscillators. In this case this frequency synthesizer may also utilize a DDS 689b in order to allow precision adjustment of its frequency, an inherent feature of a DDS.

There are alternative hybrid combinations of the above approaches--e.g. a DDS in the communication receiver, but the DDS LO output being fed to the GPS system. The general approach is that a frequency locking or phaselocking circuit in the communication receiver produces either a tuning voltage or local oscillator signals which is fed to a frequency synthesis circuit on the GPS receiver in order to stabilize the local oscillators provided by this system.

It should be noted that the phaselocking circuits in receivers 640 and 670 may be alternatively implemented wholly or in part via digital signal processing means instead of analog means. In this case the input to these circuits may be digitized via an A/D converter and the circuit functions of these blocks may be constructed using hardwired or programmable (i.e. programmable DSP) digital signal processing elements.

Figure 7 illustrates a particular sequence of power management according to one embodiment of the invention. It will be appreciated that there are numerous ways which are known in the art in order to reduce power. These include slowing down the clock provided to a synchronous, clocked component as well as completely shutting down power to a particular component or turning off certain circuits of a component but not others. It will be appreciated, for example, that phase lock loops and oscillator circuits require start up and stabilization times and thus a designer may decide not to power down completely (or at all) these components. The example shown in Figure 7 begins in step 701 in which the various components of the system are initialized and placed in a reduced power state. Either periodically or after a predetermined period of time, the communication receiver in the modem 22 is returned to full power to determine whether commands are being sent from the basestation 10. This occurs in step 703. If a request is received in step 705 for location information from a base unit, the modem 22 alerts the power management circuit in step 707. At this point in time, the communication receiver in the modem 22 may be turned off for either a predetermined period of time or turned off to be turned on periodically again at a later time; this is shown as step 709. It will be appreciated that the communication receiver may maintained at a full power state rather than turning it off at this point in time. Then in step 711, the power management circuit returns the GPS receiver portion of the mobile unit to full power by powering up the converter 42 and the analog to digital converters 44; if the frequency oscillator 38 was also powered down, this component is powered up at this time and returned to full power and allowed some time to stabilize. Then in step 713, the GPS receiver, including components 38, 42 and 44 receive the GPS signal. This GPS signal is buffered in the memory 46 which has also been returned to full power when the GPS receiver was returned to full power in step 711. After collection of the snapshot information is completed, then the GPS receiver is returned to a reduced power state in step 717; this typically comprises reducing power for the converter 42 and 44 while keeping the memory 46 at full power. Then in step 719, the processing system is returned to full power; in one embodiment, this involves providing full power to the DSP chip 32; it will be appreciated however that if the DSP chip 32 is also providing power management functions as in the case of the embodiment shown in Figure 1C, then the DSP chip 32a is typically returned to full power in step 707. In the embodiment shown in Figure 1A where the microprocessor 26 performs power management function, the processing system, such as DSP chip 32 may be returned to full power at step 719. In step 721, the GPS signal is processed according to the method of the present invention, such as that shown in Figure 3. Then, after completing the processing of the GPS signal, the processing system is placed in a reduced power state as shown in step 23 (unless the processing system is also controlling power management as noted above). Then, in step 725 the communication transmitter in the modem 22 is returned to full power in order to transmit in step 727 the processed GPS signal back to the basestation 10. After completing transmission of the processed GPS signal, such as pseudorange information or latitude and longitude information, the communication transmitter is returned to reduced power state in 729 and the power management system waits for a delay of a period of time such as predetermined period of time in step 731. Following this delay the communication receiver in the modem 22 is returned to full power in order to determine whether a request is being sent from a basestation.

Figure 8 shows a method for deriving Doppler information for satellites in view from the satellite almanac data transmitted to a remote unit according to the present invention. The remote unit receives, in step 801, the satellite almanac data and stores this data in the remote unit (e.g., storing it in flash EEPROM). Optionally, the remote unit may stamp the data with the current date and time in order to determine staleness of the almanac data later as described herein.

In step 803, the remote unit determines the approximate time of day and its approximate position. Using the approximate time and position with the satellite almanac data, the remote in step 805 determines the Doppler of all in view satellites. The remote unit, when receiving the position fix command from the basestation, may also receive an identification of satellites in view and use this identification to calculate Dopplers for only these satellites from the almanac data and from the approximate time and position determined in step 803. Although almanac data is provided in a specific form within the transmitted signal from the GPS satellites, it is not necessary that this information be supplied over the communication link in this form. For example, this data can be compressed by reducing the accuracy of the various transmitted quantities. Reduction in accuracy may reduce the Doppler accuracy, but such reduction may still be within the allowed error budget of the GPS receiver. Alternatively, another representation of the almanac data may be preferable, e.g. fitting the satellite position data to a set of curves, such as spherical harmonics. This approach may allow the GPS receiver to more easily compute Doppler from the supplied almanac data.

Approximate Doppler may be computed by computing the range from the remote to the satellites of interest at times separated by an appropriate interval (e.g. 1 second). This is done utilizing the supplied Almanac data and the approximate user position (e.g., based upon the fixed location of the cell site in a cellular phone system). The difference in these ranges is a range rate, which can be divided by the speed of light to yield a Doppler expressed in seconds per second (or another suitable set of units such as nanoseconds per second).

Although the methods and apparatus of the present invention have been described with reference to GPS satellites, it will be appreciated that the teachings are equally applicable to positioning systems which utilize pseudolites or a combination of satellites and pseudolites. Pseudolites are ground based transmitters which broadcast a PN code (similar to a GPS signal) modulated on an L-band carrier signal, generally synchronized with GPS time. Each transmitter may be assigned a unique PN code so as to permit identification by a remote receiver. Pseudolites are useful in situations where GPS signals from an orbiting satellite might be unavailable, such as tunnels, mines, buildings or other enclosed areas. The term "satellite", as used herein, is intended to include pseudolite or equivalents of pseudolites, and the term GPS signals, as used herein, is intended to include GPS-like signals from pseudolites or equivalents of pseudolites.

In the preceding discussion the invention has been described with reference to application upon the United States Global Positioning Satellite (GPS) system. It should evident, however, that these methods are equally applicable to similar satellite positioning systems, and in, particular, the Russian Glonass system. The Glonass system primarily differs from GPS system in that the emissions from different satellites are differentiated from one another by utilizing slightly different carrier frequencies, rather than utilizing different pseudorandom codes. In this situation substantially all the circuitry and algorithms described previously are applicable with the exception that when processing a new satellite's emission a different exponential multiplier is used to preprocess the data. This operation may be combined with the Doppler correction operation of box 108 Figure 3, without requiring any additional processing operations. Only one PN code is required in this situation, thus eliminating block 106. The term "GPS" used herein includes such alternative satellite positioning systems, including the Russian Glonass system.

Although Figures 1A, 1B and 1C illustrate a multiplicity of logic blocks that process digital signals (e.g. 46, 32, 34, 26, 30, 28 in Figure 1A), it should be appreciated that several or all of the these blocks may be integrated together onto a single integrated circuit, while still maintaining the programmable nature of the DSP portion of such a circuit. Such an implementation may be important for very low power and cost sensitive applications.

It will be appreciated that the various aspects of the present invention, including the use of satellite almanac data at the remote unit to derive Doppler information and including the use of a precision carrier frequency signal to calibrate the output of a GPS local oscillator which is used to acquire GPS signals, may be used in GPS mobile units having architectures such as those described in U.S. Patent Application Serial No. 08/652,833, filed May 23, 1996 by Norman F. Krasner, which application is hereby incorporated herein by reference.

It should also be appreciated that one or several of the operations of Figure 3 may be performed by hardwired logic in order to increase the overall processing speed, while retaining the programmable nature of the DSP processor. For example, the Doppler correction capability of block 108 may be performed by dedicated hardware that may be placed between the digital snapshot memory 46 and the DSP IC 32. All other software functions of Figure 3 may in such cases be performed by the DSP processor. Also, several DSPs may be used together in one remote unit to provide greater processing power. It will also be appreciated that it is possible to collect (sample) multiple sets of frames of GPS data signals and process each set as shown in Figure 3 while accounting for the time between the collection of each set of frames.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

CLAIMS

What is claimed is:

1. In a method for determining the position of a remote unit, a process comprising:

receiving, at said remote unit, a satellite almanac information for a plurality of satellites in view of said remote unit; and

computing, in said remote unit, a position information for said satellite by using a Doppler information derived from said satellite almanac information.

2. A process as in claim 1, further comprising:

transmitting said satellite almanac information from a basestation to said remote unit.

3. A process as in claim 2 wherein said satellite almanac information is obtained from a reference storage medium at said basestation.

4. A process as in claim 2 wherein said position information comprises pseudoranges to a plurality of satellites in view of said remote unit, including said satellite.

5. A process as in claim 2 wherein said position information comprises a latitude and longitude which indicates the position of said remote unit.

6. A process as in claim 4 further comprising:

transmitting said pseudoranges from said remote unit to said basestation, and wherein said basestation computes a latitude and longitude which indicates the position of said remote unit.

7. A process as in claim 4 further comprising transmitting satellite data information of said satellite to said remote unit, said satellite data information comprising data representative of ephemeris for said satellite.

8. A process as in claim 5 further comprising transmitting satellite data information of said satellite to said remote unit, said satellite data information comprising data representative of ephemeris for said satellite.

9. A mobile unit which uses data representative of GPS signals to provide the position of said mobile unit, said mobile unit comprising;

a receiver in said mobile unit, said receiver operable for coupling through a communications link to receive a satellite almanac information for a plurality of satellites in view of said mobile unit;

a processing unit in said mobile unit, said processing unit coupled to said receiver to receive said satellite almanac information and compute a position information for said satellite by using a Doppler information derived from said satellite almanac information.

10. A method of using a basestation for providing a communications link to a mobile GPS unit, said method comprising:

determining a satellite almanac information for a plurality of satellites in view of said mobile GPS unit;

transmitting said satellite almanac information to said mobile GPS unit for determination of a Doppler information.

11. A method as in claim 10, wherein said Doppler information represents the Doppler shift of GPS signals from said satellite to said basestation.

12. A method as in claim 11 wherein said Doppler information approximately represents the Doppler shift of GPS signals from said satellite to said mobile GPS unit.

13. A method as in claim 10 wherein said Doppler information is obtained from a GPS receiver at said basestation and wherein said Doppler information represents the Doppler shift of GPS signals from said satellite to said basestation.

14. A method as in claim 13 wherein said Doppler information approximately represents the Doppler shift of GPS signals from said satellite mobile GPS unit.

15. A method as in claim 14 further comprising:

receiving a position information from said mobile GPS unit, said position information being received at said basestation such that said basestation obtains a latitude and longitude which indicates the position of said mobile GPS unit.

16. A method as in claim 15 wherein said position information comprises pseudoranges to said plurality of satellites in view of said mobile GPS unit, and wherein said basestation computes said latitude and longitude from said pseudoranges.

17. A method as in claim 15 wherein said position information comprises said latitude and longitude.

18. A method as in claim 10 further comprising:

transmitting satellite data information of said satellite to said mobile GPS unit, said satellite data information comprising data representative of ephemeris for said satellite.

19. A process as in claim 1 wherein a processing unit uses said Doppler information to compensate for a Doppler shift of GPS signals from said satellite.

20. A mobile unit as in claim 9 wherein said processing unit uses said Doppler information to compensate for a Doppler shift of GPS signals from said satellite.

21. A mobile unit as in claim 20 wherein said communication link comprises a radio frequency communication medium.

22. A mobile unit as in claim 20 further comprising;
a transmitter coupled to said processing unit, said transmitter for transmitting said position information.

23. A mobile unit as in claim 22 wherein said position information comprises pseudorange to said plurality of satellites in view of said mobile unit.

24. A mobile unit as in claim 22 wherein said position information comprises a latitude and longitude which indicates the position of said mobile unit.

25. A mobile unit as in claim 20 wherein said processing unit comprises a digital signal processing integrated circuit (DSP) and wherein said DSP processes said GPS signals and said Doppler information using a fast convolution algorithm.

26. A mobile unit as in claim 25 further comprising:
a transmitter coupled to said processing unit, said transmitter for transmitting said position information.

27. A mobile unit as in claim 9 wherein said receiver is operable to receive satellite data information of said satellite from a source other than said

satellite, wherein said satellite data information comprises data representative of ephemeris for said satellite.

28. A basestation for providing a communication link to a mobile GPS unit, said basestation comprising:

a source of a satellite almanac information for a plurality of satellites in view of said mobile GPS unit;

a transmitter coupled to said source of said satellite almanac information, said transmitter for transmitting through said communications link said satellite almanac information to said mobile GPS unit for determination of a Doppler information.

29. A basestation as in claim 28 wherein said source of said satellite almanac information is a storage unit coupled to said basestation.

30. A basestation as in claim 28 further comprising:

a receiver for receiving a position information from said mobile GPS unit;

a processor coupled to said receiver.

31. A basestation as in claim 28, wherein said Doppler information approximately represents the Doppler shift of GPS signals from said satellite to said basestation.

32. A basestation as in claim 30, wherein said position information is received at said basestation such that said basestation obtains a latitude and longitude which indicates the position of said mobile GPS unit.

33. A basestation as in claim 32, wherein said position information comprises pseudoranges to at least some of said plurality of satellites in view of said mobile GPS unit, and wherein said processor of said basestation computes said latitude and longitude from said pseudorange.

34. A basestation as in claim 28 wherein said transmitter is also for transmitting satellite data information of said satellite to said mobile GPS unit, said satellite data information comprising data representative of ephemeris for said satellite.

35. A basestation as in claim 31 wherein said basestation and said mobile GPS unit are within approximately 150 kilometers of each other.

36. A method of calibrating a local oscillator in a mobile GPS receiver, said method comprising:

receiving a precision carrier frequency signal from a source providing said precision carrier frequency signal;

automatically locking to said precision carrier frequency signal and providing a reference signal;

calibrating said local oscillator with said reference signal, said local oscillator being used to acquire GPS signals.

37. A method as in claim 36 wherein said receiving step comprises extracting said precision carrier frequency signal from a data signal containing satellite data information communicated over a communication link.

38. A method as in claim 37 wherein said satellite data information comprises a satellite almanac information for a plurality of satellites in view of said mobile GPS receiver.

39. A method as in claim 37 wherein said satellite data information comprises data representative of ephemeris for a satellite.

40. A method as in claim 37 wherein said communication link is selected from the group consisting of a two-way pager link or a cellular telephone link or personal communication system or specialized mobile radio or a wireless packet data system.

41. A method as in claim 37 wherein said communication link is a radio frequency communication medium.

42. A method as in claim 36 wherein said automatic frequency control logic comprises one of a phase lock loop or a frequency lock loop or a block phase estimator.

43. A method as in claim 42 wherein said reference signal provides a reference frequency which is compared to a frequency provided by said local oscillator to calibrate said local oscillator.

44. A mobile GPS receiver comprising:

a first antenna for receiving GPS signals;

a downconverter coupled to said first antenna, said first antenna providing said GPS signals to said downconverter;

a local oscillator coupled to said downconverter, said local oscillator providing a first reference signal to said downconverter to convert said GPS signals from a first frequency to a second frequency;

a second antenna for receiving a precision carrier frequency signal from a source providing said precision carrier frequency signal;

an automatic frequency control (AFC) circuit coupled to said second antenna, said AFC circuit providing a second reference signal to said local oscillator to calibrate said first reference signal of said local oscillator, wherein said local oscillator is used to acquire said GPS signals.

45. A mobile GPS receiver as in claim 44 further comprising a comparator coupled to said AFC circuit and to said local oscillator, said comparator comparing said first reference signal and said second reference signal to adjust the frequency of said first reference signal from said local oscillator.

46. A mobile GPS receiver as in claim 45 wherein said AFC circuit comprises a phase lock loop coupled to a receiver which is coupled to said second antenna.

47. A mobile GPS receiver as in claim 44 further comprising a receiver coupled to said second antenna, said receiver for receiving said precision carrier frequency signal from said second antenna, wherein said receiver receives said precision carrier frequency signal with a data signal containing satellite data information communicated through said second antenna.

48. A mobile GPS receiver as in claim 47 wherein said satellite data information comprises a Doppler information of a satellite in view of said mobile GPS receiver.

49. A mobile GPS receiver as in claim 48 wherein said satellite data information comprises an identification of a plurality of satellites in view of said mobile GPS receiver and a corresponding plurality of Doppler information for each satellite of said plurality of satellites in view of said mobile GPS receiver.

50. A mobile GPS receiver as in claim 47 wherein said satellite data information comprises data representative of ephemeris for a satellite.

51. A method of using a basestation to calibrate a local oscillator in a mobile GPS receiver, said method comprising:

producing a first reference signal having a precision frequency;

modulating said first reference signal with a data signal to provide a precision carrier frequency signal;

transmitting said precision carrier frequency signal to said mobile GPS receiver, said precision carrier frequency signal being used to calibrate a local oscillator in said mobile GPS receiver, said local oscillator being used to acquire GPS signals.

52. A method as in claim 51 wherein said data signal contains satellite data information which comprises a satellite almanac information for a plurality of satellites in view of said mobile GPS receiver.

53. A method as in claim 51 wherein said data signal contains satellite data information which comprises data representative of ephemeris for a satellite.

54. A basestation for providing a calibration signal for use in a mobile GPS receiver to calibrate a local oscillator in said mobile GPS receiver, said basestation comprising:

a first source for a first reference signal have a precision frequency;

a modulator coupled to said first source and to a second source of satellite data information said modulator providing a precision carrier frequency signal;

a transmitter coupled to said modulator, said transmitter for transmitting said precision carrier frequency signal to said mobile GPS receiver, said precision frequency signal being used to calibrate said local oscillator, said local oscillator being used to acquire said GPS signals.

55. A basestation as in claim 54 wherein said precision carrier frequency signal has a first frequency which is substantially different from a frequency of said GPS signals.

56. A basestation as in claim 54 wherein said satellite data information comprises data representative of ephemeris for a satellite in view of said mobile GPS receiver.

57. A basestation as in claim 54 further comprising a processor coupled to said transmitter, said processor instructing said transmitter to transmit to said mobile GPS receiver.

58. A basestation as in claim 57 wherein said processor determines a plurality of satellites in view of said mobile GPS receiver and obtains said satellite data information for each satellite of said plurality of satellites, and wherein said processor instructs said transmitter to transmit to said mobile GPS receiver an identification of said plurality of satellites and said satellite data information.

59. A basestation as in claim 58 wherein said satellite data information comprises Doppler information for said plurality of satellites.

60. A basestation as in claim 58 wherein said satellite data information comprises data representative of ephemeris for said plurality of satellites.

61. A method of deriving a local oscillator signal in a mobile GPS receiver, said method comprising:

receiving a precision carrier frequency signal from a source providing said precision carrier frequency signal;

automatically locking to said precision carrier frequency signal and providing a reference signal;

using said reference signal to provide a local oscillator signal to acquire GPS signals.

62. A method as in claim 61 wherein said receiving step comprises extracting said precision carrier frequency signal from a data signal containing satellite data information communicated over a communication link.

63. A method as in claim 62 wherein said satellite data information comprises a satellite almanac information for a plurality of satellites in view of said mobile GPS receiver.

64. A method as in claim 62 wherein said satellite data information comprises data representative of ephemeris for a satellite.

65. A method as in claim 62 wherein said communication link is selected from the group consisting of a two-way pager link or a cellular telephone link or personal communication system or specialized mobile radio or a wireless packet data system.

66. A method as in claim 62 wherein said communication link is a radio frequency communication medium.

67. A method as in claim 61 wherein said step of using said reference signal comprises providing said reference signal to a frequency synthesizer and

producing said local oscillator signal from said reference signal and said frequency synthesizer.

68. A method as in claim 61 further comprising downconverting GPS signals received through a GPS antenna, said downconverting step using said local oscillator signal to downconvert said GPS signals.

69. A method as in claim 61 wherein said step of using said reference signal comprises downconverting GPS signals received through a GPS antenna, said downconverting using said local oscillator signal to downconvert said GPS signals.

70. A mobile GPS receiver comprising:

a first antenna for receiving GPS signals;

a downconverter coupled to said first antenna, said first antenna providing said GPS signals to said downconverter, said downconverter having an input for receiving a local oscillator signal to convert said GPS signals from a first frequency to a second frequency;

a second antenna for receiving a precision carrier frequency signal from a source providing said precision carrier frequency signal;

an automatic frequency control (AFC) circuit coupled to said second antenna, said AFC circuit being coupled to said downconverter to provide said local oscillator signal which is used to acquire said GPS signals.

71. A mobile GPS receiver as in claim 70 further comprising a frequency synthesizer coupled to said AFC circuit and to said downconverter, said downconverter receiving said local oscillator through said frequency synthesizer.

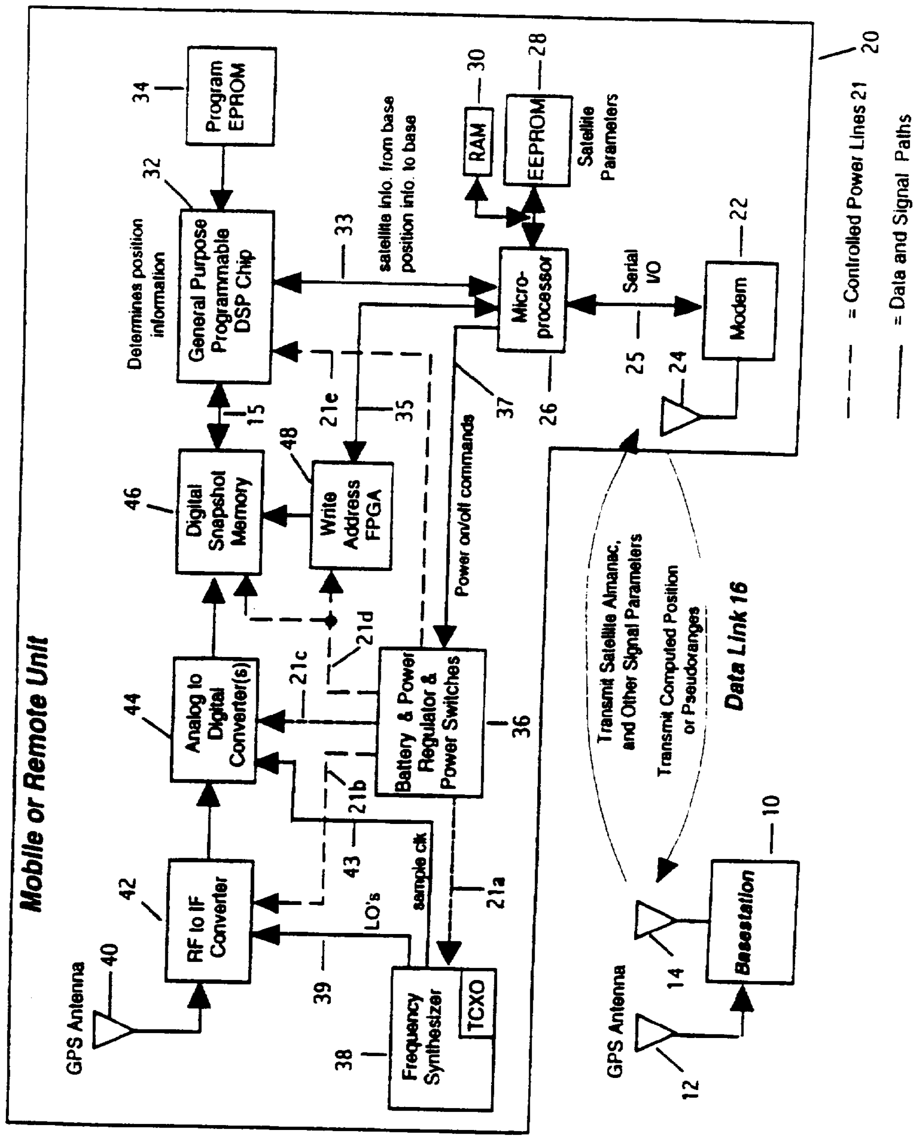

Mobile or Remote Unit
GPS Antenna
40
RF to IF Converter
42
Analog to Digital Converter(s)
44
Digital Snapshot Memory
46
General Purpose Programmable DSP Chip
32
Determines position information
Program EPROM
34
15
Write Address FPGA
48
21e
35
21c
21d
21b
43
sample clk
LO's
39
21a
Frequency Synthesizer
TCXO
38
Battery & Power Regulator & Power Switches
36
Power on/off commands
37
Micro-processor
26
33
satellite info. from base
position info. to base
RAM
30
EEPROM
28
Satellite Parameters
Serial I/O
25
Modem
22
24
20
= Controlled Power Lines 21
= Data and Signal Paths
Transmit Satellite Almanac, and Other Signal Parameters
Transmit Computed Position or Pseudoranges
Data Link 16
Basestation
10
14
GPS Antenna
12

FIG. 1A

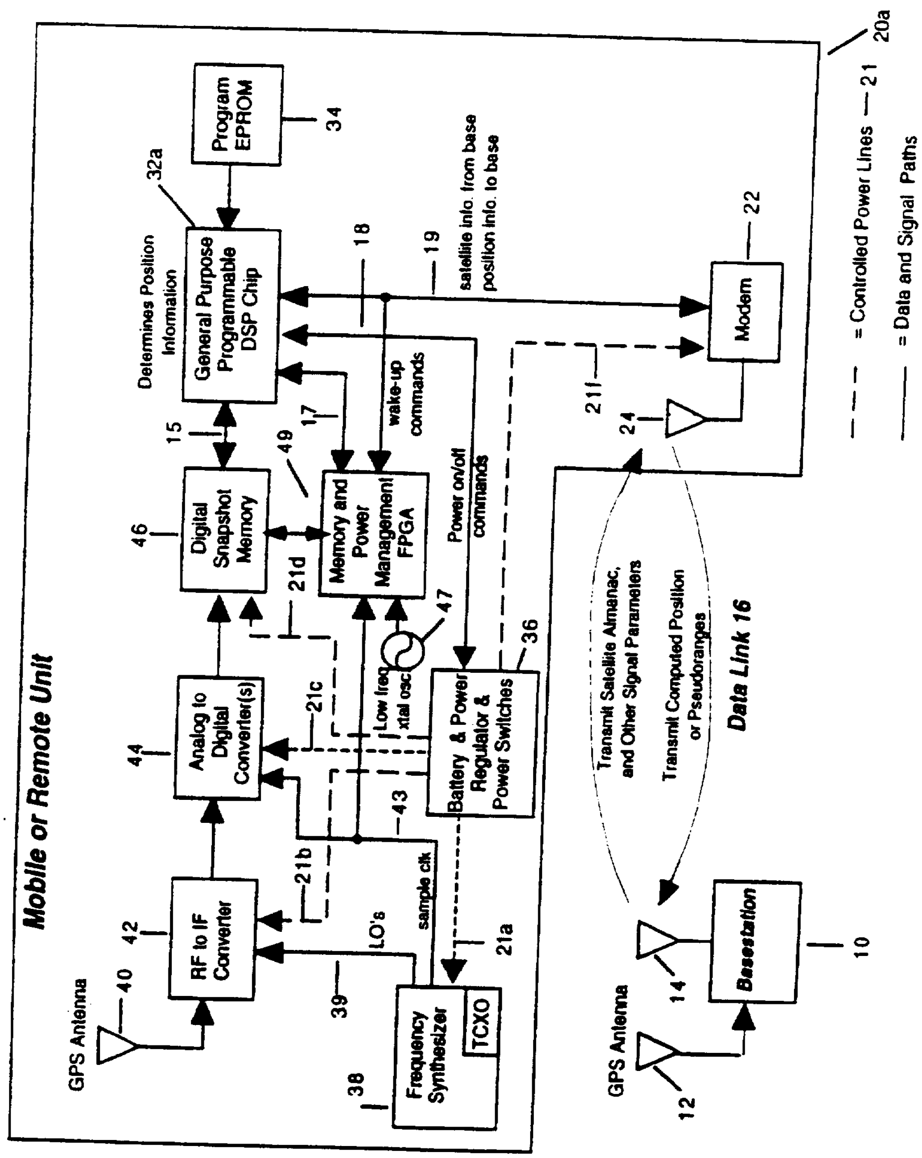

Mobile or Remote Unit
GPS Antenna
40
42
RF to IF Converter
44
Analog to Digital Converter(s)
46
Digital Snapshot Memory
15
General Purpose Programmable DSP Chip
Determines Position Information
32a
Program EPROM
34
18
19
satellite info. from base
position info. to base
Modem
22
21
24
49
17
wake-up commands
Memory and Power Management FPGA
21d
47
Low freq xtal osc
Power on/off commands
36
Battery & Power Regulator & Power Switches
21c
43
21b
LO's
sample clk
21a
39
38
Frequency Synthesizer
TCXO
Transmit Satellite Almanac, and Other Signal Parameters
Transmit Computed Position or Pseudoranges
Data Link 16
GPS Antenna
12
14
Basestation
10
= Controlled Power Lines — 21
= Data and Signal Paths
20a

FIG. 1B

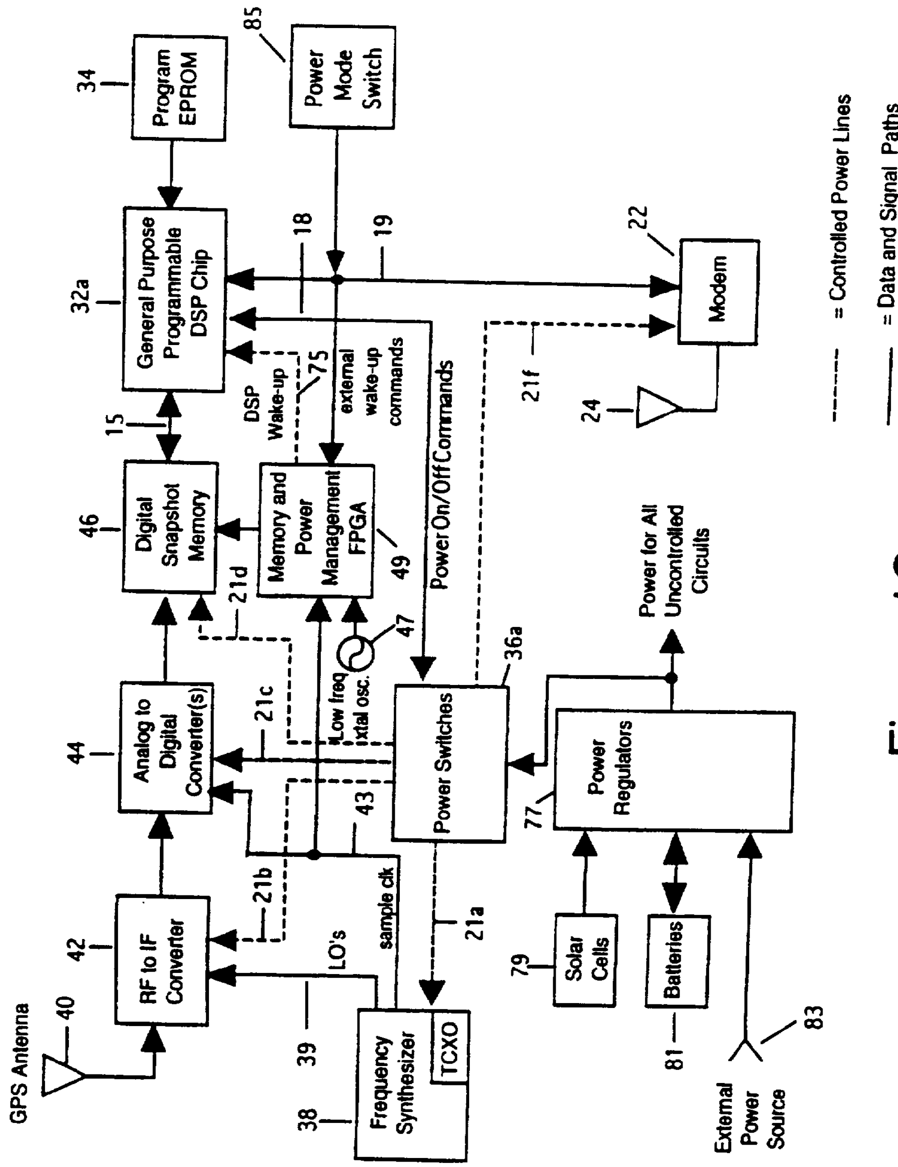

GPS Antenna
40
RF to IF Converter
42
Analog to Digital Converter(s)
44
Digital Snapshot Memory
46
General Purpose Programmable DSP Chip
32a
Program EPROM
34
15
Memory and Power Management FPGA
49
DSP Wake-up
75
external wake-up commands
18
19
Power Mode Switch
85
Modem
22
24
21f
Power On/Off Commands
Power Switches
36a
21d
21c
21b
21a
47
Low freq xtal osc.
43
LO's
sample clk
39
Frequency Synthesizer
TCXO
38
Power Regulators
77
Power for All Uncontrolled Circuits
Solar Cells
79
Batteries
81
External Power Source
83
= Controlled Power Lines
= Data and Signal Paths

Figure 1C

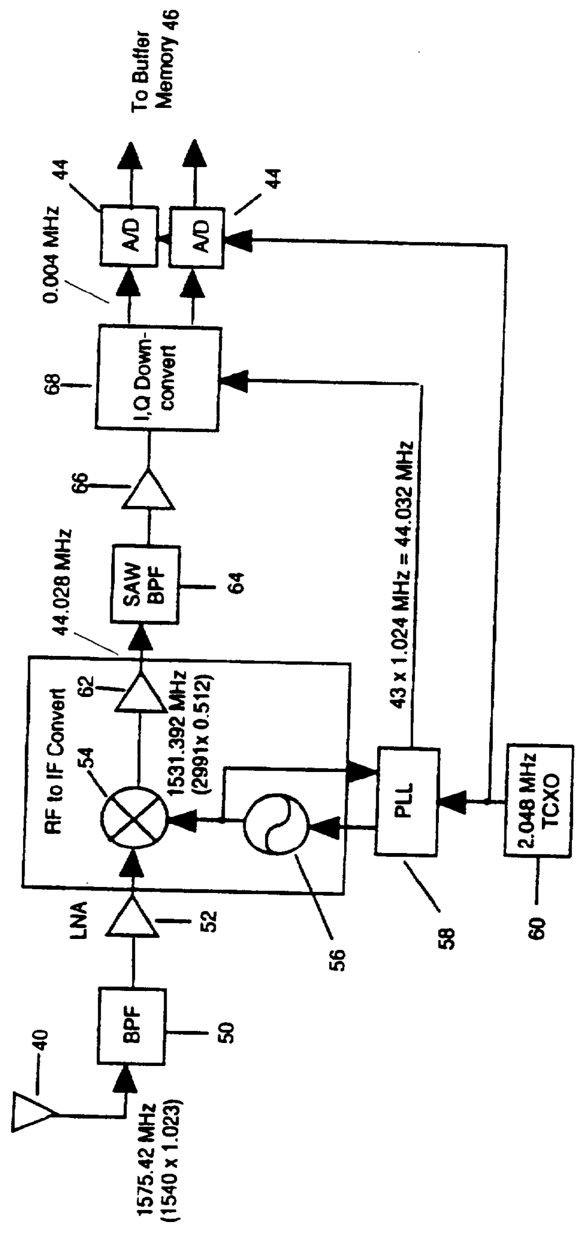

1575.42 MHz
(1540 x 1.023)
40
BPF
50
LNA
52
RF to IF Convert
54
1531.392 MHz
(2991 x 0.512)
62
56
PLL
58
2.048 MHz
TCXO
60
44.028 MHz
SAW
BPF
64
66
I,Q Down-
convert
68
43 x 1.024 MHz = 44.032 MHz
0.004 MHz
A/D
A/D
44
44
To Buffer
Memory 46

Figure 2A

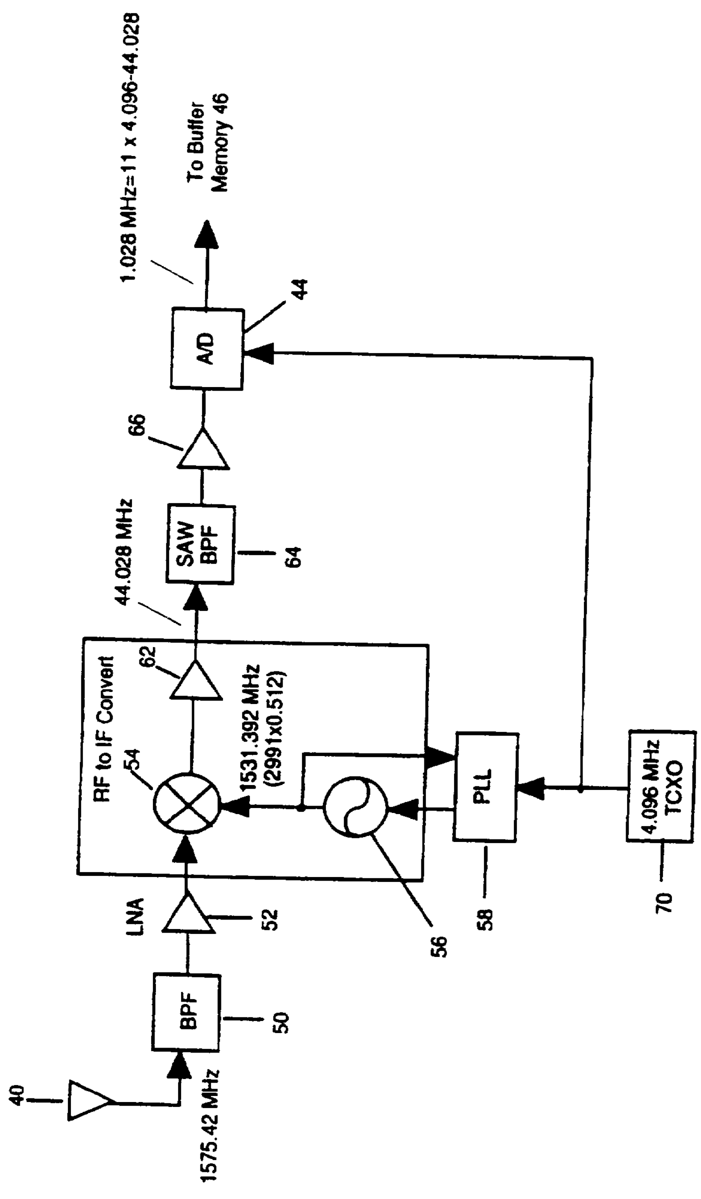

1575.42 MHz
40
BPF
50
LNA
52
RF to IF Convert
54
56
1531.392 MHz
(2991x0.512)
62
PLL
58
4.096 MHz
TCXO
70
44.028 MHz
SAW
BPF
64
66
A/D
44
1.028 MHz=11 x 4.096-44.028
To Buffer
Memory 46

Figure 2B

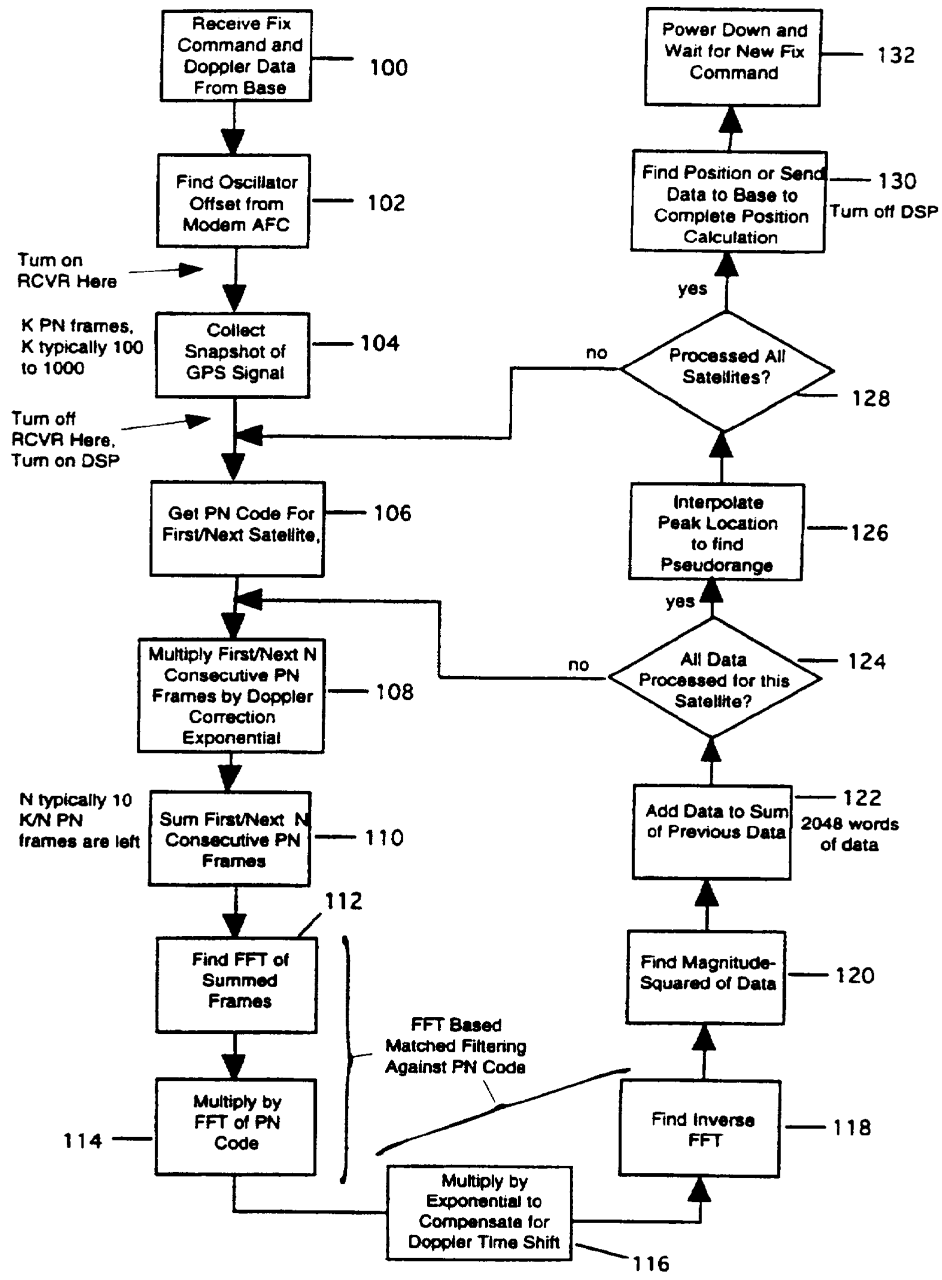
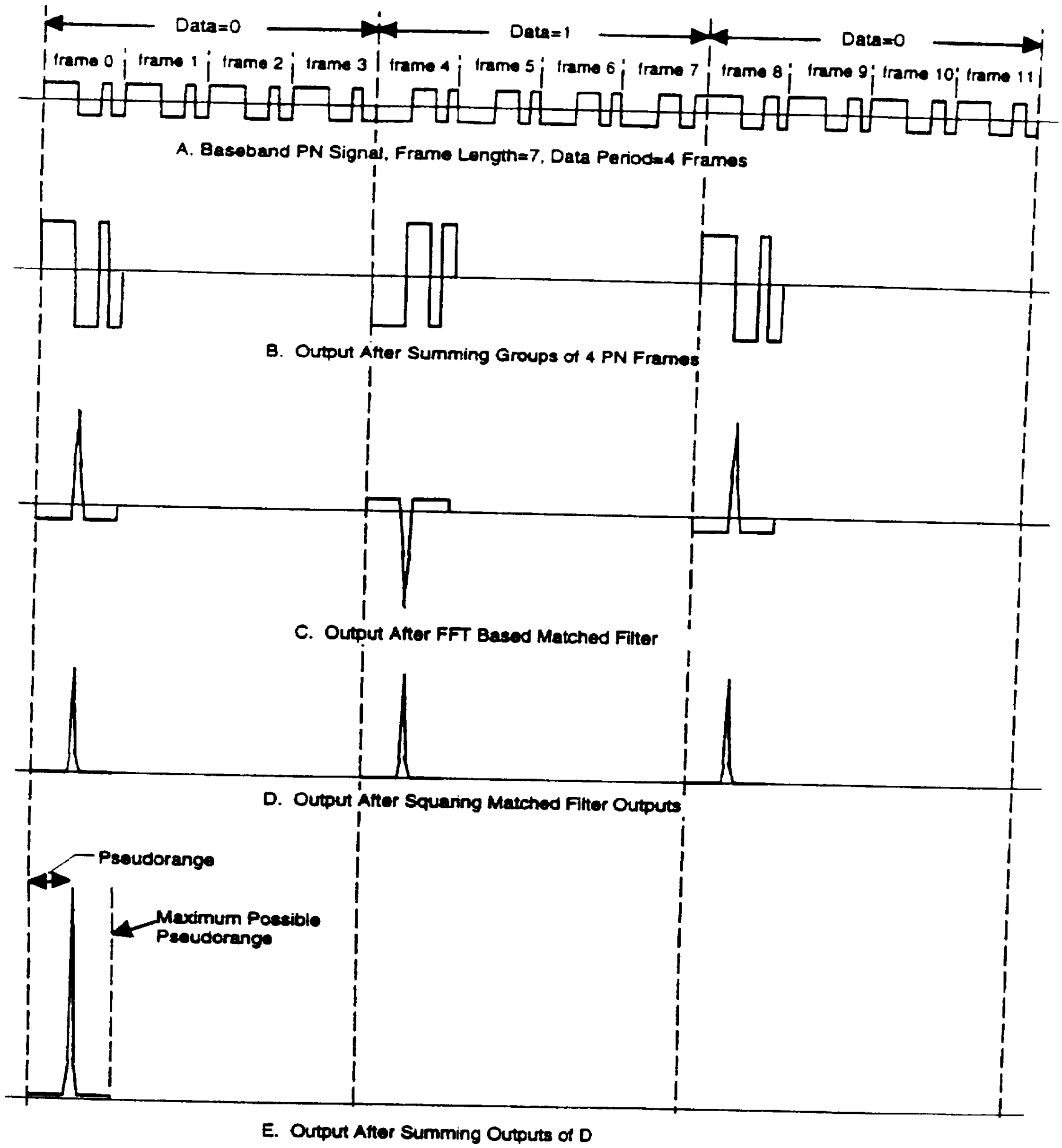

Receive Fix Command and Doppler Data From Base
100
Find Oscillator Offset from Modem AFC
102
Turn on RCVR Here
K PN frames, K typically 100 to 1000
Collect Snapshot of GPS Signal
104
Turn off RCVR Here, Turn on DSP
Get PN Code For First/Next Satellite,
106
Multiply First/Next N Consecutive PN Frames by Doppler Correction Exponential
108
N typically 10 K/N PN frames are left
Sum First/Next N Consecutive PN Frames
110
112
Find FFT of Summed Frames
Multiply by FFT of PN Code
114
FFT Based Matched Filtering Against PN Code
Multiply by Exponential to Compensate for Doppler Time Shift
116
Find Inverse FFT
118
Find Magnitude-Squared of Data
120
Add Data to Sum of Previous Data
122
2048 words of data
All Data Processed for this Satellite?
124
no
yes
Interpolate Peak Location to find Pseudorange
126
Processed All Satellites?
128
no
yes
Find Position or Send Data to Base to Complete Position Calculation
130
Turn off DSP
Power Down and Wait for New Fix Command
132

Figure 3



Figures 4A, 4B, 4C, 4D, 4E

FIGURE 5A

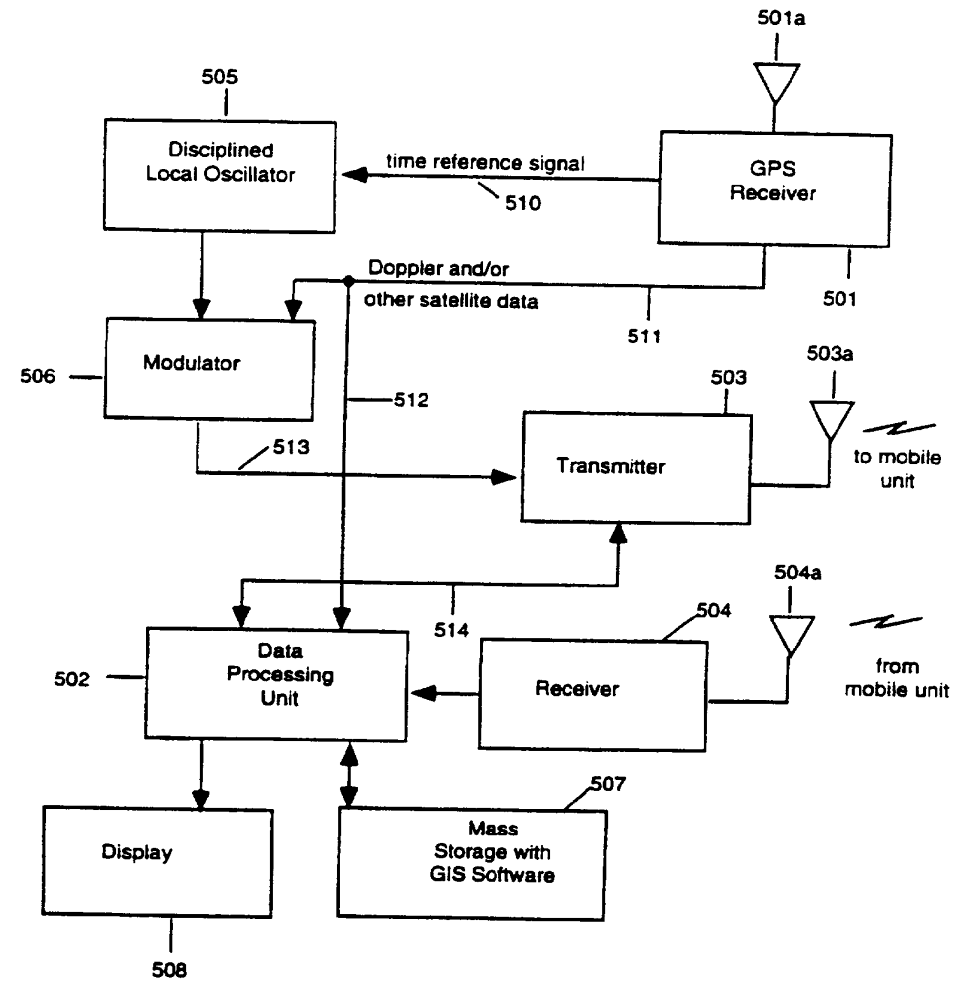
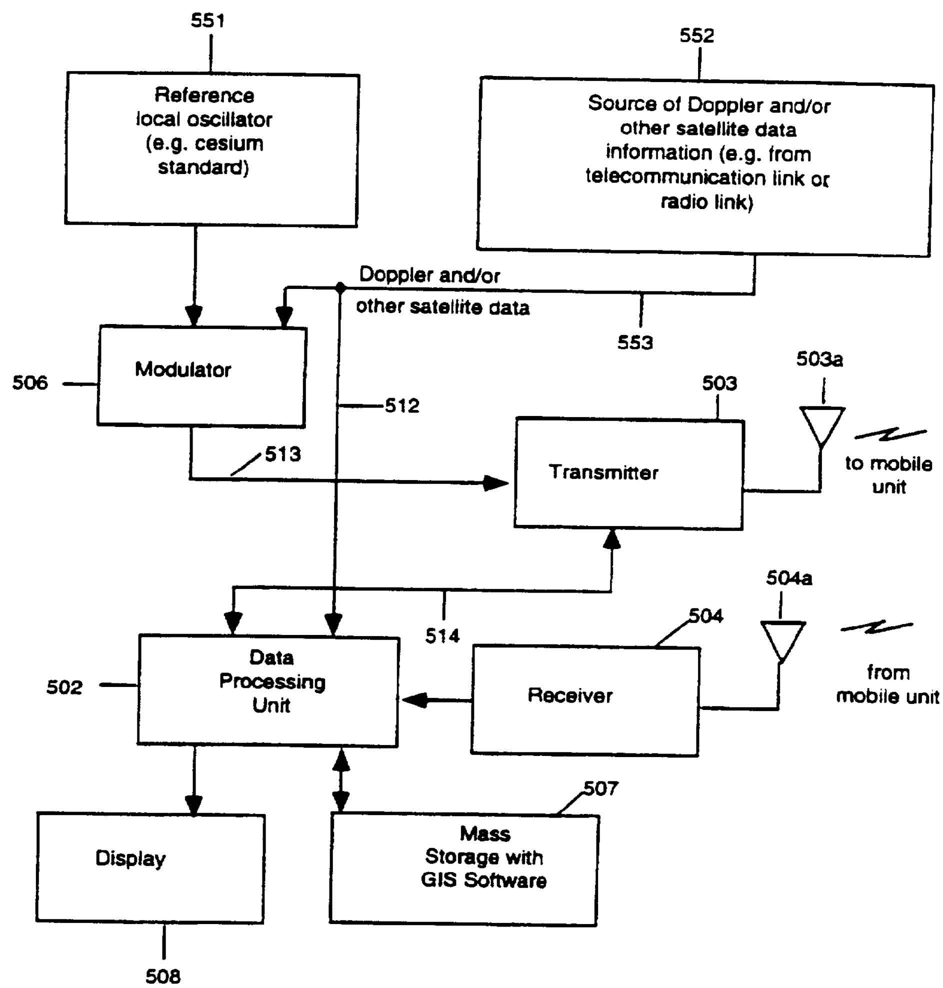

501a
505
Disciplined Local Oscillator
time reference signal
510
GPS Receiver
501
Doppler and/or other satellite data
511
Modulator
506
512
503a
503
513
Transmitter
to mobile unit
504a
504
514
Data Processing Unit
502
Receiver
from mobile unit
507
Display
Mass Storage with GIS Software
508

FIGURE 5B


551
552
Reference local oscillator (e.g. cesium standard)
Source of Doppler and/or other satellite data information (e.g. from telecommunication link or radio link)
Doppler and/or other satellite data
553
506
Modulator
512
503a
503
513
Transmitter
to mobile unit
504a
514
504
502
Data Processing Unit
Receiver
from mobile unit
507
Display
Mass Storage with GIS Software
508

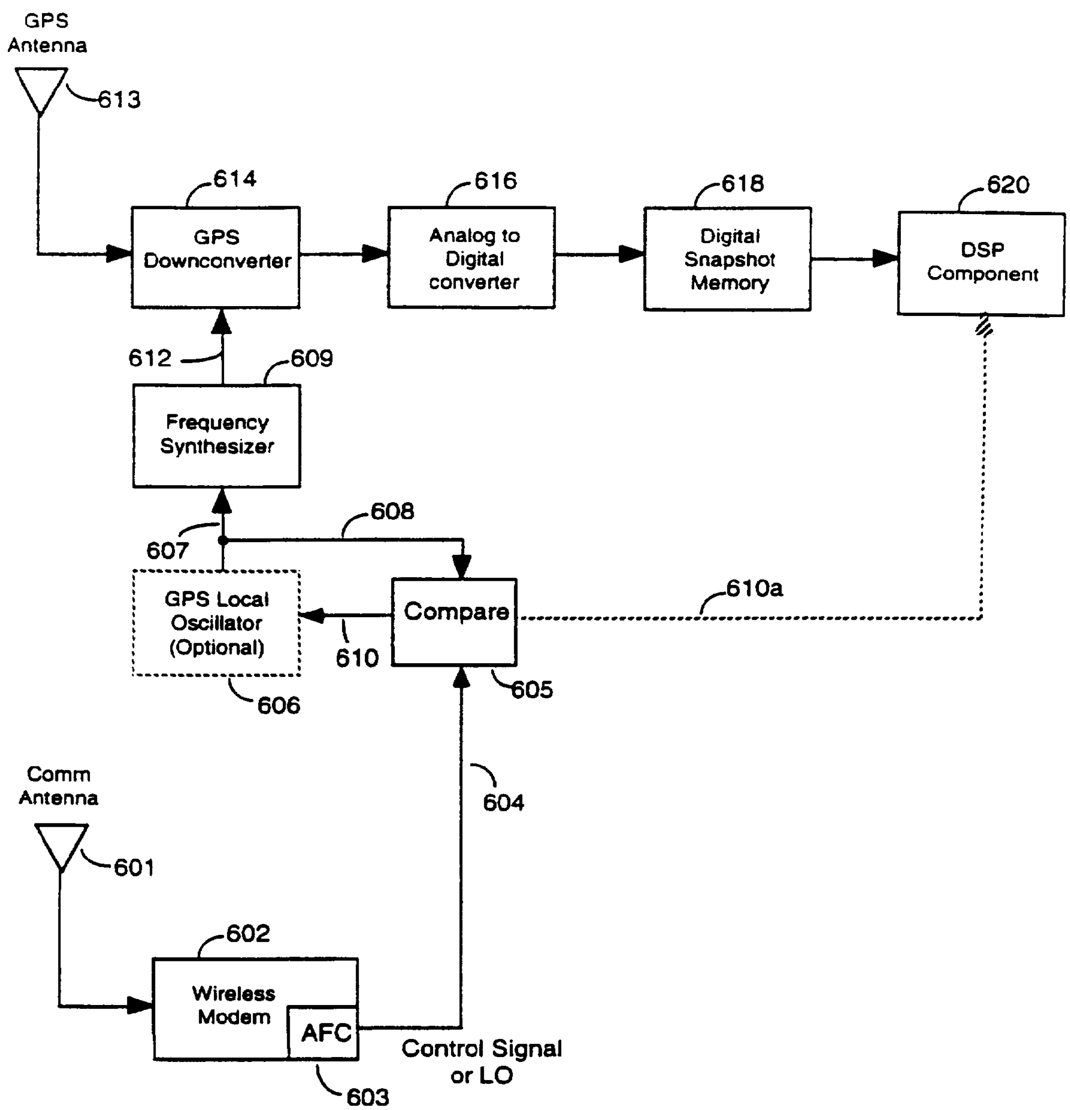

GPS
Antenna
613
614
GPS
Downconverter
616
Analog to
Digital
converter
618
Digital
Snapshot
Memory
620
DSP
Component
612
609
Frequency
Synthesizer
608
607
GPS Local
Oscillator
(Optional)
Compare
610a
610
605
606
604
Comm
Antenna
601
602
Wireless
Modem
AFC
Control Signal
or LO
603

FIGURE 6A

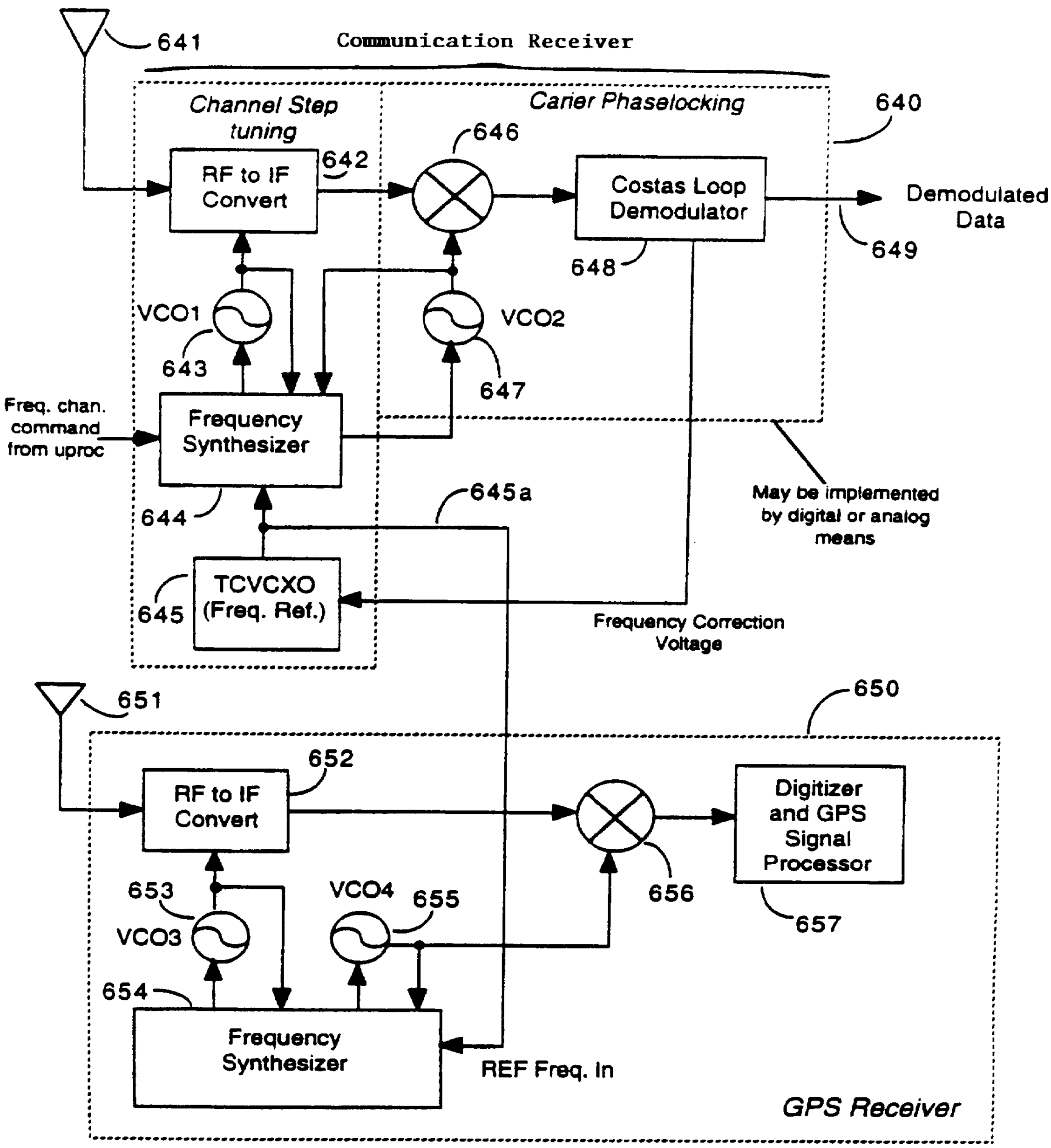

641
Communication Receiver
Channel Step tuning
Carier Phaselocking
640
RF to IF Convert
642
646
Costas Loop Demodulator
Demodulated Data
649
648
VCO1
VCO2
643
647
Freq. chan. command from uproc
Frequency Synthesizer
644
645a
May be implemented by digital or analog means
TCVCXO (Freq. Ref.)
645
Frequency Correction Voltage
651
650
652
RF to IF Convert
Digitizer and GPS Signal Processor
653
VCO3
VCO4
655
656
657
654
Frequency Synthesizer
REF Freq. In
GPS Receiver

Figure 6B

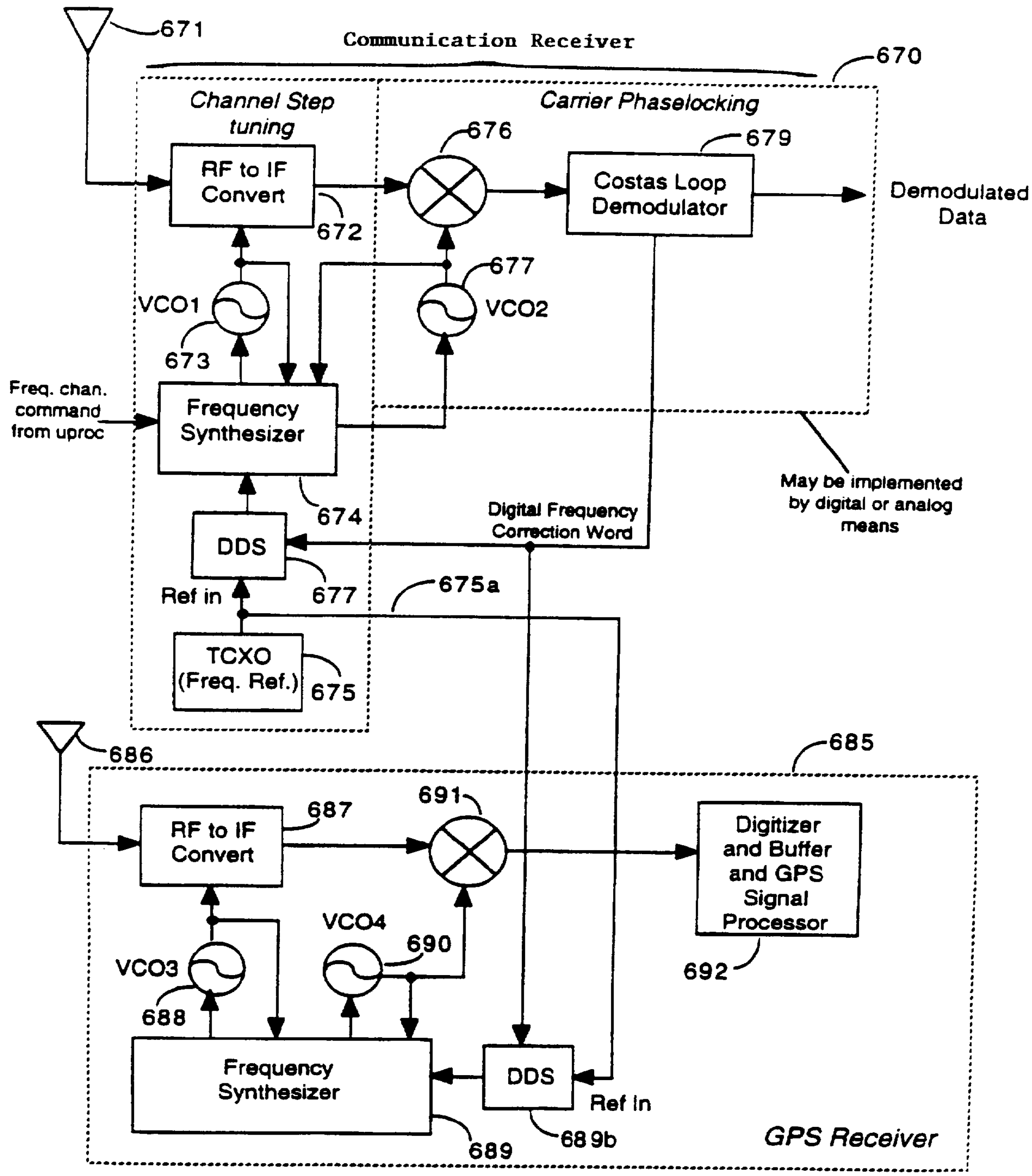

671
Communication Receiver
670
Channel Step tuning
Carrier Phaselocking
676
679
RF to IF Convert
Costas Loop Demodulator
Demodulated Data
672
677
VCO1
VCO2
673
Freq. chan. command from uproc
Frequency Synthesizer
May be implemented by digital or analog means
674
Digital Frequency Correction Word
DDS
Ref in
677
675a
TCXO (Freq. Ref.)
675
686
685
RF to IF Convert
687
691
Digitizer and Buffer and GPS Signal Processor
VCO4
690
VCO3
692
688
Frequency Synthesizer
DDS
Ref In
689
689b
GPS Receiver

Figure 6C

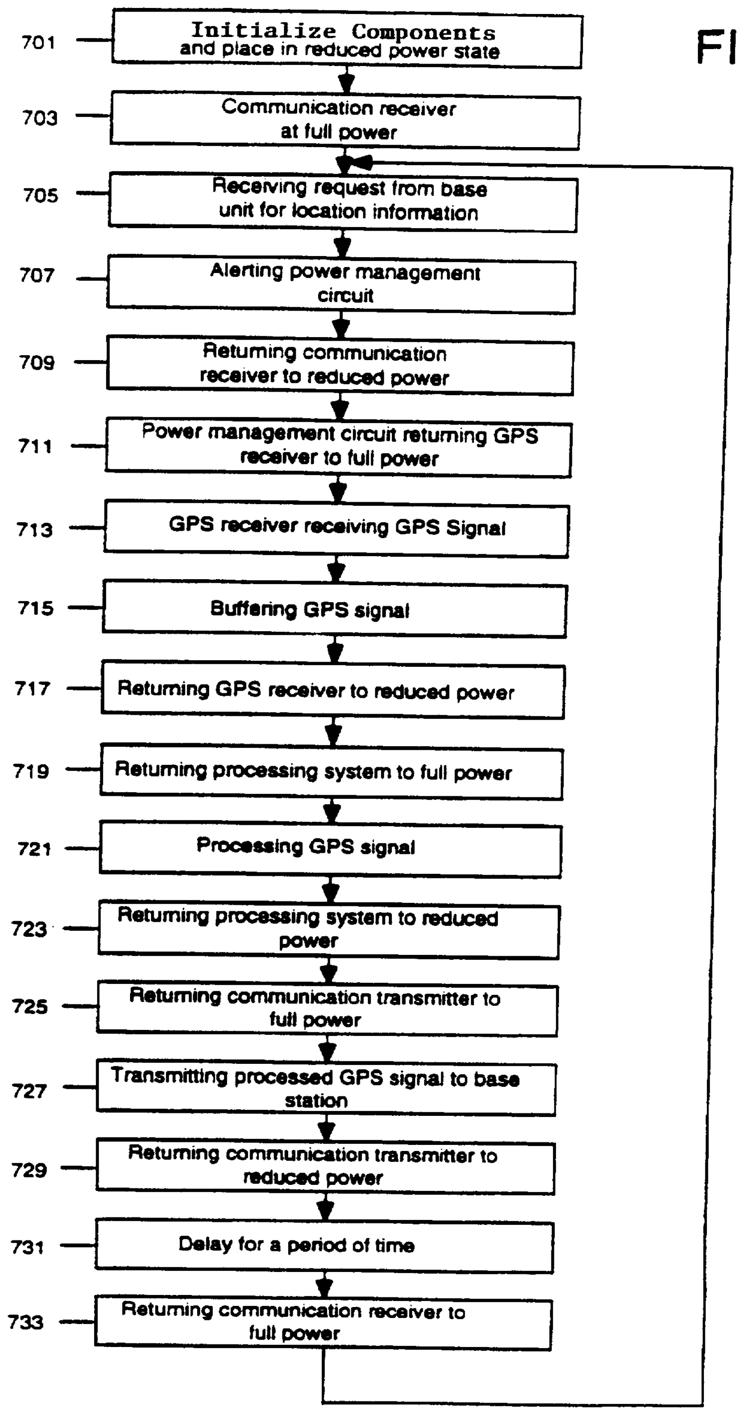

701 Initialize Components and place in reduced power state
703 Communication receiver at full power
705 Receiving request from base unit for location information
707 Alerting power management circuit
709 Returning communication receiver to reduced power
711 Power management circuit returning GPS receiver to full power
713 GPS receiver receiving GPS Signal
715 Buffering GPS signal
717 Returning GPS receiver to reduced power
719 Returning processing system to full power
721 Processing GPS signal
723 Returning processing system to reduced power
725 Returning communication transmitter to full power
727 Transmitting processed GPS signal to base station
729 Returning communication transmitter to reduced power
731 Delay for a period of time
733 Returning communication receiver to full power

FIGURE 7

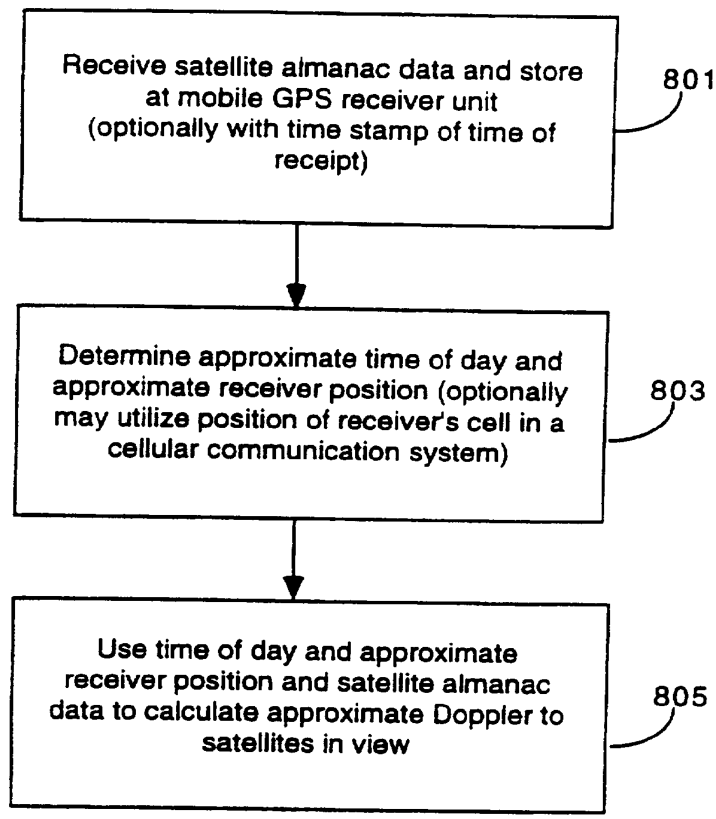

Receive satellite almanac data and store at mobile GPS receiver unit (optionally with time stamp of time of receipt)
801
Determine approximate time of day and approximate receiver position (optionally may utilize position of receiver's cell in a cellular communication system)
803
Use time of day and approximate receiver position and satellite almanac data to calculate approximate Doppler to satellites in view
805

Figure 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/03512

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04B 7/185; G01S 5/02
US CL :342/357; 364/449.7
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 342/357; 364/449.7
449.9, 449.95

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,153,598 (ALVES, JR.) 06 October 1992, See Figure 1.	1-35
X	US, A, 5,323,322 (MUELLER ET AL) 21 June 1994, See Figure 3	1-35
X	US, A, 4,445,118 (TAYLOR ET AL) 24 April 1984, See Figure 3	1-35
X	US, A, 5,119,102 (BARNARD) 02 June 1992, See Figure 3	1-35
X	US, A, 5,420,592 (JOHNSON) 30 May 1995, See Figure 2	1-71
X	US, A, 4,457,006 (MAINE) 26 June 1984, See column 4, lines 63+	36-71

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 05 JUNE 1997	Date of mailing of the international search report 11 JUL 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer for THEODORE BLUM Telephone No. (703) 305-1833

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/03512

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 5,365,450 (SCHUCHMAN ET AL) 15 November 1994, See claims 3, 9, and 11	36-71

Form PCT/ISA/210 (continuation of second sheet)(July 1992)★

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 **:** **G07C 5/08**	**A1**	**(11) International Publication Number:** **WO 98/47109** **(43) International Publication Date:** 22 October 1998 (22.10.98)

(21) International Application Number: PCT/US98/07704

(22) International Filing Date: 16 April 1998 (16.04.98)

(30) Priority Data:
08/837,432 17 April 1997 (17.04.97) US

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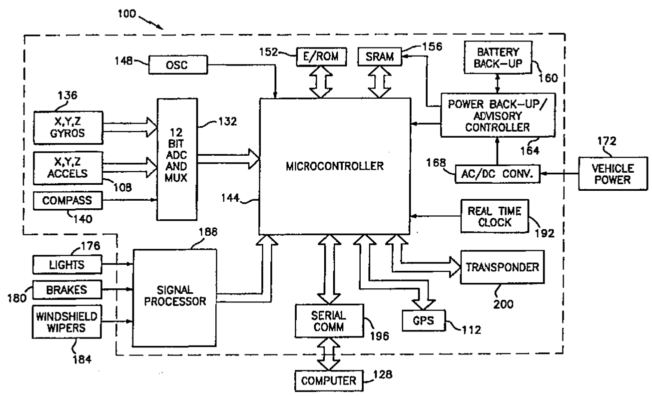
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: VEHICLE CRASH DATA RECORDER, LOCATOR AND COMMUNICATOR



(57) Abstract

A vehicle data recorder, utilized to record vehicle operational data, employs accelerometers to sense vehicle acceleration. To compensate for the inherent error in such accelerometers due to their undesired response to gravity, a gyroscope is employed. The gyroscope measures the identical false acceleration component, due to vehicle inclination, as that of the accelerometers. The gyroscope outputs are then subtracted from the accelerometer outputs, resulting in a true reading of vehicle acceleration, from which vehicle velocity is calculated. The vehicle data recorder also includes a communications port for connection to a computer utilized to reconstruct an abnormal vehicle operating condition. Also included is a signal transmitter for sending signals to appropriate rescue authorities and indicative of vehicle conditions such as the vehicle location, the severity of the accident and the time of the accident. A global positioning system is also utilized to allow the vehicle to determine its location on the earth's surface.

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VEHICLE CRASH DATA RECORDER, LOCATOR AND COMMUNICATOR

BACKGROUND OF THE INVENTION

This invention relates to data recorders for vehicles such as automobiles, and more particularly to such a data recorder having improved means for sensing vehicle acceleration prior to and during an abnormal vehicle operating condition, such as a vehicle crash.

When any type of air, water or land vehicle encounters a problematic or abnormal operating condition, such as an accident in which the vehicle strikes an object, it is desirable to determine the reasons for such a condition. This is especially important when human injury or loss of life occurs.

Historically, the reasons or causes for a vehicle accident have been determined by making an estimate of various vehicle operating parameters, such as velocity and direction. These estimates are made from readily-observable evidence, such as the length and direction of tire skid marks left on the surface of the roadway, and the amount and type of damage to the vehicle. The resulting observed values are then cross-referenced to empirical look-up tables containing relevant values for corresponding vehicle velocity and direction. These tables have been developed over time based upon the laws of physics, vehicle materials and data available from thousands of vehicle accidents.

However, this approach to determining the velocity and direction of a vehicle both prior to and at the time of an accident does not yield truly accurate data. Data accuracy is inherently limited by the fact that a certain length of tire skid marks could be caused by different vehicle speeds and various other conditions. Other factors could contribute to the skid marks, including the amount of tire tread, type of road surface (*e.g.*, asphalt, concrete, *etc.*), and the condition of the road surface (*e.g.*, dry, wet from rain, ice covered, snow covered, *etc.*). Based on the shortcomings of the empirical table look-up method, it is desirable to utilize a more accurate and scientific means and method for determining vehicle operating parameters, such as velocity, at the time of a vehicle accident or other abnormal vehicle operating condition.

It is well-known in the art of aircraft to utilize a data recorder (a.k.a., "a black box") for continuously or selectively monitoring and storing data associated with various aircraft flight parameters. Upon the crash of an aircraft, the black box is recovered. The data in the black box is then typically downloaded to a computer. The computer executes software that recreates various flight conditions which occurred in conjunction with an abnormal aircraft situation, such as a crash or an unexpected evasive maneuver. The use of such flight data recorders on aircraft is usually mandated by law, due in part to the fact that an aircraft crash most always results in loss of large numbers of human life. Thus, the need to have a recorder on-board the aircraft generally outweighs any cost considerations.

However, in the case of land and water vehicles (*e.g.*, cars, boats), this need/cost analysis historically has resulted in the exclusion of data recorders on such vehicles. Various factors have contributed to this decision, including that a significantly larger number of land and water vehicles exist as compared to aircraft, that the cost of such land and water vehicles is much less than aircraft (nevertheless the cost of such land and water vehicles is certainly influential when consumers are deciding whether to purchase such a vehicle, such that the cost of every component of a car or boat is strictly considered by its manufacturer), and that the occurrence of an accident or other abnormal operating condition associated with such land and water vehicles often does not result in serious human injury or loss of life. Indeed, as compared to various types of aircraft, no known similar laws exist mandating the usage of such data recorders on land or water vehicles.

Nevertheless, a number of prior art patents exist which describe a data recorder for use not only on aircraft but also on cars, boats and other non-aircraft vehicles. Examples of these prior art data recorders are provided in U.S. Pat. Nos. 3781824, 4638289, 5446659 and 4992943. In general, these and other prior art data recorders are somewhat similar to existing aircraft flight data recorders in that they sense or monitor various vehicle operating parameters and then utilize various schemes for storing data for later readout and vehicle operation reconstruction. The differences between aircraft data recorders and land or water vehicle data recorders reside primarily in the types of parameters sensed and stored. This is due to the inherent structural differences between these types of vehicles and in the resulting physical operating parameters involved. Yet, many similarities exist in data recorders for all three types of vehicles.

Despite the teachings of these patents, the prior art data recorders remain largely unavailable for vehicles such as consumer-purchased cars, trucks and boats. Reasons for such unavailability were discussed, in part, above. However, the inventors theorize that perhaps the cost of implementing such a data recorder on an automobile historically has been the primary reason for its exclusion. Nevertheless, rapid advances in integrated circuit semiconductor technology has reduced the size and cost, while improving the functionality and availability, of various types of sensors and signal processors. However, another reason for their unavailability on automobiles may exist, as discussed below.

With respect to any type of vehicle, perhaps the most important and desired operating parameter used in reconstructing the operation of the vehicle just prior to and during an accident is vehicle speed. As is well-known (for example, as taught by the aforementioned patents), velocity is usually (if not always) determined by these vehicle data recorders through the use of an accelerometer. The accelerometer senses the amount of vehicle acceleration (usually in a predetermined direction of travel), and this value is integrated mathematically to obtain vehicle velocity. None of the above patents, or any other known patents, teach the use of a vehicle acceleration measuring device, either in conjunction with or instead of, the well-known accelerometer.

However, the use of solely an accelerometer to measure vehicle acceleration often times leads to errors and inaccuracies in the sensed acceleration value. The error introduced into the accelerometer output is an undesirable and false amount of vehicle acceleration due to the incline or "tilt" of the accelerometer when the vehicle is not level.

Most accelerometers utilize both a mass and a flexing beam to sense acceleration. Any tilting of the sensor from a zero horizontal angular position will cause the accelerometer to incorrectly interpret such tilting as an acceleration value. This situation can occur most often simply when the vehicle is driving up or down an inclined surface. It can also occur during a collision when the car bounces, raises or acts as a projectile. The false reading adds to the true measure of any vehicle acceleration sensed by the accelerometer.

The proportional amount of the false acceleration component with respect to the overall sensed acceleration output is at its relatively largest value during small amounts of acceleration; that is, during normal driving conditions. It can also be important during the duration of a collision. Therefore, for use in a vehicle data recorder that records acceleration data just prior to an accident or crash, the use of an accelerometer can produce a significant false acceleration component.

Accordingly, it is a primary object of the present invention to provide a vehicle data recorder that overcomes the shortcomings of prior art accelerometers.

It is a general object of the present invention to provide a vehicle data recorder that utilizes an accelerometer, but compensates for any erroneous effects that gravity has on the value of the accelerometer output.

It is another object of the present invention to "decouple" the effects of gravity on an accelerometer to obtain an accurate reading of vehicle acceleration.

It is yet another object of the present invention to provide a vehicle data recorder that can distinguish between desired data indicative of true vehicle acceleration and spurious data indicative of the effects of gravity on the accelerometer.

Still another object of the present invention is to provide a vehicle data recorder that accurately measures and records data relating to various vehicle parameters, to thereby assist in the scientific recreation of the motion of the vehicle at predetermined periods of vehicle operation.

Yet another object of the present invention is to provide a vehicle data recorder that can also determine the position of the vehicle anywhere on the earth's surface.

Another object of the present invention is to provide a vehicle data recorder that also includes a signal transmitter for transmitting signals indicative of vehicle operating parameters, such as the location of the vehicle at the time of an accident, the severity of the accident and the time of day that the accident occurred.

The above and other objects and advantages of this invention will become readily apparent when the following description is read in conjunction with the accompanying drawings.

SUMMARY OF THE INVENTION

To overcome the deficiencies of the prior art and to achieve the objects listed above, the Applicants have invented a vehicle data recorder that utilizes an accelerometer, but also employs a gyroscope to compensate for any errors caused by gravity in the output signal of the accelerometer, thereby providing for a true reading of vehicle acceleration.

In a preferred embodiment of a primary aspect of the present invention, the data recorder is operable to record data associated with various operating parameters of an automobile. The data can be continuously and selectively stored and later retrieved to reconstruct the operation of the vehicle at certain instances in time; for example, just prior to and during a vehicle accident. The recorder of the present invention is of compact design and is typically mounted to the automobile body. The recorder is microprocessor-based,and senses and conditions various electronic signals, including those indicative of vehicle direction and the status of the various vehicle lights, as well as the vehicle brakes and windshield wipers.

The recorder also includes three accelerometers that sense vehicle acceleration in three different directions (*i.e.*, along the X, Y and Z axes or directions of movement), and a three-axis gyroscope. The gyroscope measures the identical amounts of false acceleration values in each axis (*i.e.*, pitch, roll and yaw) that are undesirably measured by the accelerometers due to the tilt of the accelerometers. The microprocessor utilizes the gyroscope output values to cancel the false acceleration values from the accelerometer outputs, thereby producing a true reading of vehicle acceleration from which vehicle velocity can be calculated. The vehicle recorder of the present invention contains memory for storing a predetermined amount of data relating to these various operating parameters.

According to a second aspect of the present invention, the vehicle data recorder also includes a signal transmitter for transmitting signals indicative of certain vehicle conditions to appropriate personnel. For example, once the microprocessor has determined, from the sensed data, that an accident has occurred, the data recorder of the present invention can transmit radio frequency signals to local police and rescue authorities indicative of the location and time of the accident, and the severity of the accident.

According to a third aspect of the present invention, the vehicle data recorder also includes means for determining the location of the vehicle on the earth's surface. The location determining means may be either satellite-based and/or ground-based, depending upon the type of vehicle and whether it is land or water-based.

According to a fourth aspect of the present invention, an external computer connects to the vehicle data recorder through a communications link. The data stored in the recorder that is indicative of vehicle operating parameters just prior to and during a vehicle crash is downloaded to the computer. The computer executes software that utilizes the downloaded data to accurately and scientifically reconstruct the vehicle accident to assist in determining the reasons or causes of the accident

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustration of the vehicle data recorder of the present invention, as implemented on a vehicle, and utilized with a satellite or land-based global positioning system ("GPS"), and which notifies an entity of the vehicle status;

FIG. 2 is a detailed block diagram illustration of the vehicle data recorder of FIG.1; and

FIG. 3 is a flowchart illustration of software executed by the vehicle data recorder of FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in detail, there illustrated are exemplary, preferred embodiments of a vehicle data recorder of the present invention having improved means and methodology for accurately sensing the acceleration of a vehicle. The vehicle data recorder, or "ACC" (*i.e.*, "Automobile Crash Coder"), is generally indicated therein by the reference numeral 100. In a preferred exemplary embodiment, the vehicle 104 comprises an automobile. However, it should be understood that the vehicle data recorder 100 of the present invention can be utilized on any type of land, water or air-based vehicle or craft. The primary limitation or consideration is that the vehicle data recorder 100 of the present invention be utilized with accelerometers 108. One or more of these accelerometers 108 are typically used to sense acceleration of the vehicle 104 in a corresponding one or more directions of vehicle travel. The vehicle data recorder 100 typically contains electronic signal processing means for integrating the output values from the accelerometers 108 to obtain vehicle velocity.

Referring to FIG. 1, there illustrated is the vehicle 104 containing the ACC 100 of the present invention as embodied therein. The vehicle data recorder 100 is described in greater detail hereinafter with respect to FIGS. 2 and 3. As mentioned hereinbefore, the primary functional aspect of the vehicle recorder 100 of the present invention is to compensate for the inherent error when utilizing accelerometers 108 to sense vehicle speed. However, a second primary aspect of the present invention is the provision of means for determining the location of the vehicle 104 anywhere on the earth's surface. To perform this function, the ACC 100 contains a GPS signal receiver/transmitter and corresponding signal processing means 112 (FIG. 2) that receives navigation signals from either earth-orbiting satellites 116 or land-based navigation GPS 120.

In accordance with well-known GPS technology, the GPS signal receiver/transmitter 112, located within the vehicle data recorder 100 of the present invention, may be utilized to receive corresponding directional signals from one or more satellites 116 positioned above the earth's surface. In the alternative, the vehicle data recorder 100 of the present invention may communicate with one or more land-based signal transmitters 120. Both types of GPS systems may typically allow for determination of vehicle location by triangulation. A detailed discussion of such well-known satellite or land-based global positioning systems is given in U.S. Pat. No. 5311197, which is incorporated herein by reference. Described and illustrated in detail in that patent are numerous and various satellite positioning systems, such as the Global Positioning System or the Global Orbiting Navigation System. That patent also describes and illustrates various ground-based radio navigation systems, such as LORAN, SHORAN, DECCA or TACAN.

Other examples of well-known vehicle location systems are described and illustrated in U.S. Pat. Nos. 5119102 and 4740792, both of which patents are incorporated herein by reference. A detailed description of an exemplary GPS is described hereinafter with respect to FIG. 2.

FIG. 1 also illustrates a notified entity 124 that is in communication (typically, radio communication) with the vehicle data recorder 100 of the present invention. The notified entity 124 may comprise a rescue authority, such as local or state police, fire and/or ambulance. In the alternative, the entity 124 may be a centralized reporting station that receives a signal indication from the recorder 100 of such conditions as the severity of the accident and the time and location of the accident, and reports this information to the appropriate authorities, depending upon the nature of the vehicle abnormal condition.

FIG. 1 also illustrates an external computer 128, or other data processing means, that is in either hardwired or radio communication contact with the vehicle data recorder 100 of the present invention. The computer 128 extracts the information stored in memory in the vehicle data recorder 100 and reconstructs the vehicle abnormal condition from this stored data. In a preferred exemplary embodiment of the present invention, a laptop or desktop computer 128 is utilized, which executes software that extracts the data from the vehicle data recorder 100 through a communications link, and then reconstructs the vehicle abnormal condition.

Referring now to FIG. 2, there illustrated is a detailed block diagram of the vehicle data recorder 100 of the present invention. The ACC or vehicle data recorder 100 preferably comprises those components contained within the dashed lines of FIG. 2. The vehicle data recorder 100 comprises various electronic components, all of which are typically mounted in a hermetically-sealed container that is rigidly affixed to the automobile body. The container of the vehicle data recorder 100 is preferably such that it is able to withstand the normal environment that an automobile is exposed to.

The vehicle data recorder 100 contains three separate accelerometers 108, commercially-available, for example, in the Model DMU-6 Six Axis Dynamic Measurement Unit from Crossbow of San Jose, CA. Each accelerometer 108 is dedicated to sensing acceleration in a specific one of three vehicle directions of travel: X, Y and Z. Typically, the X accelerometer output is indicative of forward vehicle motion, the Y accelerometer output is indicative of lateral or sideways vehicle motion, and the Z accelerometer output is indicative of vertical vehicle motion. In a preferred embodiment, the X-direction accelerometer has a maximum sensitivity of 180 Gs of force, while both the Y and Z accelerometers have relatively much less sensitivity, typically on the order of 5 Gs. As used herein, the term "G" refers to a unit of force equal to the gravity exerted on a body at rest.

These exemplary values of the maximum sensitivity of the three accelerometers 108 were chosen since it is widely agreed that normal automobile vehicle operation does not result in an acceleration value over 1.5 Gs. For example, published data and automobile manufacturer's technical specifications show that the magnitude of acceleration/deceleration for most passenger cars, busses and trucks normally does not exceed 1.1Gs. On the other hand, a typical car crash may involve a maximum deceleration force of approximately 65 Gs. Therefore, the X-direction accelerometer, because it is less sensitive than the Y and Z-direction accelerometers, will record vehicle acceleration data during the entire duration of the crash. In contrast, the Y and Z-direction accelerometers will typically saturate at some point during an accident, and cease to provide useful data during that accident. However, this sensed available data from both the Y and Z-direction accelerometers will typically provide useful information not only just prior to the vehicle crash but also slightly after the beginning of the crash. However, it should be understood that the chosen maximum values for the three accelerometers 108 are purely exemplary. Other accelerometer values may be utilized, as desired, in light of the teachings of the present invention.

The continuously-sensed acceleration values output from the three accelerometers 108 are provided on signal lines to a twelve-bit analog-to-digital converter ("ADC") and multiplexer ("MUX") 132. The ADC and MUX 132 may comprise a single integrated circuit, commercially-available. Also provided on signal lines to the ADC are the signal outputs from three corresponding gyroscopes 136. In a similar manner to the accelerometers, the three gyroscopes 136 may comprise the Model DMU-6 from Crossbow. As discussed hereinbefore, the gyroscopes are utilized to overcome the inherent problem with the accelerometers in that the gyroscopes will measure the amount of "tilt", in an identical amount to that measured (undesirably) by the accelerometers. In other words, the gyroscopes are sensitive only to tilting of the vehicle data recorder 100, for example, due to vehicle travel on an inclined roadway, and are insensitive to accelerations. As discussed hereinafter in detail, the identical gyroscope outputs are then subtracted from the accelerometer outputs by subsequent signal processing electronics to yield a true indication of vehicle acceleration.

A compass 140 is also provided within the vehicle data recorder 100 of the present invention. The compass 140 provides a signal indicative of absolute vehicle direction on a signal line to the ADC 132. The function of the ADC 132 is to digitize the analog inputs from the gyroscopes 136, accelerometers 108 and the compass 140, and to provide digitized values on signal lines to a microcontroller 144. The microcontroller 144 forms the central signal processing means of the vehicle data recorder 100 of the present invention. The microcontroller 144 may comprise the Zilog or Hitachi Z180, or other similar commercially-availablemicroprocessors. The primary function of the microcontrolleris to interface with all of the elements of the vehicle data recorder 100 of the present invention and direct the corresponding signal processing functions carried out thereby.

An oscillator 148 provides a square-wave signal at an exemplary frequency of 9 megahertz ("MHZ") to the microcontroller 144. The microcontroller may contain certain amounts of various types of on-board memory, or the memory may be physically separate from the micro-controller. FIG. 2 illustrates erasable read only memory (E/ROM) 152, which is non-volatile memory used to store the software instructions executed by the microcontroller 144 in carrying out the functions of the vehicle data recorder 100 of the present invention. FIG. 2 also illustrates volatile static SRAM memory 156, which stores the sensed data from the gyroscopes 136, accelerometers 108, the compass 140 and the various other vehicle devices and systems, described hereinafter. In an exemplary embodiment, 128 K of SRAM memory 156 is provided.

As is well-known, the accuracy of the digital representation of any analog quantity is strongly dependent on the sampling rate of the analog-to-digital converter 132 utilized. In the present preferred exemplary embodiment, to be able to calculate the vehicle velocity with an acceptable accuracy, the microcontroller 144 must acquire data at a minimum of approximately 50 samples per second. After performing the necessary integration of acceleration to determine velocity, the microcontroller writes the calculated velocity data to the SRAM five times per second. Typically, every set of data occupies six bytes of SRAM memory locations. With 128 K of SRAM and a per-channel sampling rate of five, the vehicle data recorder 100 of the present invention can store up to one hour of vehicle velocity information. However, these capacities are purely exemplary.

A one farad capacitor serves as a battery back-up 160 to the SRAM 156 in the event that the vehicle data recorder 100 loses power. The battery back-up 160 initially connects with a power back-up/advisory controller 164, which may be the commercially-available Model ADM691 integrated circuit.

The advisory controller 164 connects to an AC/DC converter 168, which is connected to the vehicle alternator 172 or power source. The AC/DC converter 168 provides power to all of the electronics within the vehicle data recorder 100 of the present invention. The power back-up/advisory controller 164 monitors the status of the vehicle power and switches the battery back-up 160 to the SRAM 156 in the event that the vehicle power goes below a certain predetermined value.

The power back-up/advisory controller 164 also prevents any data from being written to the SRAM 156 when the electrical power to the electronics within the vehicle data recorder 100 falls below a predetermined threshold. The advisory controller 164 further provides a watch dog timer that guards against system or software faults by resetting the microcontroller 144 if the software does not reset a timer within predetermined repetitive time intervals. In addition, the advisory controller 164 generates a non-maskable interrupt when the vehicle power falls below a predetermined threshold, giving the microcontroller 144 time to execute certain software shut-down routines.

To properly reconstruct a vehicle abnormal condition, such as an automobile accident, it is helpful if further data, regarding various vehicle components, are available. Specifically, with respect to an automobile 104, it is helpful to know the status of the various vehicle lights 176, together with the history of the brakes 180 and windshield wipers 184 in the time period just prior to a vehicle abnormal condition and during such condition. Therefore, the vehicle data recorder 100 of the present invention provides a signal processor 188 that interfaces to the vehicle lights 176, brakes 180, and windshield wipers 184, and conditions these signals prior to feeding them to the microcontroller 144. The signal processor 188 may merely comprise corresponding voltage divider networks, together with capacitor filters.

A real time clock 192, which may comprise the Model DS1302 integrated circuit commercially-available, provides time and date functions, plus 31 bytes of scratch pad RAM. The real time clock 192 provides time and date information on a signal line to the microcontroller 144, which utilizes this information to stamp the time and date of the various data prior to storing them in SRAM memory 156. To reduce the amount of memory utilized to store the sensed and/or calculated data, it is preferable that the microcontroller 144 only write the time of last data collection to a protected part of SRAM 156, typically only two bytes of memory. When the external computer 128 retrieves data from memory 156, the computer reads this time of last data collection and automatically stamps the data with the time of day.

The vehicle data recorder 100 of the present invention also includes serial communication circuitry 196 for interfacing between the microcontroller 144 and the external computer 128. The serial communication circuitry 196, which may implement the well-known, industry-standard RS 232 protocol, facilitates the access by the computer 128 to the data stored by the microcontroller 144 in the corresponding memory 156 within the vehicle data recorder 100. Typically, the vehicle data recorder 100 of the present invention collects data values, immediately prior to and during a vehicle abnormal condition, with respect to various vehicle parameters, including: direction of vehicle travel; acceleration of the vehicle 104 at impact; speed of the vehicle at impact; direction of impact; point of impact; time of impact; and the history of vehicle lights 176, brakes 180 and windshield wipers 184. The vehicle data recorder 100 stores this information in the SRAM memory 156. The external computer 128 then accesses this information by downloading it through the serial communications circuitry 196. The computer 128 then uses the data to reconstruct the accident. In an exemplary embodiment, the serial communication circuitry 196 connects to the external computer 128 which executes software that places the relevant data on a central site on the Internet to assist the appropriate personnel in reconstructing the accident.

The external computer 128 contains embedded software that downloads and retrieves the stored data. In a preferred exemplary embodiment, the software is written in the well-known C programming language. The software directs the computer to retrieve the data through the serial communications circuitry, decode the data, convert the data to appropriate engineering values, and extract the information relating to the status of the brakes, headlights and windshield wipers therefrom, together with the information about the vehicle speed and direction. It is contemplated that the person utilizing the software in the external computer can navigate easily through the data and examine it using on-screen menus. Retrieved data can be saved in, *e.g.*, ASCII format and, perhaps, exported to other software applications running on the external computer 128, or read back in later on by the vehicle data processor 100 for subsequent processing and/or storage.

Also included within the vehicle data processor 100 of the present invention is well-known, commercially-available GPS circuitry 112. In its broadest sense, the GPS circuitry may comprise a signal receiver and transmitter for communicating with various types of satellite or ground-based radio navigation systems, as discussed hereinbefore. The GPS 112 may also include signal processing circuitry which determines the location of the vehicle 104 containing the vehicle data recorder 100 of the present invention from these transmitted radio signals. In the alternative, the microcontroller 144 may operate on the received GPS signals for determining the vehicle location, perhaps by the well-known method of triangulation. While many different types of global positioning systems are commercially-available, it is contemplated that the GPS may comprise the Model Magellan GPS 2000, GPS 4000, or Trailblazer XL. In the alternative, the GPS may comprise the Model Garmin GPS 38, GPS II, GPS 45, or GPS 45 XL. These modern global positioning systems are rapidly decreasing in cost, thereby making them more popular for various consumer applications, such as automobiles.

The primary function of such a GPS 112 is to determine the position, on the earth's surface, of the subject vehicle 104. Once determined, the microcontroller 144 stores this vehicle location continuously in SRAM memory 156. Thus, vehicle location data is also available to the external computer 128 through the serial communication circuitry 196.

However, of significant importance is that the microcontroller 144 can store the location of the vehicle 104 at the exact time of the occurrence of the vehicle abnormal condition, regardless of whether the vehicle is subsequently moved from that position after the occurrence of the abnormal condition. This ability to "freeze" the vehicle location at the time of accident is of significance when reconstructing the vehicle accident and apportioning liability for improper vehicle operation.

Finally, the vehicle data recorder 100 of the present invention includes a radio signal transponder 200 that interfaces with the microcontroller 144. The transponder 200 transmits various information to different notified entities 124. In an exemplary embodiment, the transponder comprises a radio frequency signal generator, that transmits the aforementioned stored data to the appropriate rescue authorities, such as police, fire and/or ambulance personnel.

The transponder 200 may transmit signals indicative of various vehicle conditions that are directly determined from the sensed data. For example, the microcontroller may contain software that determines the severity of the accident, depending upon the largest magnitude of acceleration sensed by any of the three accelerometers 108. In the alternative, other criteria may exist for determining the severity of the accident.

The transponder 200 may simply be a radio frequency transmitter. On the other hand, the transponder may comprise other communication means, such as a cellular phone or citizens band radio. It suffices for the broadest scope of the present invention that the transponder merely comprise some means of transmitting signals indicative of both the sensed vehicle operating parameter data and operating conditions derived therefrom.

Referring now to FIG. 3, there illustrated is a flowchart of software executed by the microcontroller 144 primarily in reading in the sensed vehicle operational data and calculating vehicle velocity therefrom. This routine may represent one of several routines executed by the microcontroller in implementing the functions of the vehicle data recorder 100 of the present invention. For example, as mentioned hereinbefore, the microcontroller may execute software routines that determine the location of the vehicle 104 based on the radio navigation signals sensed by the GPS signal receiver 112. Further, the microcontrollermy execute software which determines parameters such as the severity of the accident from the sensed acceleration data.

With regard to the software routine of FIG. 3, after an enter step 204, the microcontrollermay execute a step 208 in which it retrieves information regarding the calibration set points of the various sensors used in the vehicle data recorder 100 of the present invention. This calibration information may be stored as constants in the E/ROM memory 152.

Next, the microcontroller 144 executes a step 212 in which it initializes various variables stored in the SRAM 156. These variables are utilized in the various calculations that the microcontroller will execute in calculating the various vehicle operational parameters.

The microcontroller 144 then executes a step 216 in which it reads the values of the various sensors utilized with the vehicle data recorder 100 of the present invention. Referring also to FIG. 2, those sensors include the three gyroscopes 136, the three accelerometers 108, the compass 140, the vehicle lights 176 (*e.g.*, headlights, taillights, directional lights, parking lights), the vehicle brakes 180 and the windshield wipers 184. These values are continuously available to the microcontroller for calculation purposes from both the ADC 132 and the signal processor 188 of FIG. 2.

The microcontroller then executes a step 220 in which it calculates true acceleration by subtracting the "tilt" values, output from each of the three gyroscopes 136, from the corresponding accelerometer output values. As discussed in detail hereinbefore, such subtraction or "decoupling" of the gyroscope data from the accelerometer data results in true acceleration readings output from the three accelerometers 108.

The microcontroller 144 then executes a step 224 in which it calculates vehicle velocity in each of the X, Y and Z directions of vehicle travel. The specific velocity values are calculated by integrating the decoupled acceleration data from the three accelerometers 108.

Next, the microcontroller executes a step 228 in which it increments a counter by a value of one. This counter was initially set to zero in the initialized variables step 212. The purpose of this counter is for the microcontroller to read the sensors and calculate the corresponding acceleration and velocity data ten times before it eventually writes this data to memory.

Next, the microcontroller checks, in a test 232, to see if the counter equals a value of ten. If not, the microcontroller branches back to the step 216 where it reads the sensors and calculates acceleration and velocity. Instead, if the counter does equal ten, the microcontroller then resets the counter to zero, in a step 236, and checks, in a test 240, whether the velocity equals zero. If so, the microcontroller 144 branches back to the step 216 where it reads the sensors and begins the data collection and calculation process over again. Instead, if the velocity does not equal zero, then the microcontroller executes a step 244 where it reads the various sensors. Next, the microcontroller writes the various values of the sensed data to the SRAM memory 156 in a step 248.

The microcontroller 144 then checks, in a test 252, the integrity of the power to the various electronic components within the vehicle data recorder 100 of the present invention. If the power is above a predetermined threshold, the microcontroller then branches to the step 220 where the microcontroller decouples the gyroscope data from the accelerometer data to calculate true vehicle acceleration. The microcontroller then continues on with the routine, as described hereinbefore. Instead, if there is a problem with the power, the routine exits in a step 256.

In general, when the microcontroller 144 writes various data values to the SRAM memory 156, the microcontroller initially writes the data into consecutive memory locations until those locations have been filled. While writing the data to the memory, the microcontroller may stamp or assign the time-of-day to each data value in the manner previously described. Once the memory has been filled by the microcontroller, any new data then gets written over the oldest data. In this way, the memory will always contain the most recent data pertaining to vehicle operation. Depending upon the amount of SRAM memory 156 provided, together with the number of sensors within the vehicle data recorder 100 of the present invention, and the sampling rate of the ADC 132, typically the vehicle data recorder 100 of the present invention can store anywhere from 1 to 5 hours of data for subsequent retrieval and vehicle accident reconstruction.

Generally, vehicle data is continuously recorded during normal vehicle operation. The vehicle data recorder 100 then determines that an accident has occurred when the X-direction accelerometer 108 senses a deceleration value which exceeds a predetermined threshold. For example, it is generally known that, during a typical vehicle accident, a deceleration value of at least 65 Gs will be achieved. Therefore, the software executed by the microcontroller can recognize this threshold as the onset or beginning of an accident and may then restrict the amount of data that is subsequently written to memory once this threshold has occurred. For example, the microcontroller may write data to memory for the next sixty seconds once that predetermined vehicle deceleration value has been achieved.

Generally, when a vehicle accident has occurred, the microcontroller will continue to sense and write data to memory with regard to the vehicle lights 176, brakes 180 and windshield wipers 184. This data collection may occur for a predetermined period of time, or until the vehicle speed equals zero, or until the vehicle power goes below a predetermined threshold. Also, the X-direction accelerometer would continue to have its data written to memory during the entire duration of the accident. However, since both the Y and Z-direction accelerometers have relatively less maximum sensitivity, these accelerometers 108 would typically saturate at some point during a typical accident, and cease to provide useful data. Yet the measured data from these accelerometers, both prior to the crash and somewhat during the time of the crash, would nevertheless be still written to memory, to assist in the accident reconstruction process.

Typically, the microcontroller 144 may determine the relative direction of the vehicle 104 prior to and during any accident by vector summation of the two acceleration components in the X and Y directions. In the alternative, the compass 140 provides an absolute value of vehicle direction.

The vehicle data recorder 100 of the present invention has been described herein for use on an automobile. However, it is to be understood that the vehicle data recorder may be utilized on any type of land, water or air-based vehicle or craft. It suffices for the broadest scope of the present invention that the vehicle data recorder utilize accelerometers that are affected by gravity such that they produce false acceleration readings when the vehicle is inclined. The vehicle data recorder also provides gyroscopes 136 that measure identical values of tilt or inclination of the vehicle data recorder 100, as those values are also measured, undesirably, by the accelerometers 108. The vehicle data recorder 100 of the present invention then utilizes the gyroscope data to "decouple" the false acceleration components from the accelerometer outputs due to the effects of gravity.

It should be understood by those skilled in the art that obvious structural modifications can be made to the embodiments described and illustrated herein without departing from the scope of the invention. Accordingly, reference should be made primarily to the accompanying claims, rather than the foregoing specification, to determine the scope of the invention.

Having thus described the invention, what is claimed is:

CLAIMS

1. A device, comprising:

means for sensing acceleration of a vehicle and for providing a sensed acceleration signal indicative thereof, wherein the sensed acceleration signal contains a first component indicative of any acceleration of the vehicle, and wherein the sensed acceleration signal contains a second component indicative of any angular inclination of the acceleration sensing means with respect to a predetermined reference angular level of inclination; and

means for sensing angular inclination of the acceleration sensing means and for providing a sensed inclination signal indicative thereof.

2. The device of Claim 1, further comprising signal processing means, responsive to both the sensed acceleration signal and the sensed inclination signal, for providing an output acceleration signal indicative of the first component of the sensed acceleration signal, and further comprising memory means for selectively storing signals therein.

3. The device of Claim 1, wherein the acceleration sensing means comprises means for sensing acceleration of the vehicle in more than one predetermined directions of vehicle travel and for providing a corresponding directional sensed acceleration signal for each one of the more than one predetermined directions of vehicle travel.

4. The device of Claim 1, wherein the acceleration sensing means comprises at least one accelerometer.

5. The device of Claim 1, wherein the angular inclination sensing means comprises means for sensing the angular inclination of the acceleration sensing means in more than one predetermined directions of vehicle travel, and for providing a corresponding directional sensed angular inclination signal for each one of the more than one predetermined directions of vehicle travel.

6. The device of Claim 2, wherein the second component of the sensed acceleration signal is equal to the sensed inclination signal, and wherein the signal processing means comprises means for comparing the second component of the sensed acceleration signal to the sensed inclination signal and for subtracting a result

of the comparison from the sensed acceleration signal, whereby the first component of the sensed acceleration signal results from the subtraction.

7. The device of Claim 1, wherein the angular inclination sensing means comprises a gyroscope.

8. The device of Claim 2, wherein the signal processing means comprises means for determining velocity of the vehicle from the output acceleration signal and for providing a corresponding velocity signal indicative thereof, the signal processing means comprising means for selectively storing the velocity signal in the memory means.

9. The device of Claim 8, wherein the signal processing means comprises means for selectively assigning a time parameter to the velocity signal stored in the memory means.

10. The device of Claim 8, wherein the signal processing means comprises means, responsive to a signal indicative of at least one vehicle component, for selectively storing the vehicle component signals in the memory means.

11. The device of Claim 10, wherein the at least one vehicle component is selected from the group consisting of vehicle lights, vehicle brakes and vehicle windshield wipers.

12. The device of Claim 10, further comprising communication means for connecting the signal processing means to a computer located external to the device, the external computer comprising means for selectively downloading the vehicle component signals and the velocity signal from the memory means and for reconstructing a vehicle operating condition therefrom.

13. The device of Claim 2, further comprising global positioning means for receiving at least one navigation signal from a radio navigation system located external to the device, wherein the signal processing means comprises means for determining a location of the vehicle from the at least one navigation signal and for providing a vehicle location signal indicative of the determined location of the vehicle, the signal processing means also comprising means for selectively storing the vehicle location signal in the memory means.

14. The device of Claim 13, further comprising transponder means for selectively transmitting the vehicle location signal outside of the device.

15. The device of Claim 2, wherein the signal processing means further comprises means for determining a vehicle operating condition based upon a magnitude of the output acceleration signal and for providing a vehicle operating condition signal indicative of the determined vehicle operating condition, the signal processing means comprising means for selectively storing the vehicle operating condition signal in the memory means.

16. The device of Claim 15, wherein the vehicle operating condition is a severity of contact of the vehicle with another object.

17. The device of Claim 15, further comprising transponder means for selectively transmitting the vehicle operating condition signal outside of the device.

18. The device of Claim 15, wherein the signal processing means comprises means for selectively assigning a time parameter to the vehicle operating condition signal stored in the memory means.

19. The device of Claim 18, further comprising transponder means for selectively transmitting the vehicle operating condition signal outside of the device.

20. The device of Claim 2, further comprising means for determining a direction of travel of the vehicle and for providing a travel direction signal indicative thereof.

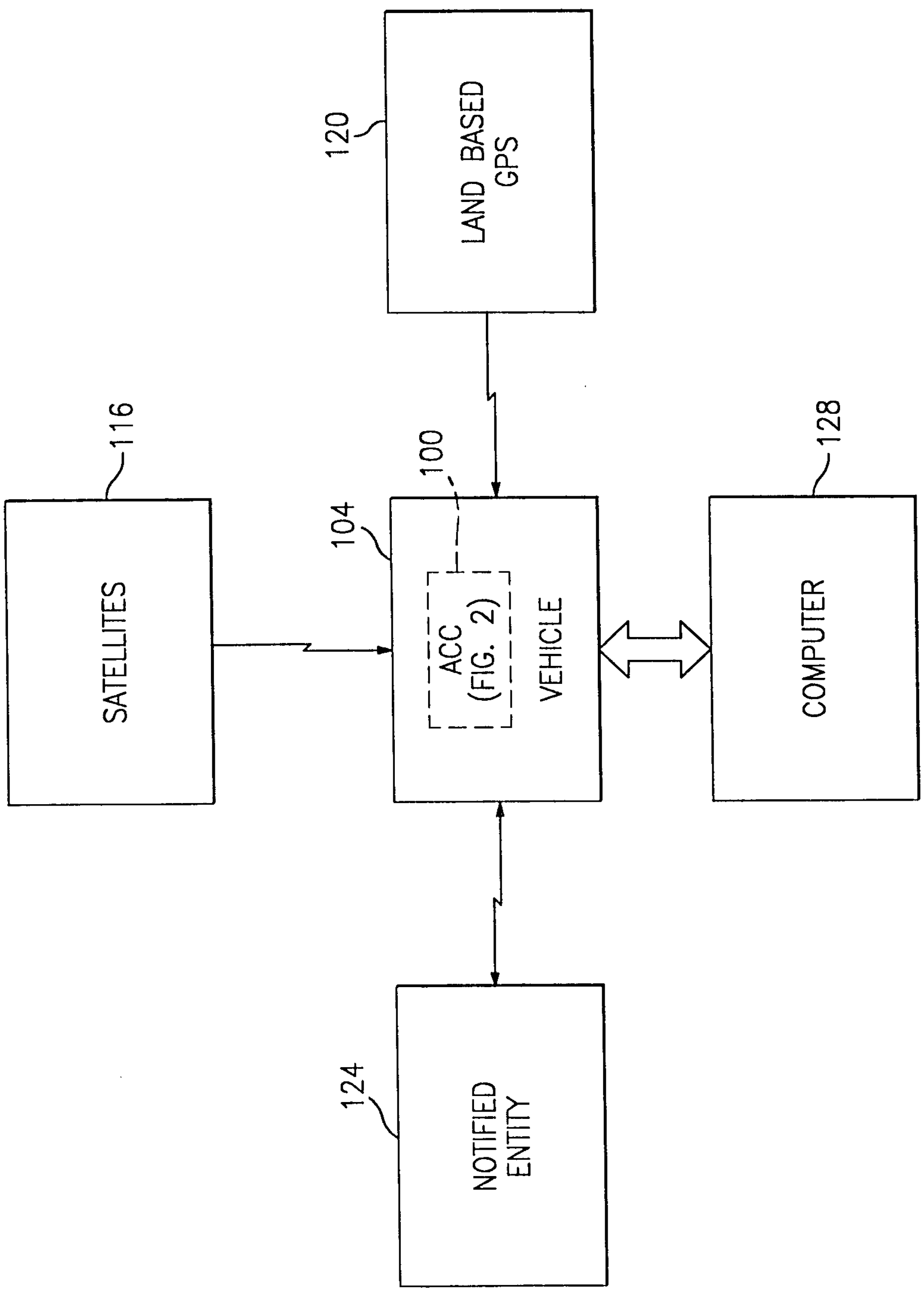
LAND BASED GPS
120
SATELLITES
116
100
104
ACC (FIG. 2)
VEHICLE
COMPUTER
128
NOTIFIED ENTITY
124

FIG. 1

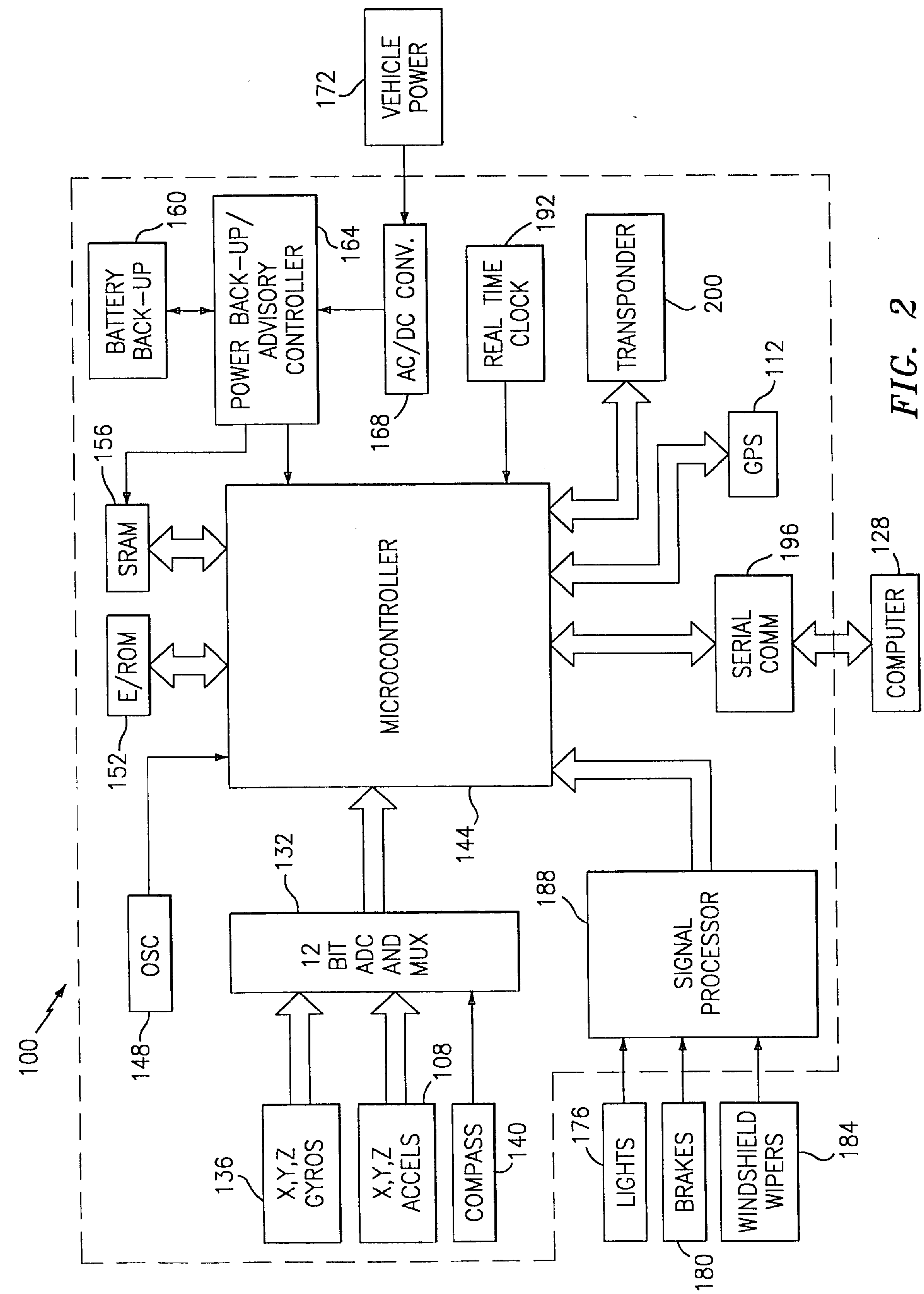
VEHICLE POWER
172
BATTERY BACK-UP
160
POWER BACK-UP/ ADVISORY CONTROLLER
164
AC/DC CONV.
168
REAL TIME CLOCK
192
TRANSPONDER
200
GPS
112
SRAM
156
E/ROM
152
MICROCONTROLLER
144
SERIAL COMM
196
COMPUTER
128
OSC
148
12 BIT ADC AND MUX
132
SIGNAL PROCESSOR
188
X,Y,Z GYROS
136
X,Y,Z ACCELS
108
COMPASS
140
LIGHTS
176
BRAKES
180
WINDSHIELD WIPERS
184
100

FIG. 2

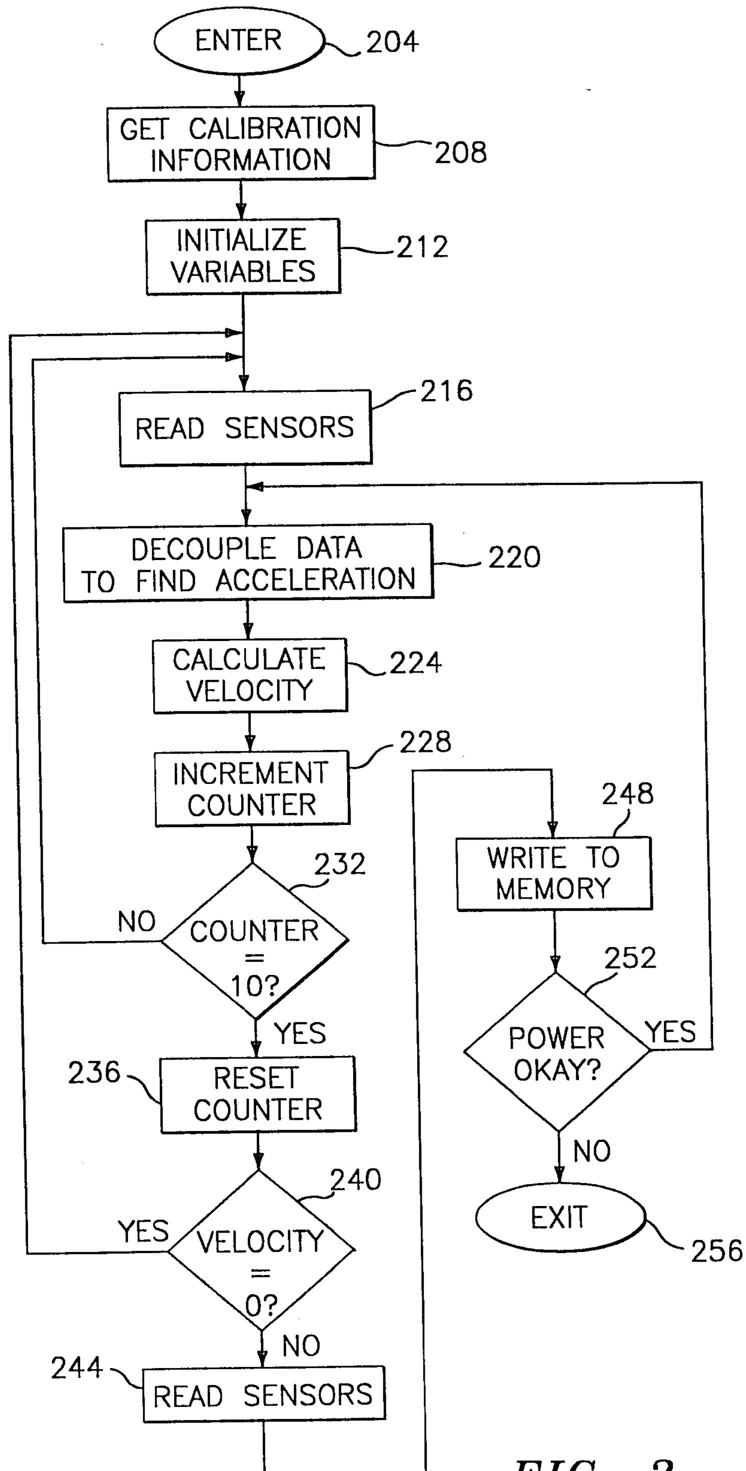
ENTER
204
GET CALIBRATION INFORMATION
208
INITIALIZE VARIABLES
212
READ SENSORS
216
DECOUPLE DATA TO FIND ACCELERATION
220
CALCULATE VELOCITY
224
INCREMENT COUNTER
228
COUNTER = 10?
232
NO
YES
RESET COUNTER
236
VELOCITY = 0?
240
YES
NO
READ SENSORS
244
WRITE TO MEMORY
248
POWER OKAY?
252
YES
NO
EXIT
256

FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/07704

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G07C5/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G07C

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	EP 0 825 568 A (DATA TEC CO LTD) 25 February 1998 see abstract; claims 1-3,14; figures 1-4,6 see column 1, line 53 - column 3, line 56 see column 5, line 6 - column 6, line 58 see column 10, line 2 - line 34 see column 11, line 54 - column 12, line 7	1-9,12, 15,16,18
A		10,11, 13,14, 17,19,20

X	EP 0 590 312 A (EATON CORP) 6 April 1994 see abstract; figures 6,7 see page 2, line 25 - page 3, line 13 see page 5, line 26 - page 7, line 20	1,2,6
Y		8,10, 12-20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 1998	03/09/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Buron, E

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	WO 94 06100 A (WAGNER JEAN JACQUES) 17 March 1994 see abstract; figures 2,3C see page 1, line 5 - page 2, line 16 see page 5, line 1 - line 9 see page 8, line 5 - page 13, line 9	1,4,5,7
Y		13,14,20
A		2,3,8,10
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A		2,8,20
Y	US 5 446 659 A (YAMAWAKI YUICHIRO) 29 August 1995 cited in the application see abstract; claim 1; figures see column 2, line 6 - column 5, line 27 see column 11, line 26 - line 29	8,10,12
Y	US 5 353 023 A (MITSUGI TATSUYA) 4 October 1994 see abstract; claims; figures see column 1, line 5 - column 2, line 58 see column 7, line 64 - column 8, line 4	13-19
A		1,10,20
A	US 4 638 289 A (ZOTTNIK EDMUND) 20 January 1987 cited in the application see abstract; figure 1 see column 3, line 38 - column 4, line 25 see column 5, line 43 - line 59	10,11

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/07704

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PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G05B 23/02	A2	(11) International Publication Number: WO 00/17721 (43) International Publication Date: 30 March 2000 (30.03.00)

(21) International Application Number: PCT/US99/21921

(22) International Filing Date: 21 September 1999 (21.09.99)

(30) Priority Data:
60/101,230 21 September 1998 (21.09.98) US
60/145,636 26 July 1999 (26.07.99) US

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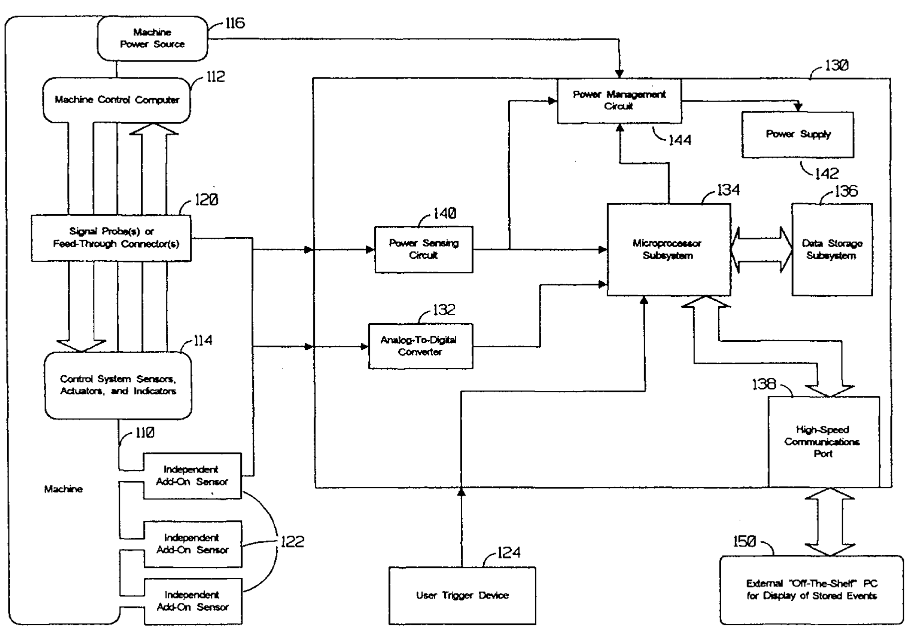
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: EVENT RECORDER

(57) Abstract



A system is used with a computer-controlled machine having real-time electrical signals corresponding to the operation of a machine, for real-time data processing of electrical signals occurring within the machine. The machine includes a controller (112) and an event node, such as an actuator, sensor, or indicator (122), with an interconnect system disposed between the controller and the event node for exchanging data. The system includes an event data recorder (136) coupled to the interconnect system for selectively storing event data. The machine comprises an automotive vehicle. The event recorder need not be connected to the serial data output of the controller but is directly coupled to the real-time electrical signals occurring between the controller and its associated sensors and actuators. This allows for direct monitoring and diagnostics of the real-time system activity within the automotive vehicle, including intermittent problems which can be missed by or even caused by the controller. The event data recorder can be triggered (124) to store the data by a user input by pressing a push-button positioned on a wire-less transmitter that communicates with the event data (150) recorder. Feedback is provided to the user indicating that the event data recorder is storing the event data.

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EVENT RECORDER

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional 60/101,230, filed September 21, 1998 and U.S. Provisional 60/145,636, filed July 26, 1999, the entire teachings of which are incorporated herein by reference.

BACKGROUND

In recent years, there has been a rapid increase in the use of microcontrollers and microprocessors (the core elements of most computer-type equipment) to enhance the performance and sophistication of a variety of complex machines, most notably motor vehicles. These "computerized" machine systems invariably consist of a group of sensors, which convert a variety of physical phenomena (such as pressure, temperature, velocity, etc.) into electrical signals ("DATA") that are used to convey information about these phenomena, a group of actuators and indicators, which convert electrical signals ("DATA") into a variety of physical phenomena (such as heat, rotation, switch closure, light, etc.), and one or more controllers, which receive the electrical signals from sensors and - based at least in part on the information obtained from the sensors - produce electrical signals to control actuators and indicators. These electrical signals, or data, can take various forms, from DC voltage levels which correspond directly to the state of a sensor, to data messages controlling and reporting system operation.

The rapid deployment of computerized motor vehicle control systems has been accompanied by a corresponding increase in the occurrence of short-term intermittent failures. Due to the "closed-loop" nature of most computerized machine systems, a momentary anomaly at any point in the system can frequently result in a chain-reaction effect, wherein the original anomaly produces an immediate reaction from another element in the loop, which then produces another immediate reaction from a third element in the loop, etc. Unless the source of the initial momentary anomaly is being monitored at the exact instant that the problem occurs, and in such a way as to identify it as in fact being the source of the initial anomaly, it is sometimes all but impossible to identify and correct the problem.

The interconnections between the sensors, actuators, indicators, and controllers are accomplished by means of wires and suitable connectors. In order to most effectively access the electrical signals which are present within the computerized machine system, for purposes of monitoring the activity of the electrical signals, diagnosis of the electrical signals, and/or external control of the electrical signals, it is necessary to establish physical connections to one or more of the elements of the machine system. A convenient place to make such connections is at the connectors that exist within the machine system. Various systems have been devised for the purpose of accessing electrical signals within motor vehicles and other electronic systems. Most commonly, these systems have taken the form of wire-piercing probes.

Some prior art systems have utilized a breakout box technique, in which one or more wiring harness connectors with a motor vehicle are disconnected from their mating connectors on a vehicular electronic device and plugged into an external breakout box. The breakout box includes an integral cable assembly that is long enough to allow the breakout box to be located at a distance from the vehicular electronic device and that terminates in connectors appropriate for plugging into the vehicular electronic device from which the vehicular wiring harness connectors were disconnected.

The breakout box is constructed such that each signal in the motor vehicle wiring harness connectors is connected through to the vehicular electronic device and is also connected uniquely to one of several probe terminals, whereby each and any of the signals existing within the vehicular wiring harness connectors can be accessed for connection to external diagnostic equipment. Such systems are hampered by the fact that they are large and cumbersome, and are thus impractical for use in instances where they would remain installed for an extended period of time. Furthermore, modern motor vehicles now have many of their electronic devices located within the engine compartment, increasing the impracticality of breakout box systems due to the limited availability of space within the engine compartment.

SUMMARY

The problems associated with the identification of the source of an intermittent failure in a motor vehicle produces an extremely inconvenient side-effect, which is the requirement that the motor vehicle be removed from its normal (owner's) use in order that a trained service technician can operate the motor vehicle and observe appropriate test equipment while waiting for the intermittent failure to occur. This results in loss of use by the owner as well as the increased costs accrued as a service technician watches for the problem to occur.

Various systems have been devised for the purpose of monitoring and recording performance data for a motor vehicle, and these systems have enjoyed only a limited degree of success in contributing to the identification and repair of intermittent control system defects. Most commonly, these systems have taken the form of devices which monitor a serial data port on a control computer that is part of the vehicular control system, storing vehicle performance data which is generated by the serial port in a recording device.

Such systems are hampered by the fact that the control computer does not have access to performance data from all devices within the vehicular system (e.g., the pressure level within the fuel system, which is a key performance parameter in modern motor vehicle engine systems) and by the fact that the data presented is the control computer's "interpretation" of the system activity, rather than a reliable indication of the actual system performance. Further, performance data is output from the control computer in serial mode (relatively slow in comparison to system activity) by sequencing through each of the system elements and performance parameters in turn. This results in a time period between data points for a given element in the system that can be sufficiently long so as to allow an intermittent failure to occur between data points, which can result in failure to identify a cause for the failure or, worse, identification of the incorrect element as the cause of the failure.

Other types of vehicular monitoring and recording systems utilize specially installed sensors which are not part of the control system of the vehicle, monitoring and storing data from these sensors in a recording device. Such systems are typically designed for long-term monitoring of vehicular performance, and while providing information that is useful in particular applications, they have difficulty providing the information that is required to identify an intermittently faulty element within the vehicular control system.

Due to the foregoing disadvantages of currently available vehicular monitoring and recording systems, servicing of motor vehicles with intermittent failures has long been a time-consuming, expensive, and frustrating experience for service technicians and vehicle owners. Within the automotive industry specifically, intermittent vehicles, and the failure to repair them quickly and cost-effectively, may represent the single greatest cause of customer dissatisfaction and of dealer re-purchase of problem motor vehicles.

Accordingly, a system and method are provided that monitors and records any of a variety of electrical signals occurring in or around a computer-controlled machine. The monitoring and recording system is particularly useful for recording electrical signals occurring in a motor vehicle, for the purpose of identifying the cause of anomalies, including those of the intermittent type, in the operation of the motor vehicle.

In one embodiment, a system is used with a computer-controlled machine having real-time electrical signals corresponding to the operation of the machine, for real-time data processing of electrical signals occurring within the machine. The machine can include a controller and an event node, such as an actuator, sensor, or indicator, with an interconnect system disposed between the controller and the event node for exchanging data. The system can include an event data recorder coupled to the interconnect system for selectively storing event data. The machine can comprise an automotive vehicle which includes the controller. The event recorder need not be connected to the serial data output of the controller but can be directly coupled to the real-time electrical signals occurring between the controller and its associated sensors and actuators. This allows for direct monitoring and diagnostics of the real-time system activity within the automotive vehicle, including intermittent problems which can be missed by or even caused by the controller.

According to other aspects, the event data recorder stores event data which is not monitored by the controller. The event data recorder can include an onboard power source to process the event data in the absence of any external power source.

According to other aspects, the event data recorder can be triggered to store the event data by a user input, for example, by actuating an actuator, for example, pressing a push-button. In one embodiment, the actuator is mounted within reach of the operator of the vehicle. For example, the actuator can be mounted on a steering wheel of the vehicle, such as the inside of the steering wheel. The actuator can also be coupled to a wire-less transmitter that communicates with the event data recorder.

The event data recorder can also be triggered to store the event data by an unintentional stall of the engine or a shut-down of a vehicular control system of the vehicle. The event data recorder can further be triggered to store the data by an alarm indication of a vehicular control system. In one embodiment, the alarm indication is a warning lamp.

According to further aspects, the event data recorder includes at least one circuit board shock-mounted to a housing of the event data recorder. The circuit board can include a first cushion member thereon to provide a cushion between the circuit board and the housing. A second cushion member can be further positioned between the first cushion member and the housing. A bolt or screw passes through the first cushion member and the second cushion member for securing the circuit board to the housing.

According to further aspects, a feedback system, such as the flashing of a warning indicator lamp of the automotive vehicle, is provided to alert the user that the event data recorder is installed and working properly. The feedback system can also alert the user to various operating states of the event recorder by flashing the warning indicator lamp at different frequencies or for distinct durations.

According to yet further aspects, a cabling device is provided that connects the event data recorder to at least one electrical system of the machine without damaging any existing electrical wiring. The cabling device can include a plurality of contact pins connected to a plurality of wires for inserting into electrical connection points of the machine. The cabling device can include a multi-pin in-line connector to provide an interface to an electronic sensor, such as a fuel pressure sensor, which is temporarily attached to the vehicle.

Alternatively, the cabling device is custom made or particularly adapted for the machine which can include at least one connector plug that connects to a computer of the machine, at least one cable jack that connects to sensors and/or actuators within the machine, a plurality of feedthrough wires that connect the connector plug and cable jack, and at least one instrument connector that connects at least one of the feedthrough wires to the event data recorder. The cabling device can further include an auxiliary connector that connects to the instrument connector.

According to further aspects, a display device which is able to be coupled to the event data recorder to access the event data stored in the event data recorder is provided to visually display the event data for diagnostic purposes. The data can be downloaded to an external computing device which can include the display device.

In accordance with further aspects, a system for use with an automotive vehicle to facilitate determining the cause of an intermittent failure includes a processor that controls operation of an event data recorder, a recording device that receives real time event data from the vehicle and stores the same for later analysis, and a wire-less transmitter including an actuator that, when actuated by a user, initiates storing of the event data. The recording device can store a predetermined amount of real-time data upon initiation of the event data recorder or can store the contents of a continuous loop of event data.

In accordance with other aspects, a system and method are provided to convey information from a device connected to a vehicle which includes an electronic circuit that flashes an indicator lamp of the vehicle in predetermined patterns under control of the device. The pattern can convey information to the user, such as the device is installed properly or the device is performing a commanded function.

A system and method are further provided for testing a computer-controlled machine which includes a testing device coupled to an electrical system of the machine and a wireless device that activates the testing device. In one embodiment, the machine is a motor vehicle and the wireless device is mounted within reach of the driver, for example, on a steering mechanism, of the vehicle.

A cabling device and method are further provided for connecting an accessory, such as an automotive car-starter or an automotive vehicle theft alarm, to a machine. The cabling device can include a plurality of contact pins connected to a plurality of wires for inserting into electrical connection points of the machine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic block diagram of an embodiment of an event recorder or data processing device for use with a generic computerized machine control system.

FIG. 2 is a schematic block diagram of another embodiment of the data processing device in a motor vehicle.

FIG. 3 is a schematic block diagram of an embodiment of the data processing device in a photocopier.

FIG. 4 is a schematic block diagram of an embodiment of a separate current-limited power supply for use with independent add-on sensor(s).

FIG. 5 is a schematic diagram of embodiment of a signal conditioning and ESD protection circuit.

FIG. 6 is a schematic block diagram of an embodiment of a multi-channel analog-to-digital converter circuit.

FIG. 7 is a schematic diagram of an embodiment of a cable decoder circuit.

FIG. 8 is a state diagram of an embodiment of the software implemented in an embodiment of the data processing device.

FIG. 9 is a state diagram of an embodiment of the software implemented in a remote computer.

FIGS. 10A-10C show a technique for shock mounting a printed circuit board.

FIG. 11 is a drawing depicting a wireless push-button transmitter equipped with a hook-and-loop fastener strip for attachment to a motor vehicle.

FIG. 12 is a drawing depicting a wireless push-button transmitter installed on the steering wheel.

FIG. 13 is a simplified schematic diagram of a proposed method of controlling an indicator lamp in a motor vehicle or electronically controlled machine wherein the indicator lamp is controlled by means of switching the negative supply voltage to the indicator lamp.

FIG. 14 is a simplified schematic diagram of a proposed method of controlling an indicator lamp in a motor vehicle or electronically controlled machine wherein the indicator lamp is controlled by means of switching the positive supply voltage to the indicator lamp.

FIG. 15 is a drawing of an embodiment of a "universal" cable for use in connecting a vehicular data recorder to any of the electrical systems within a motor vehicle.

FIG. 16 is a drawing of another embodiment of a "universal" cable of the present system, which includes a multi-conductor cable for use with an optional add-on sensor.

FIG. 17 is a drawing of a standard #1 sewing needle.

FIG. 18 is a drawing of a modified #1 sewing needle.

FIG. 19 is a drawing depicting the attachment of a flexible insulated wire to a modified #1 sewing needle.

FIG. 20 is a schematic drawing illustrating the concept of a custom breakout cable for use with a specific electronic control system.

FIG. 21 is a schematic drawing of a cable for use with an add-on sensor.

FIG. 22 is a schematic drawing of an auxiliary cable for use in place of an add-on sensor.

FIG. 23 and FIG. 24 are drawings depicting a method of attaching wires to a vehicular connector consisting of pin-type contacts.

FIG. 25 is a drawing depicting protective jackets installed on the wires of a vehicular connector assembly.

FIG. 26 is a drawing depicting a vehicular connector assembly enclosed within a protective covering.

FIG. 27 is a drawing of a first embodiment of a custom breakout cable.

FIG. 28 is a drawing of a second embodiment of a custom breakout cable.

FIG. 29 is a drawing of a male/female contact with provision for attachment of a wire.

FIG. 30 is a drawing showing two (2) views of a custom breakout connector.

FIG. 31 is a drawing depicting a cutaway view of a section of a custom breakout connector, showing attachment of probe wires on some of the contacts.

FIG. 32 is a drawing depicting an assembled custom breakout connector with multiple probe wires exiting the connector.

FIG. 33 is a drawing depicting a side view of an assembled custom breakout connector with multiple probe wires exiting both sides of the connector.

FIG. 34 is a drawing of a third embodiment of a custom breakout cable.

FIG. 35 is a drawing depicting typical automotive mating connectors, used on computers and wiring harnesses.

FIG. 36 is a drawing illustrating typical automotive connectors that have been wired together to form a feed-through male/female connector.

FIG. 37 is a drawing illustrating a feed-through male/female connector with probe wires attached to form a breakout connector.

FIG. 38 is a drawing depicting the breakout connector of FIG. 37 enclosed within a protective covering.

FIG. 39 is a drawing depicting right-angle socket connectors for use in converting a typical automotive cable connector into a printed circuit (pc) -mounted connector.

FIG. 40 is a drawing illustrating pc-mounted automotive pin and socket connectors mounted back-to-back on a pc board, with probe wires additionally mounted to the pc board to form a breakout connector.

FIG. 41 is a drawing depicting the breakout connector of FIG. 26 enclosed within a protective covering.

DETAILED DESCRIPTION

The system will be explained in conjunction with the drawing in which FIG. 1 illustrates a basic embodiment of an event recorder or data processing device for use with a generic computerized machine control system. This figure designates an exemplary machine incorporating the data processing device. Only those parts of the machine which are pertinent to this embodiment are shown in FIG. 1 which include the machine power source 116, the machine designated by reference numeral 110, and a computerized control system comprising a machine control computer 112 which connects to a group of sensors, actuators, and indicators 114 in order to monitor and control the functioning of the machine and provide the user with visual indication of the functioning.

The event recorder system comprises signal probe(s) or feed-through connector(s) 120 adapted to provide access to one or more electrical signals existing within the computerized control system 112 / 114, one or more optional independent sensor(s) 122 adapted to generate electrical signals conveying information about one or more physical phenomena within or around the machine 110, an event recorder 130, and a user trigger device 124 adapted to provide the user with a means to control at least one function of the event recorder. The event recorder 130 comprises an analog-to-digital converter circuit 132 coupled to a processor or microprocessor subsystem 134, adapted to sample designated electrical signals from the signal probe(s) or feed-through connector(s) 120 and any optional independent sensor(s) 122. A data storage subsystem 136 is coupled to the microprocessor subsystem 134, which is coupled to a high-speed communications port 138. A power sensing circuit 140 is coupled to the microprocessor subsystem 134 and to a power management circuit 144. The power management circuit 144 is also coupled to the microprocessor subsystem 134 and to a power supply or source 142. An independent external computer 150 may be coupled to the high-speed communications port 138 at appropriate times, to allow the user to transfer recorded data to the external computer 150 and display the recorded data thereon.

In accordance with the present system, at least one and preferably a plurality of signal probes or feed-through connectors 120 and/or independent sensors 122 are employed to couple the analog-to-digital converter circuit 132 to electrical signals which convey information about the functioning of machine 110 and its control system.

The analog-to-digital converter circuit 132 samples one or more electrical signals at predetermined regular intervals, converting the electrical signals to digital data that is a representation of the sampled signal at the specific point in time at which the sampling occurred. The digital data thus generated is coupled by microprocessor subsystem 134 into the data storage subsystem 136. When event recorder 130 is monitoring and recording the electrical signal activity from one or more signal probe 120 or sensor 122 inputs, the digital data thus generated is transferred to data storage subsystem 136 for a predetermined period (global) of time. At the end of the predetermined period of time, the oldest data begins to be overwritten by the newest data, creating, effectively, an endless-loop recording device. When a pre-programmed trigger event occurs, e.g., machine 110 operation ceases while the machine power source remains active or the user activates user trigger device 124 to initiate an event recording, microprocessor subsystem 134 ceases the data conversion and storage process. The data which had been stored for the fixed period of time preceding the trigger event is now stored in a semi-permanent state until it has been transferred to external computer 150 via the high-speed communications port 138. The high-speed communications port 138 is adapted to provide for the transfer of stored data from event recorder 130 to the external computer 150 for display and analysis.

Power management circuit 144 provides a means whereby event recorder 130 can be partially or fully powered off at such times that machine 110 is powered off, such capability being crucial when the machine utilizes a battery system as its power source. The power management circuit 144 couples machine power source 116 to power supply 142 under control of power sensing circuit 140 and/or microprocessor subsystem 134, thus providing the capability to power event recorder 130 on in response to machine 110 being powered on. The power management circuit also provides the capability for microprocessor subsystem 134 to cause event recorder 130 to remain powered on when machine 110 is powered off, in order that any pending event recorder activity can be completed prior to powering the event recorder off. In order to ensure that the microprocessor subsystem 134 can cause the event recorder 130 to remain powered on when the machine 110 is powered off, it is necessary that power management circuit 144 be coupled to machine power source 116 such that the machine power source will supply power at all times, regardless of the operating state of the machine. Alternatively, a backup battery 238, as illustrated in FIG. 2, can be employed to provide temporary power in the absence of power from the machine power source 116.

A vehicular embodiment of the present system will be explained with reference to FIG. 2. This figure designates an exemplary vehicle incorporating the system monitoring and recording described above. Only those parts of the vehicle which are pertinent to this embodiment are shown in FIG. 2 which include the vehicular battery 216, the vehicular fuel system designated by reference numeral 218, and a computerized control system comprising a control computer 112 which connects to a group of sensors, actuators, and indicators 114 in order to monitor and control the functioning of the engine and to provide the driver with visual indication of various operating parameters of the vehicle.

The event recorder system comprises signal probe(s) or feed-through connector(s) 120 adapted to provide access to one or more electrical signals existing within the computerized control system 112 / 114, an optional independent fuel pressure sensor 222 adapted to generate electrical signals conveying the pressure within the vehicular fuel system 218, an event recorder 130, and a miniature wireless user-trigger push-button 224. The push-button 224 is adapted to broadcast a coded control signal by way of an antenna 226 connected thereto, which may be externally connected to the wireless push-button or may be contained internally therein, providing the user with a means to control at least one function of the event recorder 130.

The event recorder 130 comprises signal conditioning and ESD protection circuits 234, coupled to an analog-to-digital converter circuit 132. The analog-to-digital converter circuit 132 is coupled to a microprocessor subsystem 134, and adapted to sample designated electrical signals from the signal probe(s) or feed-through connector(s) 120 and the optional fuel pressure sensor 222. A data storage subsystem 136 is coupled to the microprocessor subsystem 134, which is coupled to a high-speed communications port 138. A vehicle power sensing circuit 140 is coupled to the microprocessor subsystem 134 and to a power management circuit 144. The power management circuit 144 is also coupled to the microprocessor subsystem 134, a power supply 142, vehicular battery circuit 216, an optional backup battery 238, and an optional AC-DC converter 240. An independent external computer 150 may be coupled to the high-speed communications port 138 at appropriate times, to allow the user to transfer recorded data to the external computer 150 and display the recorded data thereon. An antenna 228 is coupled to a wireless user-trigger receiver 230, adapted to receive and decode the coded control signal broadcast by antenna 226. The wireless user-trigger receiver has its output connected to microprocessor subsystem 134. In alternative embodiments, push-button 224 is hard-wired to the microprocessor subsystem 134 for controlling at least one function of the even recorder 130.

In accordance with the present system at least one and preferably a plurality of signal probe(s) or feed-through connector(s) 120 and an optional fuel pressure sensor 222 are employed to couple analog-to-digital converter circuit 132 to electrical signals which convey information about the functioning of the engine and its control system.

The analog-to-digital converter circuit 132 samples one or more electrical signals at predetermined regular intervals, converting the electrical signals to digital data that is a representation of the sampled signal at the specific point in time at which the sampling occurred. The digital data thus generated is coupled by microprocessor subsystem 134 into the data storage subsystem 136. When event recorder 130 is monitoring and recording the electrical signal activity from one or more signal probe 120 inputs and/or the optional fuel pressure sensor 222 input, the digital data that is generated is transferred to the data storage subsystem 136 for a pre-determined period of time. At the end of the pre-determined period of time, the oldest data begins to be overwritten by the newest data, creating, effectively, an endless-loop recording device. When a pre-programmed trigger event occurs, e.g., the engine stalls while the ignition remains on, the vehicular computer 112 activates the "Check Engine" or similar indicator, or the user presses the wireless user-trigger push-button 224 to initiate an event recording, microprocessor subsystem 134 ceases the data conversion and storage process.

The data which had been stored for the fixed period of time preceding the trigger event is now stored in a semi-permanent state until it has been transferred to external computer 150 via to the high-speed communications port 138. In one embodiment, sufficient data storage will be implemented so as to allow one or more additional events to be recorded using a different section of data storage subsystem 136, providing for the monitoring, recording, and storing of multiple events before transferring the stored data to the external computer 150 for display and analysis.

In one embodiment, in order to provide a visual indication to the user that the trigger signal from miniature wireless user-trigger push-button 224 has been successfully received and decoded by wireless user-trigger receiver 230 and that an event recording has been stored in data storage subsystem 136, microprocessor subsystem 134 utilizes visual indicator driver 232 to flash the vehicle "Check Engine" indicator for several seconds. Thus, a feedback system is provided to alert the user that the event recorder 130 is installed and working properly.

High-speed communications port 138 is adapted to provide multiple functions of the present system, including but not limited to the transfer of stored data from event recorder 130 to external computer 150 for display and analysis, the transfer of software upgrades to event recorder 130 for the purpose of adding new and/or improved functionality, and the transfer of configuration information to event recorder 130 to allow the user to specify and customize functionality. Optional AC-DC converter 240 can be connected to power management circuit 144 when it is desirable to operate event recorder 130 in isolation from a motor vehicle, for purposes of utilizing any of the functionality available through the high-speed communications port 138.

In accordance with principles of the present system, physical phenomena which are not monitored by the computer system(s) within a vehicle, but which are deemed to have significance in analysis of the performance of the vehicle, can be monitored by means of one or more independent sensors 222 which are coupled to the vehicle for use with event recorder 130. Examples of physical phenomena which are not monitored by motor vehicle computer systems are the pressure in the fuel system and the line pressure in the automatic transmission, which are phenomena of particular interest to a service technician in the evaluation of vehicular performance problems. In one embodiment, an electronic pressure sensor is coupled to the vehicular fuel system, or to the automatic transmission, to provide a means to monitor the pressure therein. Power for the pressure sensor is provided by event recorder 130 and the electrical signals produced by the pressure sensor are coupled to the event recorder 130 for conversion and recording. Alternatively, in a different embodiment, two separate pressure sensors can be used to monitor both fuel pressure and transmission line pressure simultaneously. Other phenomena which are deemed of importance can be monitored and recorded by similar means through the appropriate use of independent add-on sensors.

A cable decoder circuit 236 is employed to provide a means for microprocessor subsystem 134 to determine the specific input cable which is connected to event recorder 130. Thus, a variety of input cables, using a variety of sensor probe(s) and feed-through connector(s) 120 can be constructed. Such cables employing one or more of the feed-through connectors 120 can be constructed so as to connect specific electrical signals from within a specific vehicle or a specific class of vehicles to specific signal inputs of event recorder 130. Installation of appropriate wire jumpers within the connector which connects to event recorder 130 will allow cable decoder circuit 236 to determine which cable has been connected, allowing event recorder 130 to configure signal conditioning circuits 234 appropriately for the supplied input signals, as well as allowing for automatic identification of input signals without user intervention.

A crucial requirement for electronic devices which are installed in motor vehicles, whether permanently or temporarily, and powered by the battery systems therein, is that they consume little or no power when the vehicle is inactive, in order to avoid excessive drain on the vehicular battery during the inactive period. In one embodiment of the present system, event recorder 130 will initiate normal operation, i.e., constant data conversion and recording, and power consumption when the motor vehicle becomes active, e.g., when the ignition switch is set to the "on" position. A vehicular power sensing circuit 140 couples vehicle power to power management circuit 144, which activates power supply 142 to provide power to event recorder 130 and the circuits of which it is comprised.

When the vehicle becomes inactive, microprocessor subsystem 134 controls power management circuit 144 to maintain power output from power supply 142 only for a minimum period of time required to allow event recorder 130 to complete any pending activity associated with normal operation, after which microprocessor subsystem 134 will cause power management circuit 144 to deactivate power supply

142 such that event recorder 130 will cease normal operation and the power consumption will be reduced to a minimum.

Alternatively, in the event that the microprocessor subsystem 134 has the capability to implement a low power mode in which its power consumption is sufficiently reduced so as to provide an acceptably low power drain on the vehicular battery 216 the power management circuit 144 can be configured to remove power from any and all circuits that are not required to maintain the microprocessor subsystem in the low power mode. In the event that data storage subsystem 136 requires constant power in order to maintain stored data within the data storage subsystem, the power management circuit 144 will ensure that constant power is made available to the data storage subsystem.

An exemplary non-vehicular embodiment of the present system will be explained with reference to FIG. 3. This figure designates a monitoring and recording system for use with a computerized control system within a photocopier. Only those parts of the photocopier which are pertinent to the embodiment are shown in FIG. 2 which include the photocopier power source 116, the photocopier designated by reference numeral 110, and a computerized control system comprising a machine control computer 112 which connects to a group of sensors, actuators, and indicators 114 in order to monitor and control the functioning of the photocopier and provide the user with visual indication of the functioning.

The event recorder system comprises signal probe(s) or feed-through connector(s) 120 adapted to provide access to one or more electrical signals existing within the computerized control system 112 / 114, one or more optional independent add-on sensor(s) 122 adapted to generate electrical signals conveying information about one or more physical phenomena within or around the photocopier, an event recorder 130, and a user-trigger push-button 242. In one embodiment push-button 242 is a simple push-button adapted for temporary attachment to an external surface of the photocopier 110, adapted to provide the user with a method to control at least one function of the event recorder 130. The event recorder 130 comprises signal conditioning and ESD protection circuits 234, coupled to an analog-to-digital converter circuit 132. The analog-to-digital converter circuit is coupled to a microprocessor subsystem 134, and adapted to sample designated electrical signals from the signal probe(s) or feed-through connector(s) 120 and any optional independent add-on sensor(s) 122. A data storage subsystem 136 is coupled to the microprocessor subsystem 134, which is coupled to a high-speed communications port 138. A power sensing circuit 140 is coupled to the microprocessor subsystem 134 and to a power management circuit 144. The power management circuit 144 is also coupled to the microprocessor subsystem 134, a power supply 142, the machine power source 116, an optional backup battery 238, and an optional AC-DC converter 240. An independent external computer 150 may be coupled to the high-speed communications port 138 at appropriate times, to allow the user to transfer recorded data to the external computer 150 and display the recorded data thereon. A user-trigger input circuit 244 isolates and couples the input from user-trigger push-button 242 to microprocessor subsystem 134.

In accordance with the present system, at least one and preferably a plurality of signal probes or feed-through connectors 120 and/or independent sensors 122 are employed to couple analog-to-digital converter circuit 132 to electrical signals which convey information about the functioning of photocopier 110 and its control system.

Sampling, data conversion, and data storage are accomplished as described above. When a pre-programmed trigger event occurs, e.g., machine operation ceases while the machine power source remains active or the user activates the user-trigger push-button 242 to initiate an event recording, microprocessor subsystem 134 ceases the data conversion and storage process. The data which had been stored for the fixed period of time preceding the trigger event is now stored in a semi-permanent state until it has been transferred to external computer 150 coupled to the high-speed communication port 138. In one embodiment, in order to provide a visual indication to the user that the trigger signal from user-trigger push-button 242 has been processed by user-trigger input circuit 244 and applied to microprocessor subsystem 134, and that an event recording has been stored in data storage subsystem 136, the microprocessor subsystem utilizes visual display / indicator driver 246 to apply appropriate visual display or indicator control signals to visual display or indicator(s) 248. The visual display or indicator(s) 248 can range, depending on the specific application, from a simple Light Emitting Diode (LED) which is flashed for several seconds when an event is stored, to a multiple LED array conveying additional information, to a multi-character display which provides information such as number of events stored automatically, number of user-initiated events stored, condition of backup battery, etc. In one embodiment, the visual display or indicator(s) 248 is included in a common package with user-trigger push-button 242.

High-speed communications port 138 is adapted to provide for the transfer of stored data from event recorder 130 to external computer 150 for display and analysis, as well as providing the additional functionality described earlier.

In accordance with principles of the present system, physical phenomena which are not monitored by the computer system(s) within a photocopier, but which are deemed to have significance in analysis of the performance of the photocopier, can be monitored by means of one or more independent add-on sensors 122 which are coupled to the photocopier for use with event recorder 130. As required and/or desired, appropriate power for the independent add-on sensor(s) can be provided by the event recorder 130, in order to increase the ease-of-use of the independent add-on sensor(s) in conjunction with the event recorder.

A cable decoder circuit 236 is employed to provide a means for microprocessor subsystem 134 to determine the specific input cable which is connected to event recorder 130 as described earlier for the automotive embodiment. Power control can also be implemented in this embodiment as described earlier for the automotive embodiment. It is noted that principles of the present system can easily be adapted for use with any type of computer-controlled equipment which is experiencing intermittent anomalies.

According to principles of the present system, event recorder 130 can supply the power required by independent add-on sensor(s) 122 which are connected to a machine in order to measure phenomena which are not routinely measured by a computerized machine control system incorporated within the machine. Since the power for the add-on sensor(s) must be brought outside of the event recorder 130, the opportunity exists for the power to be intentionally or accidentally connected in such a way as to place an excessive load or short circuit on a power supply which forms the source of the power. In order to prevent such excessive load from drawing excessive current, which could pose a safety hazard, and/or further risk disruption of the function of the event recorder 130, and which could further risk damage to the event recorder, the present system provides for the use of a separate, current-limited power supply 254 as the power source for use with the add-on sensor(s).

FIG. 4 illustrates details of an embodiment of the separate, current-limited power supply implemented as part of the vehicular event recorder embodiment illustrated in FIG. 2. Only that part of the vehicle which is pertinent to this embodiment of the separate current-limited power supply is shown in the drawing, which is the vehicular battery 216. Only those parts of the event recorder system which are pertinent to this embodiment of the separate current-limited power supply are shown in the drawing and they include the event recorder 218, fuel pressure sensor 222, additional independent add-on sensor 122, microprocessor subsystem 134, power management circuit 144, power supply 142, signal conditioning and ESD protection 234, and analog-to-digital converter 132. The power supply 142 comprises multiple independent power sources, consisting of a +5 Volt supply 250 for microprocessor subsystem 134, a +5 Volt supply 252 to provide power for the remaining event recorder circuits, and a +5 Volt / 0.2 Amp supply 254 to provide power for the fuel pressure sensor 222 and/or the additional independent add-on sensors 122.

Each of the independent power sources is individually controlled by power management circuit 144. Thus microprocessor subsystem 134 has the ability, through the power management circuit, to remove power from external sensors 122 /222 by deactivating +5 Volt supply 254 and/or remove power from the remaining event recorder circuits by deactivating +5 Volt supply 252, at such times that the sensors and/or event recorder circuits do not need to be operational. Additionally, the use of a separate supply for external sensors prevents disruption of the functioning of the remainder of event recorder 130 in the event that excessive loading is applied to the separate supply.

The +5 Volt / 0.2 Amp supply 254 is coupled through signal conditioning and ESD protection circuit 234 to analog-to-digital converter 132, providing a means for microprocessor subsystem 134 to determine the output level of the +5 volt / 0.2 Amp supply. In the event that the supply is excessively loaded, which will result in the output level being unacceptably low, the microprocessor subsystem 134 can control power management circuit 144 to disable the supply. In the event that fuel pressure sensor 222 and/or any additional independent add-on sensor operates ratiometrically, i.e., the sensor output is a ratio of the supply voltage which is coupled to the sensor, the +5 Volt / 0.2 Amp supply 254 can be sampled and converted to digital data by analog-to-digital converter 132, thus providing an accurate reference for use in determining the correct value represented by the output of the ratiometric sensor(s).

The +5 Volt / 0.2 Amp supply 254 can be limited to a maximum short-circuit current of 0.2 Amp, which will prevent safety risks and will prevent damage to the event recorder in the event that excessive loading or a short circuit is applied to the +5 Volt / 0.2 Amp supply. The +5 Volt / 0.2 Amp supply 254 additionally contains thermal overload protection, which will prevent damage to the supply in the event of excessive current drain due to excessive loading or short circuit.

FIG. 5 illustrates an embodiment of a circuit providing ESD protection and signal conditioning for an analog input 300. The analog input is applied to spark gap 302, which is coupled to circuit ground 304, and to resistor 306. The spark gap 302 and the resistor 304 are designed such that an electrostatic discharge (ESD) at analog input 300 will spark across the spark gap at a significantly lower voltage than would be required to spark across the resistor. Signal diodes 308, 310 act with resistor 306, which acts as a current limit, to protect amplifier 316 and capacitor 314 from excessive and damaging electrical voltages produced by ESD or application of excessive voltage to analog input 300, by clamping the voltage at the amplifier at a maximum of a diode-drop above power supply 332 and at a minimum of a diode-drop below circuit ground 304. Resistor 312 acts with resistor 306 to divide the voltage at the analog input 300 to ensure that the dynamic range of amplifier 316 is not exceeded when the maximum specified input voltage exists at the analog input. Capacitor 314 acts with resistor 312 and capacitor 320 acts with resistor 322 to provide noise filtering. Resistors 324, 326 act with resistor 322 to produce appropriate gains in amplifier 316 when coupled to signal ground by switches 328, 330. Microprocessor subsystem 134, not shown in this figure, controls the gain of amplifier 316 by controlling switches 328, 330.

FIG. 6 illustrates an embodiment of analog-to-digital converter 132. A plurality of input signals are coupled from signal conditioning and ESD protection circuits 234 to a multiplexer 256, which presents each of the input signals in turn to sample and hold / analog-to-digital converter 258. Digital data 266, representing the sampled analog signals, is coupled from the sample and hold / analog-to-digital converter to a FIFO (first-in-first-out memory device) 270 and from the FIFO to microprocessor subsystem 134. A programmable clock source 262 couples a periodic converter clock signal 268, controlled by quartz crystal 264 for high frequency stability, to a data conversion controller 260 and to the microprocessor subsystem 134. The data conversion controller 260 is coupled to and controls the function of multiplexer 256, sample and hold / analog-to-digital converter 258 and FIFO 270.

At the start of data sampling and conversion, each of one or more data inputs is connected in turn through multiplexer 256 to sample and hold / analog-to-digital converter 258, converted to digital data and coupled into FIFO 270, under control of data conversion controller 260. Thereafter, the data conversion controller 260 repeats this sequence upon the occurrence of each converter clock signal 288. Microprocessor subsystem 134 initiates converted data requests 272 to the data conversion controller 260 upon the occurrence of the converter clock signal, whereupon FIFO 270 couples digital data 266 to the microprocessor subsystem under control of the data conversion controller. The converted data requests 272 are issued in sufficient quantity so as to ensure that the stored data in the FIFO 270 is maintained at an amount sufficiently low so as to prevent overflow of the FIFO 270 and the resultant loss of digital data.

According to principles of the present system, the number of analog inputs can easily be expanded by implementing multiplexer 256 using a device with a greater number of inputs, while ensuring that sample and hold / analog-to-digital converter 258 is fast enough to convert the additional analog inputs to digital data within a single converter clock period. Alternatively, the number of analog inputs can be expanded by duplicating the data conversion subsystem comprised of multiplexer 256, data conversion controller 260, sample and hold / analog-to-digital converter 258, and FIFO 270.

FIG. 7 illustrates an embodiment of cable decoder 236. Two code inputs are shown, providing the ability to decode up to three different input cables, since a total lack of wire jumpers at the code inputs is interpreted as "no cable connected". The number of allowable input cables can be expanded by replicating the circuits illustrated in FIG. 7

A cable, not shown in this figure, coupled to input connector 350 has one or more wire jumpers installed so as to couple one or more code inputs 352, 354 to a ground pin 356 on the input connector, the ground pin coupling to circuit ground 380. In the event that code input 352 is not coupled to ground pin 356, power supply 382 is coupled through resistors 362, 364 to buffer 378. Conversely, in the event that the code input 352 is coupled to the ground pin 356, circuit ground 380 is coupled through resistor 364 to the buffer 378. Code input 354 operates on the same principle, in conjunction with resistors 370, 372. Microprocessor subsystem 134, not shown in this figure, couples to cable decoder 236 through buffer 378.

The buffer 378 is protected from excessive input voltage and from ESD by the circuits consisting of spark gaps 358, 360, resistors 364, 372, and signal diodes 366, 368, 374, 376. The principles of these circuits are explained in the description of FIG. 5 (Signal Conditioning and ESD Protection Circuit).

FIGS. 10A to 10C illustrate a method of shock-mounting circuit boards that is implemented in an embodiment of the present system, in order to minimize the possibility of failures due to shock and vibration, most especially in vehicular environments. FIG. 10A illustrates the preparation of a printed circuit board 710, which is represented by a cutaway side view. The preparation consists of the installation of a rubber grommet or first cushion member 712 into a hole, which has been specifically designed for this purpose, in the printed circuit board 710.

FIG. 10B illustrates the specifics of shock-mounting the printed circuit board 710 which has been so prepared into a target housing 714, also represented by a cutaway side view. A screw 716, for example, a 40 x ½ inch screw 716 is inserted through a mounting hole in the housing 714, then through a second rubber grommet or cushion member 722, then through grommet 712, which was previously installed in the printed board, then through a washer 718, for example, a #4 flat washer, and finally into a hex nut 720, for example, a 4.40 hex nut. Threadlocker is used to ensure that the hex nut 720 will not loosen from the screw 716 in the event of severe vibration.

FIG. 10C illustrates the completed assembly. Printed circuit board 710 is now isolated from housing 714 and from mounting screw 716 by rubber grommets 712, 722, such that any shock or vibration that is coupled to the housing 714, and thereby to the mounting screw, will be significantly attenuated by the rubber grommets before affecting the printed circuit board.

In one embodiment, screw 716 is replaced by a threaded post, for example, a 4-40 x ½ inch threaded post, which is permanently pressed into housing 714, with second rubber grommet 722, then the printed circuit board containing grommet 712, then #4 flat washer 718, and finally 4-40 hex nut 720 installed onto the threaded post, thereby simplifying the assembly of the printed circuit board into the housing.

An important event trigger when analyzing intermittent failures in a motor vehicle is an engine stall. This condition can be detected by monitoring for loss of normal engine function while the vehicle ignition system remains energized, because the normal engine function is normally terminated by the act of de-energizing the ignition system. In modern computerized engine control systems, the ignition control circuits generate one or more control or reference signals which are not present until the engine is operating, and which cease when the engine ceases operating due to a stall or due to the ignition system being de-energized. The following technique can be utilized to detect a vehicle stall:

1) Connect the ignition voltage to an appropriate input to event recorder 130 and an appropriate ignition-generated signal to another appropriate input to the event recorder.
2) Monitor the ignition-generated signal to determine the point in time at which the engine is operating.
3) Continue monitoring the ignition-generated signal to determine the point in time at which the engine ceases operating.
4) At the point in time at which the engine ceases operating, check the state of the ignition voltage to determine whether the ignition system is energized (this constitutes a stall event)

or whether the ignition system is de-energized (this constitutes a normal shut-down).

This technique can be implemented with a combination of hardware and software, wherein the hardware produces register values corresponding to the physical states of the ignition-generated signal and the ignition voltage and the software polls the register values to determine the physical states. Alternatively, event recorder 130 can contain a hardware circuit that is adapted to produce a trigger signal only in the event that the ignition-generated signal ceases while the ignition system remains energized.

Similar techniques can be adapted for use with other types of computer-controlled equipment, utilizing appropriate signals which are present only when the equipment is operating normally, in order to detect abnormal termination of the proper operation of the equipment.

The system which forms the subject matter of this application can be readily implemented with state-of-the-art devices. Thus, readily available single-board computers, e.g., of the type which are presently utilized in numerous special-purpose computer-controlled devices, may serve as the microprocessor subsystem 134. Examples of such single-board computers appear on pages 36, 37, and 59 of the February 1998 issue of "Circuit Cellar INK" magazine. Many commercially available single-board computers provide the functionality of a data storage subsystem 136 and a high-speed communications port 138, with some also providing an integral analog-to-digital converter circuit 132.

Alternatively, a separate analog-to-digital converter circuit 132 can be implemented and coupled to microprocessor subsystem 134, for example, as shown on pages 91 through 94 of "Data Acquisition Techniques Using Personal Computers" by Howard Austerlitz, Copyright 1991 by Academic Press, Inc., the contents of which are incorporated herein by reference. Microprocessor subsystem 134 could alternatively be implemented by using multiple microprocessors and/or microcontrollers. A first microcontroller can be used to control analog-to-digital converter 132 while a second microcontroller or microprocessor can be used to control data storage subsystem 136 and high-speed communications port 138. The first microcontroller would couple output data from the analog-to-digital converter

132 to the second microcontroller, which would the output data to the data storage subsystem and/or the high-speed communications port as appropriate.

Signal probes 120 can be implemented by utilizing individual wire-piercing probes such as those which are commercially available for use as accessories for electronic multi-meters. These probes, by design, inflict damage to the insulation of the wires that are probed, and a great deal of care is required to ensure reliable connection to the inner conductor of the pierced wire. Due to the mechanical complexity of these probes, they are relatively costly. Alternatively, feed-through coupling connectors can be inserted between a machine control computer 112 and sensors/actuators/indicators 114 and adapted to couple the desired signals into event recorder 130. For automotive embodiments, the feed-through coupling connectors can take the form of commercially available "breakout box" harnesses which are readily available and widely used in automotive diagnosis and repair. In one embodiment, one of the breakout cables of the present system is utilized. For non-automotive embodiments, similar feed-through connector harnesses can be developed and implemented.

A user trigger device 124 may take the form of a simple push-button switch which is coupled into event recorder 130, such that pressing the switch will act as a trigger to cause an event to be recorded. Alternatively, a wireless user-trigger push-button 224 may take the form of a wireless remote control device, similar in form to a wireless garage door opener or a wireless doorbell.

In accordance with principles of the present system, a data storage subsystem 136 can be implemented with magnetic mass storage devices of the type commonly used in modern computers, most notably in small "lap-top" portable computers, providing a large amount of data storage at relatively low cost. Alternatively, solid state memory devices, including, but not limited to, flash and static RAM (SRAM), may be used in the event that a smaller amount of data storage is required, implementing a data storage system that is smaller and avoids the mechanical and environmental limitations inherent in magnetic storage devices.

In a first embodiment of the present system, data storage subsystem 136 is implemented as a first memory which exists within the dynamic RAM (DRAM) supplied as part of a single-board computer and a second memory which exists within a flash memory (FLASH) supplied as part of the single-board computer. The first memory is used for temporary storage of data while waiting for a trigger event. Upon the occurrence of a trigger event, microprocessor subsystem 134 transfers data from the first memory to the second memory for semi-permanent storage until such time as the data is transferred to external computer 150. An alternative embodiment may use a single memory implemented in static RAM, with the memory used for temporary, endless-loop data storage while waiting for a trigger event, upon which event the memory will be maintained as semi-permanent storage until such time as the data existing within the memory is transferred to external computer 150. The memory can be subdivided to allow storage of multiple events prior to transfer of the contents of the memory to the external computer.

A high speed communications port 138 can be implemented through various means, including but not limited to high speed serial communications, bi-directional parallel communications, wireless infra-red data communications, etc. At such time as the new high-speed USB (Universal Serial Bus) and FireWire (IEEE P1294 Standards Serial Interface) technologies are widely implemented, they will provide an advantageous communications means, due to a high communications speed and the ease that they provide for coupling multiple peripheral devices to a computer. Also, as use of local area networks and the internet increases, it may become advantageous to implement high speed communications port 138 as a network node, using a network protocol such as ethernet to connect directly to a local area network, or as an internet appliance, using an internal modem to connect directly to the internet.

External computer 150 can take the form of a desk-top PC-compatible computer, providing the advantage of plentiful data processing power and high quality graphics display. Alternatively and more preferably, the external computer 150 can be a portable lap-top computer, as such computers of modern vintage provide data processing power and graphics capability which rivals that of desk-top computers while allowing a technician to transfer and display data in close proximity to the machine 110, typically without the requirement of removing event recorder 130 from the machine.

Required power supply circuits within power supply 142 can be implemented through the use of any of the many commercially available monolithic or modular power supply circuits which are appropriate for the voltage and current requirements of the specific implementation of the event recorder.

In accordance with principles of the present system, microprocessor subsystem 134 includes permanent memory for a custom software program. The software program is executed by the microprocessor subsystem in order to implement the functionality of event recorder 130.

FIG. 8 illustrates the multiple states in which a first embodiment of the software can exist and the conditions which cause a transition from one state to another, and is explained in conjunction with the block diagram of FIG. 2. Upon initial power up of event recorder 130, which occurs when power is applied to power sensing circuit 140 or when power is applied by means of optional AC-DC converter 240, the active state is initialization state 510. Upon completion of initialization, the state transitions to "wait for communications" state 516 in response to power sense OFF 550, which condition may exist when power is applied by means of optional AC-DC converter 240, or the state transitions to data collection state 512 in response to power sense ON 552.

Data collection state 512 is the usual state of event recorder 130. When a trigger is activated 560, the state transitions from data collection state 512 to event storage state 514. When event storage is completed 562, the state transitions back to data collection state 512 UNLESS loss of power 554 has occurred, in which case the state transitions to "wait for communications" state 516. While in data collection state 512, activation of a communications interrupt 566 will cause a transition to communications idle state 518, in which communications through high-speed communications port 138 has been initiated but no active communications state has yet been initiated. Loss of power 554 or detection of power sense OFF 550 will cause a transition from the data collection state 512 to "wait for communications" state 516.

Upon entering the "wait for communications" state 516, microprocessor subsystem 134 relinquishes control of power management circuit 144, in which case event recorder 130 will only remain active when power is applied to power sensing circuit 140 (power sense ON 552), in which case the state transitions back to data collection state 512, or when power is applied by means of optional AC-DC converter 240. In the event that the "wait for communications" state exists without power input by means of the AC-DC converter 240, the event recorder 130 will automatically power down 558. While the "wait for communications" state 516 exists, activation of a communications interrupt 566 causes a transition to communications idle state 518.

Communications idle state 518 exists until such time as an active communication state is initiated or until communication is terminated. Upon termination of communications 582, the state transitions to "wait for communications" state 516. Upon initiation of stored event transfer 568, the state transitions to stored event transfer state 522 in which the user can transfer one or more events from data storage subsystem 136 to external computer 150. Upon completion of stored event transfer 570, the state transitions back to communications idle state 518, from which another communication state can be initiated or communications can be terminated 582.

Upon initiation of configuration transfer 572, the state transitions to configuration transfer state 520 in which the user can download the current configuration of event recorder 130 to external computer 150 or upload a new/updated configuration from the external computer to the event recorder 130. Note that the configuration is implemented by the event recorder 130 only when the event recorder is coupled to a "general purpose" input cable consisting of one or more signal probes 120 which can be connected to any of a multitude of electrical signals within a vehicle. When coupled to a special coded cable which has been designed to connect to specific electrical signals, the event recorder 130 is automatically configured for operation with the cable, regardless of the current user-specified configuration. Upon completion of configuration transfer 574, the state transitions back to communications idle state 518.

Upon initiation of real-time data collection and transfer 576, the state transitions to real-time data collection / transfer state 524 in which the user can transfer, for immediate viewing on external computer 150, digitized data for one or more input signals as they are actually occurring. Upon termination of real-time data collection and transfer 578, the state transitions back to communications idle state 518.

In accordance with principles of the present system, external computer 150 will be used to implement the display of recorded data. Commercially available software, provided by numerous manufacturers of data acquisition equipment, can be implemented for the purpose of displaying the data. Alternatively, custom software may be created in order that new features which are deemed advantageous to the present system can be provided. The custom software may also provide functions pertaining to configuration of the event recorder 130, as well as data transfer functionality, in a single integrated program so as to maximize ease of use. Using state of the art software techniques, external computer 150 could potentially be programmed to analyze the stored data and assist the service technician in identifying performance problems, abnormalities, the cause of an intermittent failure, etc., thereby allowing less trained technicians to successfully utilize the event recorder system.

FIG. 9 illustrates the multiple states in which a first embodiment of custom software for implementation in the external computer can exist and the conditions which cause a transition from one state to another. Upon startup of the software, the initial state is main menu state 610, in which the user can select from among several activities. Upon user initiation of event data display 652, the state transitions to event data display state 612, in which the user can select and display any of at least one events which are accessible to the external computer, e.g., residing on a connected hard drive, floppy disk, CD ROM, etc. The event data display state provides functionality to re-create and display the electrical signals which were sampled and converted to digital data by event recorder 130, and to allow viewing of the electrical signals at differing time resolutions to facilitate the interpretation of the electrical signals, scrolling of the electrical signals to view activity at different points in time, and printing of the current display using a printer connected to the external computer. While in event data display state 612, user initiation of printing of the current display 682 causes the state to transition to print current display state 630. Upon termination of the printing activity 684, the state transitions back to event data display state 612. Upon termination of event data display 654, the state transitions back to main menu state 610.

Upon user initiation of configuration creation 656, the state transitions to configuration creation state 614, which provides functionality including, but not limited to, allowing the user to assign labels to any or all of the inputs to event recorder 130, to specify the voltage input range of the inputs, to assign identifying information pertaining to the vehicle in which the event recorder will be installed, to save a configuration for transfer to the event recorder, and to modify an existing configuration. Upon termination of configuration creation 658, the state transitions back to main menu state 610.

Upon user initiation of any function that requires communications 660, the state transitions to communications idle state 616, which provides functionality for establishing communications with event recorder 130 and exists until such time as an active communication state is initiated, an unsuccessful communication attempt is intentionally aborted or times out, or successful communication is completed. In the event that an active communication state is initiated and then unintentionally terminated, functionality is provided within the communications idle state to attempt to re-establish the active communication state until the attempt is intentionally aborted or times out. Upon termination of communications 662, the state transitions back to main menu state 610.

When communication with the event recorder 130 is successfully established in response to the user initiating a configuration upload 664, the state transitions to configuration upload state 620, which provides functionality for uploading a user-specified configuration from remote computer 150 to the event recorder. Upon termination of configuration upload 668, the state transitions back to communications idle state 616.

When communication with the event recorder 130 is successfully established in response to the user initiating a configuration download 670, the state transitions to configuration download state 622, which provides functionality for downloading the current configuration from the event recorder to remote computer 150. Upon termination of configuration download 672, the state transitions back to communications idle state 616.

When communication with the event recorder 130 is successfully established in response to the user initiating a stored event data download 674, the state transitions to stored event data download state 624, which provides functionality for downloading one or more stored events from the event recorder to remote computer 150. Upon termination of stored event data download 676, the state transitions back to communications idle state 616.

When communication with the event recorder is successfully established in response to the user initiating the download and display of real-time data 678, the state transitions to download and display real-time data state 626, which provides functionality for downloading real-time or quasi-real-time digitized data from the event recorder and for using the digitized data to recreate and display, on remote computer 150, the electrical signals which are being sampled and converted to digital data by the event recorder, and to allow viewing of the electrical signals at differing time resolutions to facilitate the interpretation of the electrical signals. Upon termination of real-time data download and display 680, the state transitions back to communications idle state 616.

According to principles of the present system, the display of recreated electrical signals are presented on a computer monitor such that each signal will occupy its own area of the display screen on the computer monitor. In a first embodiment, the display screen is divided into 16 horizontal channels, representing the 16 possible electrical signals recorded and stored by event recorder 130. The recreated electrical signals are displayed in time synchronization, i.e., a vertical line drawn through any point on the display represents the same point in time for all signals intersected by the vertical line. The time synchronization ensures that an observer can readily determine the time relationships between any and all signals.

As a further aid to interpretation of the electrical signals, color is used to differentiate various signal states. In one embodiment, the display background is rendered in a light gray. For each channel, the ground reference level is displayed in black and the full-scale level is displayed in red. As any electrical signal is recreated on the display, three colors are used in the presenting the electrical signal. When a sample of the electrical signal is below a first specified value, close to the ground reference, the sample is recreated in blue. When a sample of the electrical signal is above a second specified value, close to full scale, the sample is recreated in green. When a sample of the electrical signal is between the first and second specified values, the sample is recreated in white.

As a further aid to interpretation of the electrical signals, the user can change the time period represented by a full-screen display of the electrical signals. In a first embodiment, the user can choose to have the display show time durations from 1/16 of a second to 1 second, allowing the user to scroll through signals rapidly at the longer duration, then switch to shorter durations to observe greater detail in an area of interest.

Alternative embodiments of this software allow the user to select the number of channels to display at one time, which provides better resolution when fewer channels are displayed. The user is also able to select which channels to display.

The wireless push-button in the present system is implemented by use of a miniature key-fob type wireless transmitter, which has a single large push-button or actuator. The push-button provides a distinct audible and tactile click when pressed, providing the user with the desired feedback. In order that the user can press the push-button without diverting his/her eyes from the road ahead and without removing his/her hands from the steering wheel, the wireless push-button transmitter is mounted within reach of the user. In one embodiment, the wireless push-button transmitter is mounted on the vehicle steering wheel, using a hook-and-loop fastener strip in order that there is no damage to the vehicle. In other embodiments, the wireless push-button transmitter is mounted on the steering mechanism of the vehicle to be monitored, such as on the handle bar of a motorcycle. Further, the wireless push-button transmitter is mounted such that its body is located towards the inside of the steering wheel, minimizing the possibility of hand injury in the event that the steering wheel spins rapidly.

An embodiment of the wireless user-trigger push-button will be described in conjunction with FIG. 11 and FIG. 12. FIG. 11 illustrates a miniature "key-fob" type wireless transmitter 224, of the type commonly used for garage door openers and other simple remote control functions. Attached to the wireless transmitter is a ½ inch by 8 inch strip of hook-and-loop fastener strip 815, constructed such that one surface of the hook-and-loop fastener strip consists of hooks that will adhere to the loops on the other surface of the hook-and-loop fastener strip. FIG. 12 illustrates a method of attaching wireless transmitter 224 to a motor vehicle steering wheel 817 by means of the hook-and-loop fastener strip, which has been wrapped around the steering wheel and back over itself, such that the top and bottom surfaces of the hook-and-loop fastener strip adhere to each other and hold the wireless transmitter securely in place. Note the placement of the wireless transmitter so that it resides on the INSIDE surface of the steering wheel, positioned much like the Push-To-Talk switch for an aircraft radio is positioned on an aircraft yoke.

In an embodiment, one or more of the malfunction indicator lamps that are integral to a motor vehicle or other machine control system are utilized in a feedback system to provide a visual indication of vehicular event recorder status. In alternative embodiments, other feedback means can be implemented, for example, the actuation of a audible device such as a chime. In the event that the vehicular event recorder has failed, does not have an effective connection to the vehicular power system, or is in the start-up initialization process, the malfunction indicator lamp is maintained in a steady "active" state until such time as the problem is corrected or the initialization is completed. In the event that the vehicular event recorder is working normally, the malfunction indicator lamp is flashed briefly at fixed intervals, the intervals being approximately 4 seconds in one embodiment.

In the event that the vehicular event recorder is in the process of recording an event, the malfunction indicator lamp is flashed at a 50% duty cycle and at a fixed frequency, the fixed frequency being approximately 3 Hz in one embodiment. In the event that the vehicular event recorder has not been properly configured prior to installation into a motor vehicle or other machine control system, but is otherwise functioning normally, the malfunction indicator lamp is flashed at a 50% duty cycle and at a fixed frequency, the fixed frequency being significantly and obviously different than the fixed frequency utilized when the vehicular event recorder is in the process of recording an event, the fixed frequency further being approximately 0.25 Hz in one embodiment. As the foregoing discussion demonstrates, the present system provides for a multitude of different status conditions to be conveyed to the user by means of different flash patterns and different flash frequencies.

A method of utilizing the malfunction indicator lamp to provide visual status indication to the user will be described in conjunction with FIG. 13 and FIG. 14. FIG. 13 is a simplified schematic diagram in which only those parts of a motor vehicle 810 and a vehicular data recorder 812 that are pertinent to one embodiment of the present system are shown. The positive terminal of a malfunction indicator lamp 818 is connected to the vehicle switched ignition voltage 816 such that power is available to the malfunction indicator lamp only when the ignition in the motor vehicle is switched on.

The negative terminal of the malfunction indicator lamp is connected to an appropriate terminal on a computer connector 824 that is attached to a vehicular computer 811, the vehicular computer containing a switching device 820 capable of connecting the terminal on the computer connector to a computer ground 823, which is further connected to vehicular ground 822 by means of a different appropriate terminal on computer connector 824.

The vehicular event recorder contains a switching device 836 which connects to a probe wire 834 which, during installation of the vehicular event recorder, is coupled to the terminal on computer connector 824 to which the negative terminal of the malfunction indicator lamp is connected. Vehicular event recorder switching device 836 also connects to vehicular event recorder ground 842 which is further connected to probe wire 832 which, during installation of the vehicular event recorder, is coupled to the terminal on computer connector 824 to which vehicular ground 822 is connected. Thus, the vehicular event recorder is able, by means of switching device 836, to activate the malfunction indicator lamp at such times that vehicular computer 810 is NOT activating the malfunction indicator lamp.

FIG. 14 is a simplified schematic diagram of a second embodiment of the present system which would be utilized in the event that malfunction indicator lamp 818 is controlled by switching the positive supply to the malfunction indicator lamp. Again, only those parts of motor vehicle 810 and vehicular data recorder 812 that are pertinent to one embodiment of the present system are shown. The negative terminal of the malfunction indicator lamp is connected to vehicle ground 822. The positive terminal of the malfunction indicator lamp is connected to an appropriate terminal on computer connector 824 that is attached to vehicular computer 811, the vehicular computer containing a switching device 820 capable of connecting the terminal on the computer connector to vehicular switched ignition voltage 816 by means of a different appropriate terminal on computer connector 824. Computer ground 823 is connected to vehicular ground 822 by means of an appropriate terminal on the computer connector.

A separate device, an indicator lamp control interface 814, is utilized to allow vehicular event recorder 812 to control the malfunction indicator lamp by means of a positive voltage. The vehicular event recorder contains a switching device 836 which connects to a probe wire 834 which, during installation of the vehicular event recorder, is coupled to a relay coil 838 within indicator lamp control interface 814. The relay coil also connects to probe wire 828 which, during installation of the vehicular event recorder, is coupled to the terminal on computer connector 824 that connects to vehicular switched ignition voltage 816, whereby the vehicular switched ignition voltage is applied to the relay coil. Probe wire 828 also connects the vehicular switched ignition voltage to relay contacts 840 within the indicator lamp control interface, with the other side of the relay contacts connected to probe wire 830 which, during installation of the vehicular event recorder, is coupled to the terminal on computer connector 824 that connects to the positive terminal on malfunction indicator lamp 818.

Vehicular event recorder switching device 836 also connects to vehicular event recorder ground 842, which is further connected to probe wire 832 which, during installation of the vehicular event recorder, is coupled to the terminal on computer connector 824 to which vehicular ground 822 is connected. Thus, the vehicular event recorder is able, by means of switching device 836, to activate relay coil 838 within indicator lamp control interface 814, thereby closing relay contacts 840 to activate the malfunction indicator lamp at such times that vehicular computer 810 is NOT activating the malfunction indicator lamp.

Switching devices 820, 836, and 838/840 can be implemented by means of electro-mechanical relays or by means of any of a variety of solid-state switching devices, including transistors, field-effect-transistors, etc. The functionality of indicator lamp control interface 814 can be implemented in a separate enclosure, as shown in FIG. 14, or can be incorporated into vehicular event recorder 812.

Due to the method employed by most motor vehicles and machine control systems to control a malfunction indicator lamp, in which the malfunction indicator lamp is directly connected to a power source when activated and disconnected from the power source when deactivated, it is possible and practical for an external device to activate the malfunction indicator lamp at such times that the motor vehicle or machine control system is not activating the malfunction indicator lamp, without first disturbing the wiring of the malfunction indicator lamp within the motor vehicle or machine control system. Only by disturbing the wiring of the malfunction indicator lamp, whereby to sever the connection between a control computer and the malfunction indicator lamp, would it be practical for an external device to de-activate the malfunction indicator lamp at such times that the motor vehicle or machine control system is activating the malfunction indicator lamp.

It is not the intent of the present system that the wiring of the malfunction indicator lamp be disturbed, since activation of the malfunction indicator lamp by the control computer within the motor vehicle or machine control system, or steady-state activation of the malfunction indicator lamp by the vehicular event recorder, is an indication to the user of a malfunction requiring the immediate attention of a trained service technician, who will determine and correct the problem.

In order to detect an occurrence of a control computer activating a malfunction indicator lamp that is integral to a motor vehicle or other machine control system, the vehicular event recorder monitors the status of the malfunction indicator lamp at the times that the malfunction indicator lamp is not being activated by the vehicular event recorder. In the circuit of FIG. 13, the voltage level at probe wire 834 can be buffered and coupled to a hardware register, providing a data point whereby the application software in the vehicular event recorder is able to determine the status of the malfunction indicator lamp. In the circuit of FIG. 14, the voltage level at probe wire 830 can be coupled into the vehicular event recorder, buffered, and coupled to a hardware register, providing a data point whereby the application software in the vehicular event recorder is able to determine the status of the malfunction indicator lamp.

FIG. 15 illustrates an embodiment of a universal breakout cable or cabling device for use in connecting a vehicular data recorder to any of the electrical systems within a motor vehicle. The universal breakout cable comprises a connector 910 that connects to the vehicular data recorder, a group of flexible, insulated wires 912, and metal contact pins 918. A protective jacket 914 is installed on approximately half the length of the flexible insulated wires 192 as protection and to maintain the wires in a contained bundle. The remainder of the length of the flexible insulated wires is left unjacketed, to allow the user to separate the flexible insulated wires 912 as required, in order to reach the desired connection points within the motor vehicle. An insulator 916, such as shrink tubing, is installed to cover the attachment between each individual insulated wire 912 and metal contact pin 918, and to cover part of the length of the metal contact pin. In one embodiment, approximately 1 ¼ inch at the tip of the metal contact pin 918 is left uninsulated.

Metal contact pins 918 can be fashioned from readily available standard #1 sewing needles (shown in FIG. 17). To ensure safety and easy of use, the sharp points on the sewing needles are ground off as shown in FIG. 18. Alternatively, metal contact pins can be custom made with a diameter of 0.040 inches, a length of 2 ½ to 3 inches, a rounded tip as shown in FIG. 18, and an attachment hole similar to the "eye" of a #1 sewing needle. Alternatively, other wire attachment methods including, but not limited to, crimping can be implemented. Other embodiments utilize pins of a different diameter and/or length in order to mate properly with other types of electrical connectors and contacts.

Flexible insulated wires 912 are attached to the metal contact pins by removing the insulation from the ends of the insulated wires, inserting the resulting uninsulated wire into the attachment hole in the metal contact pin and wrapping the uninsulated wire around the metal contact pin as shown in FIG. 19, and applying solder to establish a permanent mechanical and electrical connection.

Insulator 916 provides strain relief for the connection of the flexible insulated wire 912 to the metal contact pin 918. The insulator 916 also prevents shorting of the metal contact pin 918 to nearby conductive objects and provides a convenient surface by which to grasp the metal contact pin during installation and removal of the metal contact pin in a target electronic wiring system. In order to ensure that the insulator will not slide along the length of the metal contact pin during installation and removal of the metal contact pin in the electronic wiring system, the insulator should be implemented using the type of shrink tubing that is supplied with an adhesive inner liner. In order to provide for ease of installation and removal of the metal contact pin, the insulator should extend ½ to ¾ inch along the length of the flexible insulated wire. The insulator 916 on each of the metal pins 918 may be permanently marked with an easily recognizable identifier to indicate either a) the target system signal to which the metal contact pin should be connected or b) the input on the data recorder to which the metal contact pin is attached. The identifier may be protected from abrasion by installing an additional, transparent insulator over the identifier. Ease of use may also be enhanced by attaching or fixing a duplicate of the identifier on the flexible insulated wire at a location on the flexible insulated wire that is close to protective jacket 914.

The present system will be utilized by selecting the appropriate terminal on the appropriate vehicular connector, and then inserting the corresponding metal contact pin 918 alongside the vehicular wire attached to the terminal and into the body of the vehicular connector, through any existing integral rubber seal, such that the uninsulated section of the metal contact pin 918 is inserted between the plastic connector housing and the metal terminal to which the vehicular wire is attached.

Due to the design of modern motor vehicle connectors and the design of the metal contact pins 918 of the present system, when the metal contact pin is inserted through the integral rubber seal and between the plastic connector housing and the vehicular wire terminal, sufficient pressure will be exerted between the vehicular wire terminal and the metal contact pin so as to ensure a good electrical connection, and so as to provide sufficient friction to retain the metal contact pin within the plastic connector housing and in contact with the vehicular wire terminal until such time as the metal contact pin is intentionally removed from the plastic connector housing.

FIG. 16 illustrates a second embodiment of a universal breakout cable that further consists of a multi-pin in-line connector 922, which connects by means of a short, flexible, multi-conductor cable 920 to the connector 910 which mates with the data recorder. The in-line connector 922 provides an interface to an appropriate and desired electronic sensor, including but not limited to a pressure sensor for the purpose of monitoring vehicular fuel pressure, by means of a sensor cable.

FIG. 21 is a schematic diagram illustrating the design of one embodiment of a sensor cable, which consists of an appropriate multi-pin in-line connector 1032 for mating with in-line connector 922, whereby the in-line connector 922 provides power and ground to an attached sensor, through connecting wires 1034 and an appropriate sensor connector 1030, while also providing a path to connect the sensor output to a desired input to the data recorder. Connector 1032 contains a built-in wire jumper 1024 that acts to connect a digital input on the data recorder to ground, indicating that a sensor is actually present.

FIG. 22 is a schematic diagram illustrating the design of an optional and alternative "auxiliary data probe", constructed without the built-in jumper, that can be connected to in-line connector 922 when an electronic sensor is not in use. The auxiliary data probe consists of a flexible, insulated wire 1034 (similar to 912), a probe pin 1036 (similar to metal contact pin 918), and an insulator (similar to 916), with the insulated wire, metal contact pin, and insulator attached to an appropriate multi-pin in-line connector 1032 to mate with the in-line connector 922. The auxiliary data probe can be connected to a signal of the user's choice.

FIG. 20 is a schematic diagram illustrating the basic concept of a custom breakout cable for use in connecting a vehicular data recorder to specific electrical signals within a specific group of motor vehicles. The custom breakout cable comprises one or more Breakout Cable connector plug(s) 1012 that connect to one or more computer connector(s) 1004 in place of corresponding vehicle wiring harness connector(s) 1006 within a motor vehicle, one or more Breakout Cable jack(s) 1010 to which the corresponding vehicle wiring harness connector(s) are connected, a group of feedthrough wires 1014, one or more add-on instrument connector(s) 1018 which connect to the vehicular data recorder, a group of probe wires 1016 which couple the add-on instrument connector(s) to the Breakout Cable connector plug(s), one or more auxiliary connector(s) 1022, and one or more group(s) of auxiliary interconnect wires 1026 which couple the auxiliary connector(s) to the add-on instrument connector(s).

Electrical signals by which a vehicle on-board computer 1000 controls actuators and receives data from sensors within a vehicle control system 1002 are normally coupled through the computer connector(s) 1004 and attached mating vehicle harness connector(s) 1006. The current system is implemented by removing the mating vehicle harness connector(s) from the computer connector(s) 1004, attaching the appropriate Breakout Cable connector plug(s) 1012 to the computer connector(s), and attaching the mating vehicle harness connector(s) to the appropriate Breakout Cable connector jack(s). The coupling of all electrical signals between the computer connector(s) 1004 and attached mating vehicle harness connector(s) 1006 is accomplished by the feedthrough wires connecting the corresponding terminals on the Breakout Cable connector plug(s) and the Breakout Cable connector jack(s), so that vehicle operation is unimpeded. Probe wires 1016 are attached to the feedthrough wires 1014 that couple to electrical signals of interest, with the probe wires attaching to appropriate terminals on one or more add-on instrument connector(s) 1018, such that the electrical signals of interest are coupled to the vehicular data recorder. Multiple add-on instrument connectors allow for flexibility in the use of the current system; for example, engine-related signals can be coupled to one connector while transmission-related signals are coupled to a second connector. Where appropriate, an electrical signal coupled through an individual feedthrough wire 1014 can be coupled to more than one of the add-on instrument connectors (some examples are: battery voltage, ground, switched ignition).

One or more appropriate and desired electronic sensors, including but not limited to pressure sensors for the purpose of monitoring vehicular fuel pressure or vehicular transmission pressures, can be coupled to add-on instrument connector 1018 by means of one or more auxiliary connector(s) 1022 and appropriate auxiliary interconnect wires 1026.

A first embodiment of a custom breakout cable of the present system, for use in connecting a vehicular data recorder to late-model OBDII-equipped General Motors (GM) automobiles, will be described in conjunction with FIG. 23 through FIG. 27. FIG. 23 depicts a method of attaching flexible, insulated wires 912 to a GM OBDII header 930 (which is constructed with 160 pin-type contacts) which has been assembled with special straight pins rather than the standard right-angle pins with which the OBD II header is customarily supplied to General Motors for use in vehicular computers.

The flexible, insulated wires are installed into two (2) GM OBDII cable connectors 932 (which are each constructed with 80 socket-type contacts, such that two of these connectors are required). Wires that are designated as feed-through wires (1014 on FIG. 20) are routed away from the GM OBDII cable connectors 932 in one direction, while wires that are designated as probe wires (1016 on FIG. 20) are routed away in the other direction. Note that all contacts in the GM OBDII cable connectors 932 contain a wire 912 that is designated as a feed-through wire, and that more than one wire 912 is installed in any contact containing a wire 912 that is designated as a probe wire. Subsequent to the installation of the flexible, insulated wires into the cable connectors 932, the cable connectors are plugged onto the back of the GM OBDII header as shown in FIG. 24. FIG. 25 depicts the connector assembly of FIG. 24 with the addition of protective jackets 914 on the bundles of wires that are now attached to the connector assembly. FIG. 26 depicts the connector assembly of FIG. 25 enclosed within a protective covering, which can consist of a sheet metal box, plastic box, or epoxy encapsulant 934.

FIG. 27 illustrates a completed embodiment of a custom Breakout Cable according to aspects of the present system. The flexible, insulated wires 912 and protective jackets 914 incorporated in a connector assembly as depicted in FIG. 26 are of sufficient length so as to extend approximately 18 inches from the GM OBDII header 930 and sheet metal box, plastic box, or epoxy encapsulant 934. The flexible, insulated wires which are designated as feed-through wires (1014 on FIG. 20) are coupled to GM OBDII cable connectors 932 in a one-to-one correspondence that provides a connection from pin 1 on header 930 to pin 1 on cable connector 932, a connection from pin 2 on the header to pin 2 on the cable connector, etc.

The flexible, insulated wires which are designated as probe wires (1016 on FIG. 20) are coupled to two separate connectors 910 that individually connect to the vehicular data recorder. As detailed above, each of the connectors 910 can attach to shared and to unique electrical signals present at GM OBDII header 932, in order that different vehicular activity may be recorded by the vehicular data recorder. One connector 910 further attaches by means of a short, flexible, multi-conductor cable 920 to a multi-pin in-line connector 922, whereby an appropriate and desired electronic sensor may be connected to the vehicular data recorder.

FIG. 28 illustrates a second embodiment of a custom breakout cable of the present system, similar to the first embodiment, wherein both vehicular data recorder connectors 910 are coupled to multi-pin in-line connectors 922, allowing for additional use of appropriate and desired add-on electronic sensors. As desired, additional multi-pin in-line connectors 922 can be added, allowing the use of additional add-on electronic sensors, when the add-on electronic device to which connector 910 attaches is configured to facilitate the use of the additional add-on electronic sensors.

A third embodiment of a custom breakout cable of the present system, also for use in connecting a vehicular data recorder to late-model OBDII-equipped General Motors (GM) automobiles, will be described in conjunction with FIG. 29 through FIG. 34. FIG. 29 depicts a custom manufactured male/female metal contact 936, consisting of a pin at one end and a socket at the other end, wherein the pin and socket are dimensionally similar to the pins and sockets employed in the OBDII connectors that are used in the OBDII-equipped automobiles. The custom manufactured male/female metal contact is formed with a through-hole located near its center, providing a means whereby a flexible insulated wire 912 may be attached to the male/female metal contact, typically by means of solder.

FIG. 30 depicts two (2) views of a custom plastic connector housing 938, with a cutaway view depicting a group of male/female metal contacts 936 installed. The plastic connector housing is constructed such that the side which houses the socket side of male/female metal contact 936 will effectively mate with a GM OBDII header 930 that is integral to an automotive computer, whereas the side which houses the pin side of the male/female contact will effectively mate with a GM OBDII cable connector 932 that is integral to an automotive wiring harness. As illustrated in FIG. 30, custom plastic connector housing 938 is designed such that a raised channel 940 is provided on each side of the connector housing, for the purpose of allowing the installation of probe wires within the plastic connector housing.

FIG. 31 is a cutaway view of plastic connector housing 938 which depicts the installation of flexible insulated wires 912 into several male/female metal contacts 936, to serve as probe wires connecting targeted electrical signals within the plastic connector housing to the vehicular data recorder. FIG. 32 depicts an assembled breakout connector 942, comprising custom plastic connector housing 938, installed male/female metal contacts 936, and installed flexible insulated wires 912 which exit raised channel 940 at one end of the plastic connector housing. Alternative designs would provide for the flexible insulated wires to exit the raised channel at both ends of the plastic connector housing, or at another point along the length of the raised channel. FIG. 33 depicts a side view of the assembled breakout connector 942 with flexible insulated wires 912 exiting from raised channels 940 on both sides of the breakout connector. An alternative design could provide for a raised channel 940 on only one side of custom plastic connector housing 938, in the event that this would improve ease-of-use.

FIG. 34 illustrates a completed third embodiment of a custom Breakout Cable according to the present system, which is functionally equivalent to the second embodiment illustrated in FIG. 28. The third embodiment utilizes custom breakout connectors 942 in place of the GM OBDII header 930, the GM OBDII cable connectors 932, and the flexible insulated feed-through wires 912 connecting the header 930 and the cable connectors 932 in the second embodiment.

In accordance with principles of the present system, there are numerous other techniques that can be employed in fabricating custom breakout connectors and cable assemblies, which are applicable to virtually any and all connector systems employed in motor vehicles and other types of machine control systems. One such technique will be described in conjunction with FIG. 35 through FIG. 38. FIG. 35 depicts a set of typical automotive mating connectors. A cable connector 946, which contains socket-type contacts intended for attachment to the individual wires within a motor vehicle wiring harness, is designed to mate with a computer header 944, which contains right-angle pin-type contacts and is intended for attachment to a pc board within a motor vehicle computer. Matching sets of the cable connectors and the computer headers can be wired together as illustrated in FIG. 36, using short lengths of flexible insulated wire 912, with socket #1 of the cable connector attached to pin #1 of the computer header, socket #2 of the cable connector attached to pin #2 of the computer header, etc., to form a feed-through connector which can be installed between a vehicular cable connector and its mating header on the vehicular computer. FIG. 37 illustrates the attachment of additional flexible insulated wires 912 to desired header contacts, to serve as probe wires connecting the corresponding electrical signals on the header contacts to a vehicular data recorder, thus forming a custom breakout connector. FIG. 38 depicts the connector assembly of FIG. 37 enclosed within a protective covering, which can consist of a sheet metal box, plastic box, or epoxy encapsulant 934.

Another technique will be described in conjunction with FIG. 39 through FIG. 41. FIG. 39 depicts a set of right-angle socket contacts 950, designed to mate with the pin contacts in computer header 944, and used to convert cable connector 946 into a right-angle pc mounted connector. FIG. 40 illustrates the right-angle socket contacts installed in the cable connector, with the combination thereof attached to a printed circuit board 952. Computer header 944 is also attached to the printed circuit board, with copper traces on the printed circuit board acting to connect pin #1 of the computer header to socket #1 of the cable connector and pin #2 of the computer header to socket #2 of the cable connector, etc., to form a feed-through connector which can be installed between a vehicular cable connector and its mating header on the vehicular computer.

Flexible insulated wires 912 are further attached to the printed circuit board, in such a way as to be in contact with the copper traces that are connected to desired contacts on the computer header, to serve as probe wires connecting the corresponding electrical signals on the header contacts to a vehicular data recorder, thus forming a custom breakout connector. FIG. 41 depicts the connector assembly of FIG. 40 enclosed within a protective covering, which can consist of a sheet metal box, plastic box, or epoxy encapsulant 934.

Breakout connectors constructed using these and other techniques can be incorporated into breakout cable systems similar to that illustrated in FIG. 34, thereby producing custom breakout cables for any desired motor vehicle or machine control system. In alternative embodiments, the breakout cable systems described above can be used with other accessories. In addition to being a feed-through device as described above, an active device which changes one of the data signals can be used with the breakout cable systems described above. For example, the breakout cable system can be used to connect an automotive vehicle theft alarm or car-starter device to the electronics of the vehicle.

The present system is not limited to short-duration data recording such as is appropriate for pinpointing intermittent failures, but may be employed for longer term data recording and analysis. For example, some jurisdictions within the United States have implemented motor vehicle inspection programs in which the vehicle is put through a driving regimen which simulates a variety of driving conditions. In the event that the vehicle emissions exceed permitted levels during the course of the test sequence, trained service technicians must diagnose and correct the cause of the failure. An embodiment of the present system could be optimized for single-event, longer term recording, so as to provide a record of the entire driving test. This record could then be extracted and displayed, allowing a trained service technician to observe all pertinent system activity as it occurred during the test sequence, providing a valuable tool in diagnosing the cause of a failure.

An embodiment of the present system could be adapted for use in boats and ships, for use in monitoring and recording electrical signal activity within any computerized control system which is experiencing intermittent anomalies. In addition to the computerized control of engine operation, boats and ships typically contain computerized navigation systems. The computerized navigation systems comprise multiple sensors and actuators and are subject to the same types of intermittent anomalies as other computer-controlled machine systems. As in motor vehicles, the present system will facilitate the timely and accurate identification of sources of intermittent anomalies within any of the electrical systems comprising a boat or ship.

An embodiment of the present system could be adapted for use in monitoring and recording electrical signal activity within an aircraft that is experiencing intermittent anomalies. A key and complex computerized system within a modern aircraft is the "auto-pilot", which frequently controls many of the routine maneuvers and steady-state flight functions of the aircraft. The auto-pilot system is subject to the same types of intermittent anomalies as other computer-controlled machine systems, anomalies which can cause sudden and severe altitude changes, banking maneuvers, and other unexpected aircraft movement that can be unnerving and life-threatening. Complicating efforts to identify the source of an intermittent anomaly within an aircraft is the fact that key electronic systems are frequently located in parts of the aircraft that are inaccessible during flight (e.g., in the tail section). Identification and repair of intermittent anomalies within aircraft electronic systems has typically been accomplished in much the same manner that has been employed in motor vehicles, which consists of replacing system components until the problem ceases to occur. The present system facilitates timely and accurate identification of the sources of intermittent anomalies within aircraft electrical systems, thus contributing to increased comfort and safety of air travel and reduced aircraft maintenance costs.

The present system is not limited to use as a data recording device, but may be employed as part of a real-time or quasi real-time monitor and display device, similar in function to a multi-channel oscilloscope. The digital data that is generated by the analog-to-digital conversion process can be transferred through the high-speed communications port 138 to an external computer 150 for immediate display, rather than transferred to a data storage subsystem 136. This would allow the user to observe system activity as it occurs rather than at a later time, providing another valuable tool to the service technician, especially as a means to verify that reliable connection to desired signals has been achieved and that the correct signals are being probed when using wire-piercing probes or a universal breakout cable. In the event that a market need is identified, a further embodiment of the present system could be adapted to transfer the digital data simultaneously to the high-speed communications port and to the data storage subsystem, providing a means to store the system activity as it is presented for real-time viewing on the external computer.

The present system is not limited to use in motor vehicles, ships, aircraft, and photocopiers, but may be employed to monitor and record electrical signal activity in other types of computerized machine control systems. For example, modern HVAC systems, which contain one or more control computers with associated sensors and actuators, frequently experience short-term intermittent failures which are difficult to identify and correct. With appropriate signal probes and / or feed-through connectors, the present system can be deployed to monitor and record electrical activity within HVAC control systems and within other computerized equipment and machinery. Appropriate trigger events could be determined and implemented, as well as a user trigger device and visual indicator(s) appropriate to the particular application.

As the foregoing discussion demonstrates, numerous modifications, substitutions and equivalents will now occur to those skilled in the art, all of which fall within the spirit and scope contemplated by the present system.

CLAIMS

1. A system for diagnosing failures in a computer-controlled machine, the machine having a controller and an event node, with an interconnect system disposed between the controller and the event node for exchanging event data, the system comprising:

an event data recorder coupled to the interconnect system for selectively storing event data.

2. The system of claim 1, wherein the event data recorder stores event data of the machine for later analysis.

3. The system of claim 1, wherein the event node includes at least one actuator, sensor, or indicator.

4. The system of claim 1, wherein the machine is an automotive vehicle.

5. The system of claim 4, wherein:

the event data recorder stores data generated by a component of the automotive vehicle; and

the event data recorder is directly connected to the event node.

6. The system of claim 4, wherein the event data recorder stores event data which is not monitored by the controller.

7. The system of claim 4, wherein the event data recorder is triggered to store the event data by a user input.

8. The system of claim 7, wherein the user actuates an actuator to initiate storing of the event data.

9. The system of claim 8, wherein the actuator is mounted within reach of an operator of the vehicle.

10. The system of claim 8, wherein the actuator is coupled to a wire-less transmitter that communicates with the event data recorder.

11. The system of claim 1, wherein the event data recorder includes an onboard power source.

12. The system of claim 4, wherein the event data recorder is triggered to store the event data by a stall of an engine of the vehicle.

13. The system of claim 4, wherein the event data recorder is triggered to store the event data by a shut-down of a vehicular control system.

14. The system of claim 4, wherein the event data recorder is triggered to store the event data by an alarm indication.

15. The system of claim 1, further comprising a feedback system to provide information to a user of the event data recorder.

16. The system of claim 15, wherein the provided information indicates that the event data recorder is storing the event data.

17. The system of claim 15, wherein the provided information is conveyed by an indicator lamp of the machine.

18. The system of claim 15, wherein the provided information indicates an operating state of the event recorder.

19. The system of claim 1, wherein the event data recorder includes at least one circuit board shock-mounted to a housing of the event data recorder.

20. The system of claim 1, further comprising a cabling device that connects the event data recorder to at least one electrical system of the machine.

21. The system of claim 20, wherein the cabling device connects to the electrical system without damaging any existing electrical wiring.

22. The system of claim 21, wherein the cabling device includes a plurality of contact pins connected to a plurality of wires for inserting into electrical connection points of the machine.

23. The system of claim 20, wherein the cabling device includes a multi-pin in-line connector to provide an interface to an electronic sensor of the machine.

24. The system of claim 23, wherein the sensor is a temporarily installed sensor.

25. The system of claim 20, wherein the cabling device is particularly adapted for the machine.

26. The system of claim 25, wherein the cabling device comprises:

at least one connector plug that connects to a computer of the machine;

at least one cable jack that connects to at least one actuator or sensor of the machine;

a plurality of feedthrough wires that connect the connector plug and cable jack; and

at least one instrument connector that connects at least one the feedthrough wires to the event data recorder.

27. The system of claim 26, further comprising an auxiliary connector that connects to the instrument connector.

28. The system of claim 1, further comprising a display device able to be coupled to the event data recorder to access the event data stored in the event data recorder.

29. A system for use with an automotive vehicle to facilitate determining the cause of an intermittent failure, comprising:

a processor that controls operation of an event data recorder;

a recording device that receives real time event data from the vehicle and stores the same for later analysis; and

a wire-less transmitter including an actuator that, when actuated by a user, initiates storing of the event data.

30. The system of claim 29, wherein the recording device stores a predetermined amount of real-time data upon initiation of the event data recorder.

31. The system of claim 29, wherein the recording device stores the contents of a continuous loop of event data.

32. The system of claim 29, wherein the event data recorder includes a power source such that the event data recorder can function without any external power.

33. The system of claim 29, wherein the event data recorder is triggered to store the event data by a stall of an engine of the vehicle.

34. The system of claim 29, wherein the event data recorder is triggered to store the event data by a shut-down of a vehicular control system.

35. The system of claim 29, wherein the event data recorder is triggered to store the event data by an alarm indication.

36. The system of claim 29, further comprising a feedback system to provide information to a user of the event data recorder.

37. The system of claim 36, wherein the provided information indicates that the event data recorder is storing the event data.

38. The system of claim 36, wherein the provided information is conveyed by an indicator lamp of the machine.

39. The system of claim 36, wherein the provided information indicates an operating state of the event recorder.

40. The system of claim 29, wherein the event data recorder includes at least one circuit board shock-mounted to a housing of the event data recorder.

41. The system of claim 29, further comprising a cabling device that connects the event data recorder to at least one electrical system of the machine.

42. The system of claim 41, wherein the cabling device connects to the electrical system without damaging any existing electrical wiring.

43. The system of claim 42, wherein the cabling device includes a plurality of contact pins connected to a plurality of wires for inserting into electrical connection points of the machine.

44. The system of claim 41, wherein the cabling device includes a multi-pin in-line connector to provide an interface to an electronic sensor of the machine.

45. The system of claim 44, wherein the sensor is a temporarily installed sensor.

46. The system of claim 41, wherein the cabling device is particularly adapted for the machine.

47. The system of claim 46, wherein the cabling device comprises:

at least one connector plug that connects to a computer of the machine;

at least one cable jack that connects to at least one actuator or sensor of the machine;

a plurality of feedthrough wires that connect the connector plug and cable jack; and

at least one instrument connector that connects at least one the feedthrough wires to the event data recorder.

48. The system of claim 47, further comprising an auxiliary connector that connects to the instrument connector.

49. The system of claim 29, further comprising a display device able to be coupled to the event data recorder to access the event data stored in the event data recorder.

50. A method for diagnosing failures in a computer-controlled machine, the machine having a controller and an event node, with an interconnect system disposed between the controller and the event node for exchanging event data, the method comprising:

coupling an event data recorder to the interconnect system; and

storing real time data from the machine.

51. The method of claim 50, further comprising storing the event data of an automotive vehicle for later analysis.

52. The method of claim 50, wherein the event node includes at least one actuator, sensor, or indicator, further comprising connecting the event data recorder directly to the event node.

53. The method of claim 50, further comprising triggering the event data recorder to store the event data by a user input.

54. The method of claim 53, further comprising triggering the event data recorder with a wire-less transmitter that communicates with the event data recorder.

55. The method of claim 53, further comprising indicating to the user when the event data recorder is storing the data.

56. The method of claim 50, further comprising triggering the event data recorder to store the data by a stall of an engine of the vehicle.

57. The method of claim 50, further comprising triggering the event data recorder to store the data by an alarm indication

58. The method of claim 50, further comprising shock-mounting at least one circuit board to a housing of the event data recorder.

59. The method of claim 50, further comprising alerting the user that the event data recorder is installed and working properly.

60. The method of claim 50, further comprising connecting the event data recorder to the interconnect system without damaging any existing electrical wiring.

61. The method of claim 60, further comprising inserting a plurality of contact pins connected to a plurality of wires into electrical connection points of the machine.

62. The method of claim 60, further comprising including a multi-pin in-line connector to provide an interface to an electronic sensor of the machine.

63. The method of claim 57, further comprising visually displaying the stored data.

64. A method for conveying information from a device not an original equipment device connected to a machine, comprising flashing an indicator lamp of the machine in predetermined patterns under the control of the device.

65. The method of claim 64, wherein the pattern indicates the device is installed properly.

66. The method of claim 64, wherein the pattern indicates the device is performing a commanded function.

67. A system for conveying information from a device not an original equipment device connected to a machine, comprising an electronic circuit that flashes an indicator lamp of the machine in predetermined patterns under the control of the device.

68. The system of claim 67, wherein the pattern indicates the device is installed properly.

69. The system of claim 67, wherein the pattern indicates the device is performing a commanded function.

70. A system for testing a computer-controlled machine, comprising:
a testing device coupled to an electrical system of the machine; and
a wireless device that controls at least one function of the testing device.

71. The system of claim 70, wherein the machine is a motor vehicle and the wireless device is mounted within reach of the driver of the vehicle.

72. The system of claim 71, wherein the wireless device is mounted on a steering mechanism.

73. A method of testing a computer-controlled machine, comprising:

connecting a testing device to an electrical system of the machine; and

controlling at least one function of the testing device with a wireless device.

74. The method of claim 73, wherein the machine is a motor vehicle, further comprising mounting the wireless device within reach of a driver of the vehicle.

75. The method of claim 74, further comprising mounting the wireless device on a steering mechanism.

76. A cabling device for connecting an accessory to a machine, comprising a plurality of contact pins connected to a plurality of wires for inserting into electrical connection points of the machine.

77. The cabling device of claim 76, wherein the accessory is an automotive car-starter device.

78. The cabling device of claim 76, wherein the accessory is an automotive vehicle theft alarm.

79. A method for connecting an accessory to a machine, comprising inserting a plurality of contact pins connected to a plurality of wires into electrical connection points of the machine.

80. The method of claim 79, further comprising connecting an automotive car-starter device to the machine.

81. The method of claim 79, further comprising connecting an automotive vehicle theft alarm to the machine.

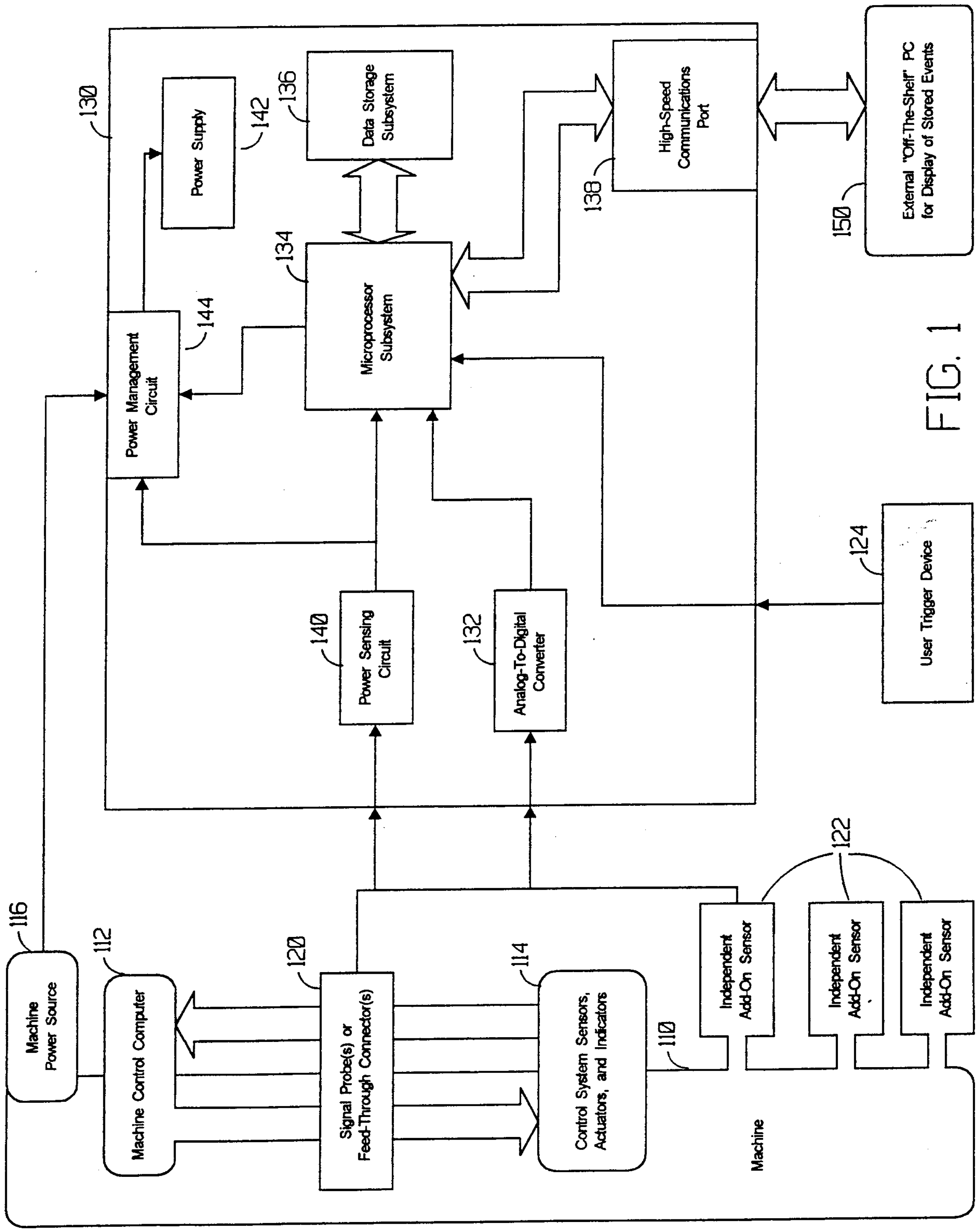

Machine Power Source
116
Machine Control Computer
112
Signal Probe(s) or Feed-Through Connector(s)
120
Control System Sensors, Actuators, and Indicators
114
110
Machine
Independent Add-On Sensor
Independent Add-On Sensor
Independent Add-On Sensor
122
130
Power Management Circuit
144
Power Supply
142
Data Storage Subsystem
136
Microprocessor Subsystem
134
High-Speed Communications Port
138
External "Off-The-Shelf" PC for Display of Stored Events
150
Power Sensing Circuit
140
Analog-To-Digital Converter
132
User Trigger Device
124

FIG. 1

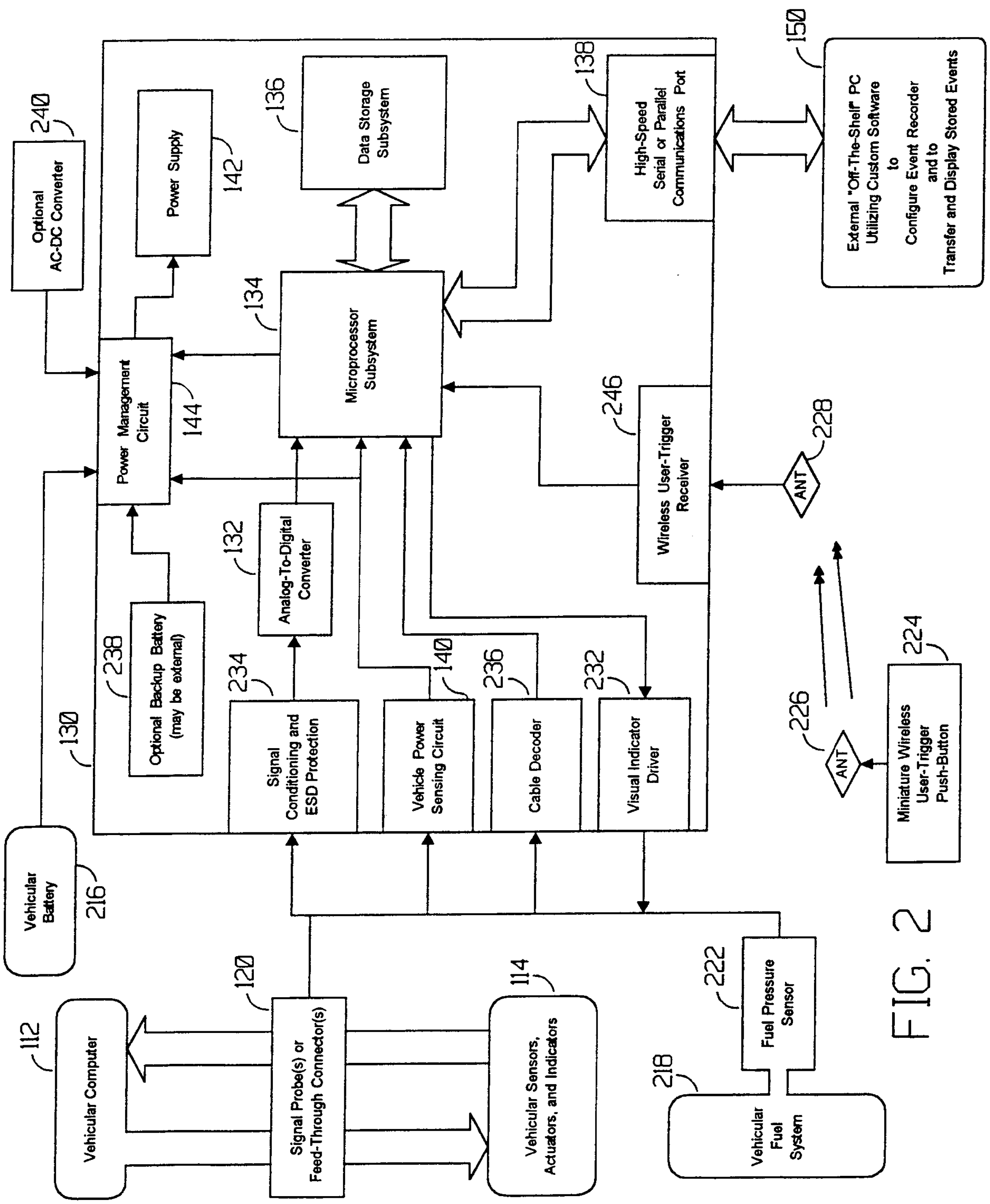

Optional AC-DC Converter
240
Power Supply
142
Data Storage Subsystem
136
High-Speed Serial or Parallel Communications Port
138
150
External "Off-The-Shelf" PC Utilizing Custom Software to Configure Event Recorder and to Transfer and Display Stored Events
Power Management Circuit
144
Microprocessor Subsystem
134
Wireless User-Trigger Receiver
246
ANT
228
Analog-To-Digital Converter
132
Optional Backup Battery (may be external)
238
130
Signal Conditioning and ESD Protection
234
Vehicle Power Sensing Circuit
140
Cable Decoder
236
Visual Indicator Driver
232
ANT
226
Miniature Wireless User-Trigger Push-Button
224
Vehicular Battery
216
Vehicular Computer
112
Signal Probe(s) or Feed-Through Connector(s)
120
Vehicular Sensors, Actuators, and Indicators
114
Fuel Pressure Sensor
222
Vehicular Fuel System
218

FIG. 2

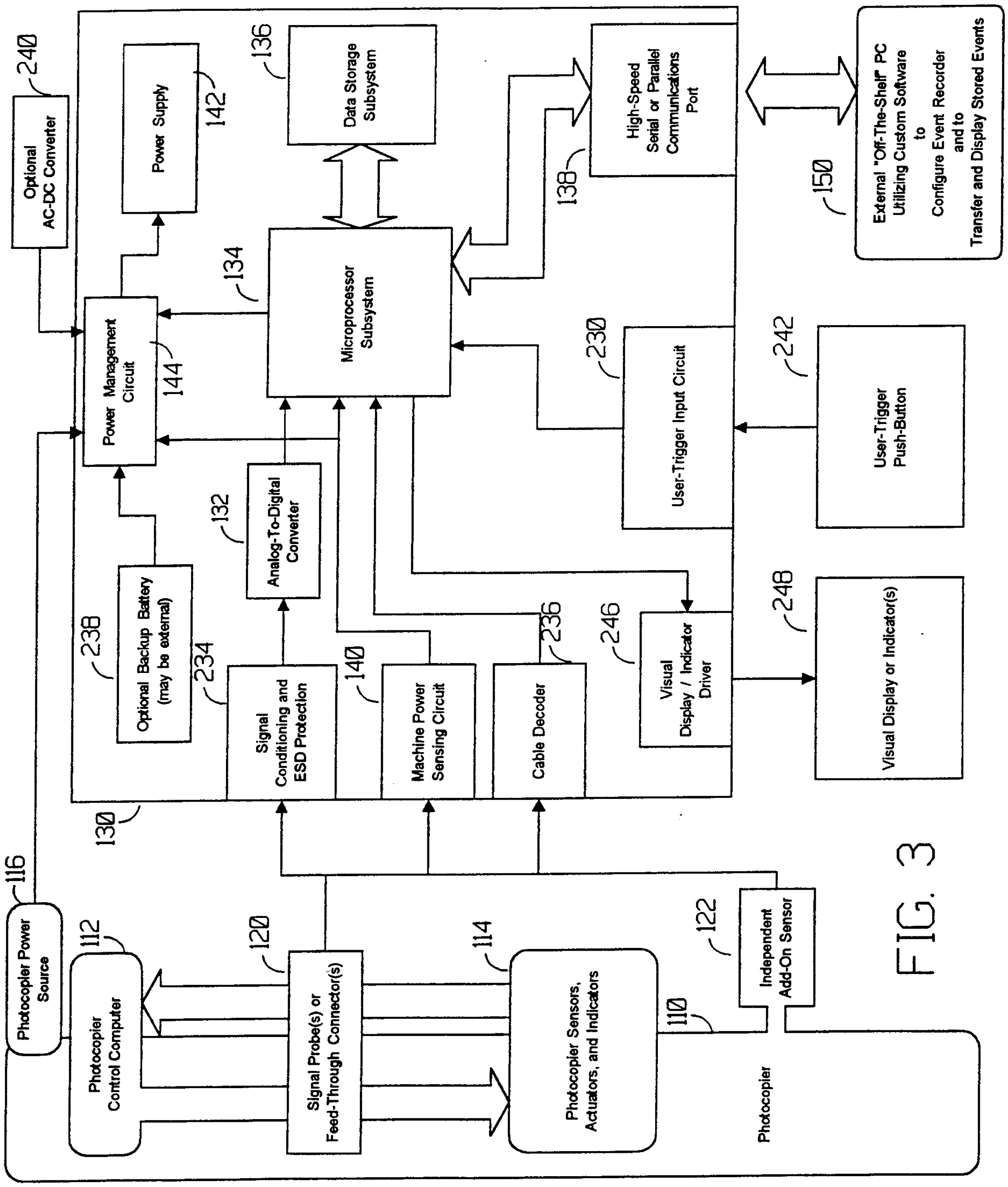
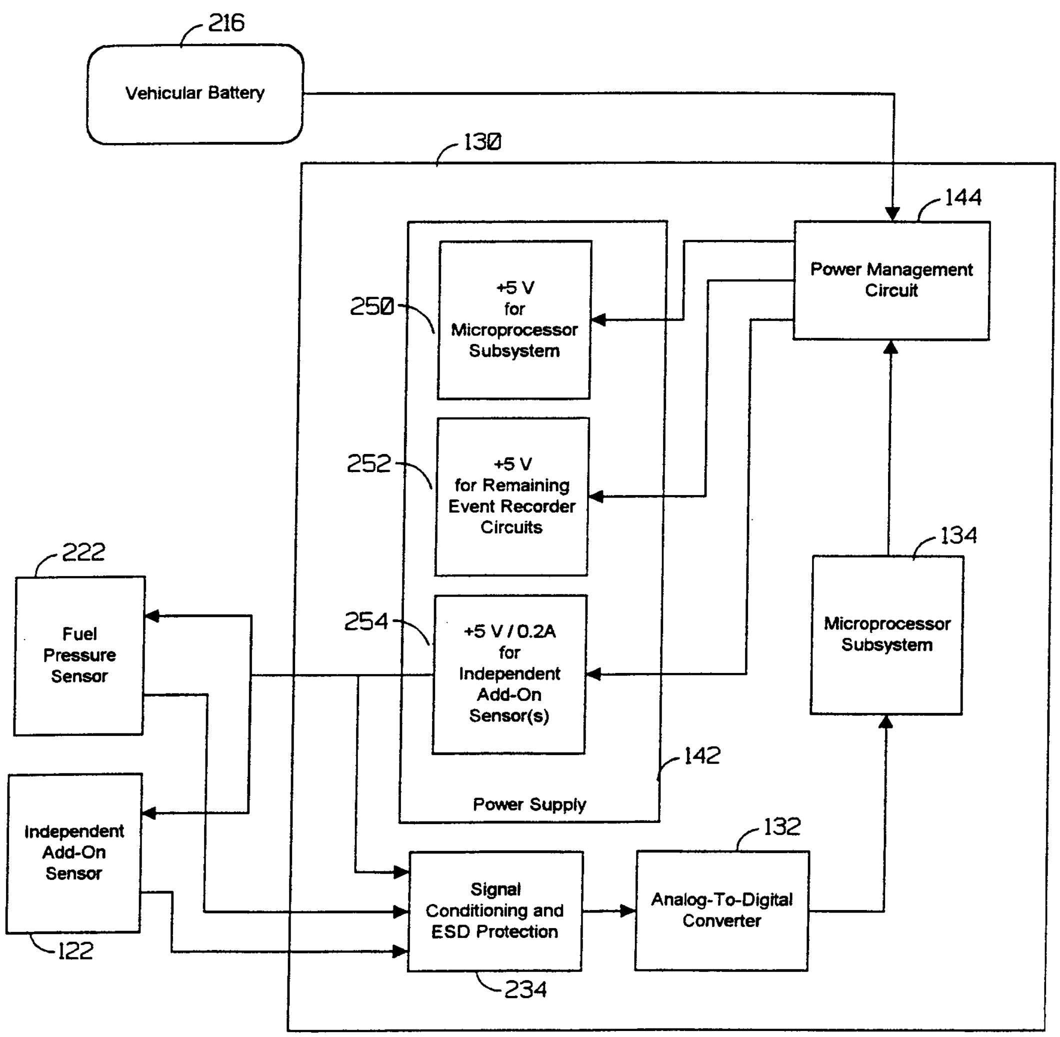

Optional AC-DC Converter
240
Power Supply
142
Data Storage Subsystem
136
High-Speed Serial or Parallel Communications Port
138
External "Off-The-Shelf" PC Utilizing Custom Software to Configure Event Recorder and to Transfer and Display Stored Events
150
Microprocessor Subsystem
134
Power Management Circuit
144
User-Trigger Input Circuit
230
User-Trigger Push-Button
242
Analog-To-Digital Converter
132
Optional Backup Battery (may be external)
238
Signal Conditioning and ESD Protection
234
Machine Power Sensing Circuit
140
Cable Decoder
236
Visual Display / Indicator Driver
246
Visual Display or Indicator(s)
248
130
Photocopier Power Source
116
Photocopier Control Computer
112
Signal Probe(s) or Feed-Through Connector(s)
120
Photocopier Sensors, Actuators, and Indicators
114
Independent Add-On Sensor
122
110
Photocopier

FIG. 3

FIG. 4


216
Vehicular Battery
130
144
Power Management Circuit
250
+5 V for Microprocessor Subsystem
252
+5 V for Remaining Event Recorder Circuits
254
+5 V / 0.2A for Independent Add-On Sensor(s)
142
Power Supply
134
Microprocessor Subsystem
222
Fuel Pressure Sensor
Independent Add-On Sensor
122
Signal Conditioning and ESD Protection
234
132
Analog-To-Digital Converter

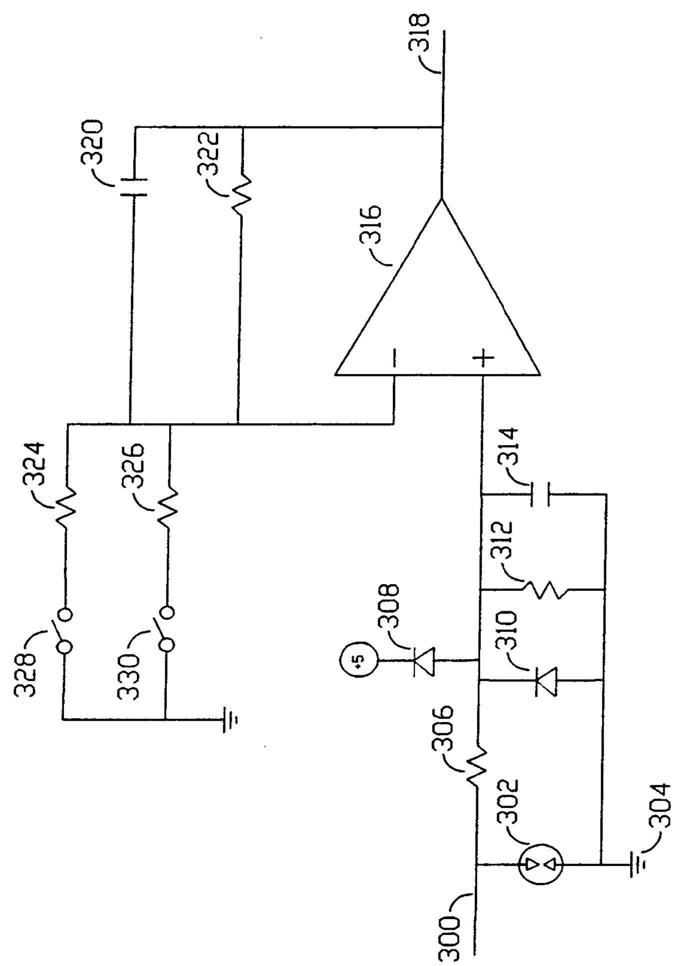


FIG. 5

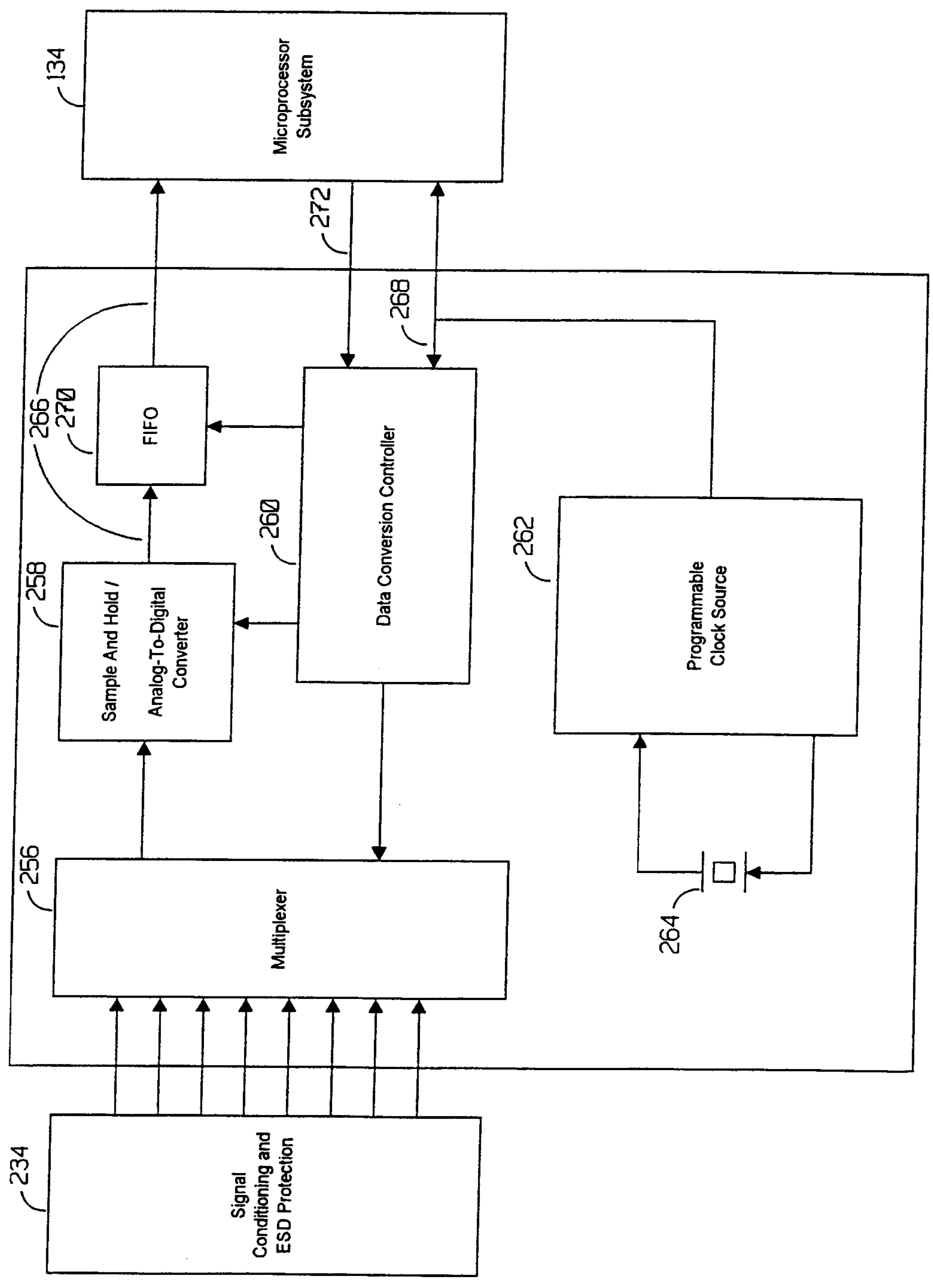

134
Microprocessor Subsystem
272
268
266
270
FIFO
Data Conversion Controller
260
258
Sample And Hold / Analog-To-Digital Converter
262
Programmable Clock Source
256
Multiplexer
264
234
Signal Conditioning and ESD Protection

FIG. 6

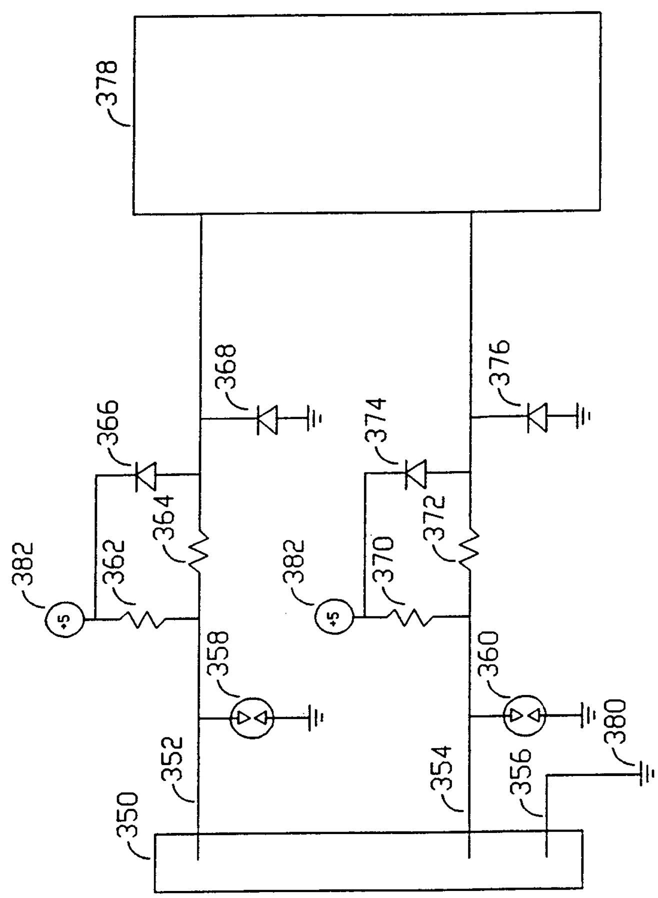

378
366
368
374
376
382
362
364
382
370
372
+5
+5
358
360
350
352
354
356
380

FIG. 7

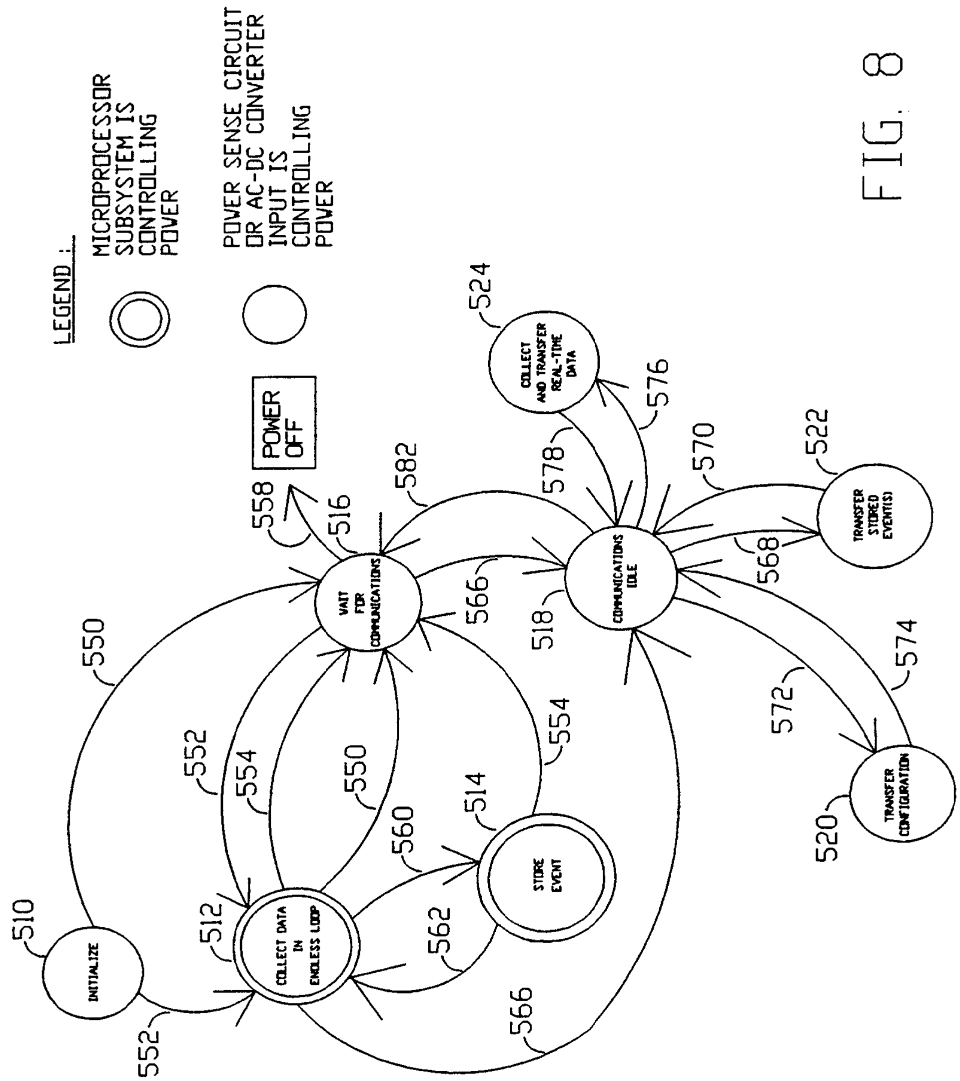

LEGEND :
MICROPROCESSOR SUBSYSTEM IS CONTROLLING POWER
POWER SENSE CIRCUIT OR AC-DC CONVERTER INPUT IS CONTROLLING POWER
POWER OFF
INITIALIZE
COLLECT DATA IN ENDLESS LOOP
STORE EVENT
WAIT FOR COMMUNICATIONS
COMMUNICATIONS IDLE
COLLECT AND TRANSFER REAL-TIME DATA
TRANSFER STORED EVENT(S)
TRANSFER CONFIGURATION
510
512
514
516
518
520
522
524
550
552
554
558
560
562
566
568
570
572
574
576
578
582

FIG. 8

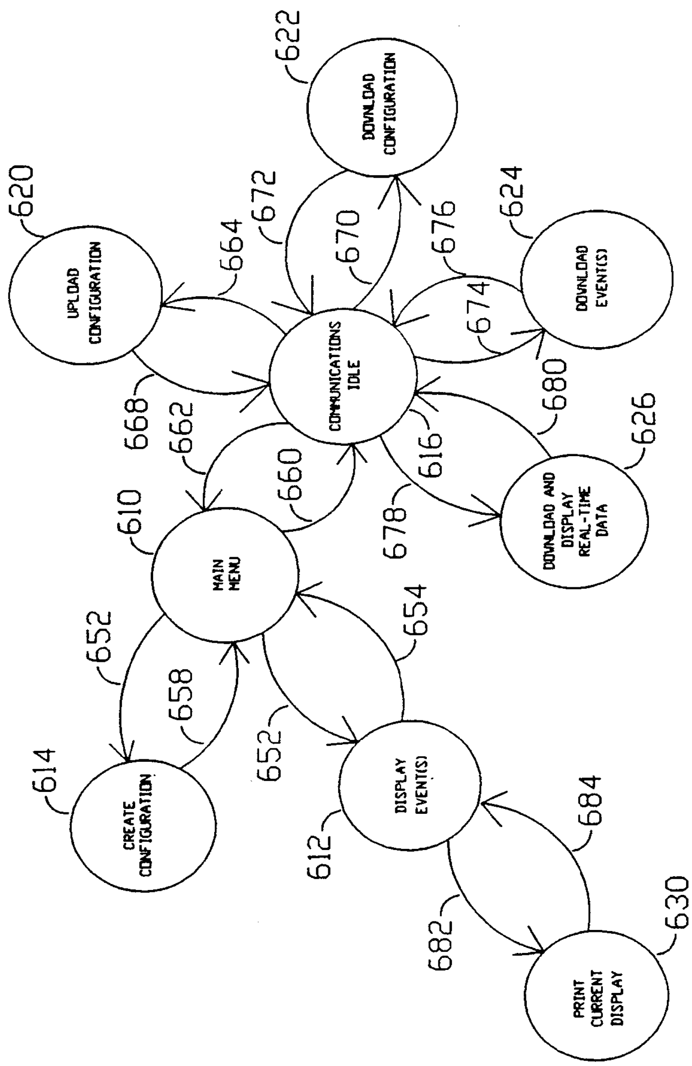

UPLOAD CONFIGURATION
620
DOWNLOAD CONFIGURATION
622
DOWNLOAD EVENT(S)
624
COMMUNICATIONS IDLE
DOWNLOAD AND DISPLAY REAL-TIME DATA
626
MAIN MENU
610
CREATE CONFIGURATION
614
DISPLAY EVENT(S)
612
PRINT CURRENT DISPLAY
630
664
672
670
676
674
668
662
660
680
616
678
652
658
654
652
684
682

FIG. 9

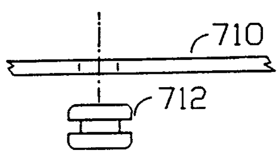


FIG. 10A

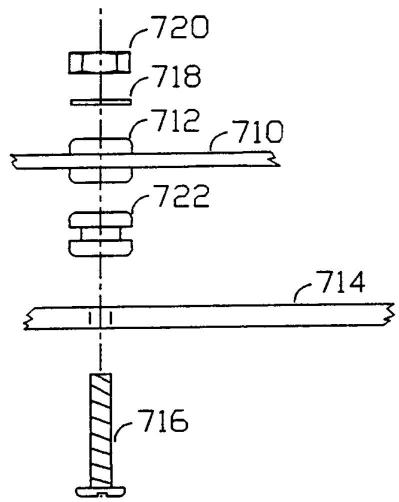


FIG. 10B

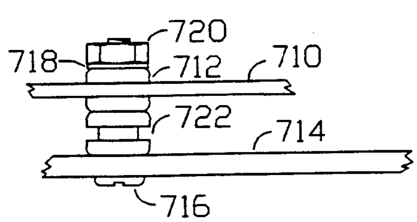


FIG. 10C

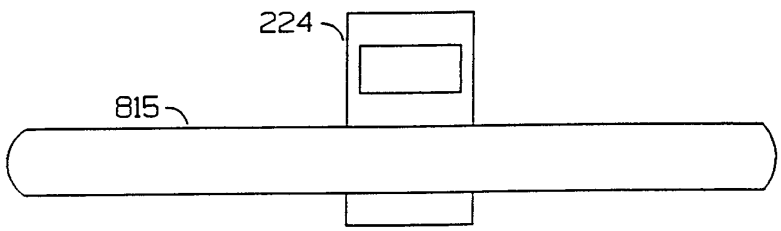


FIG. 11

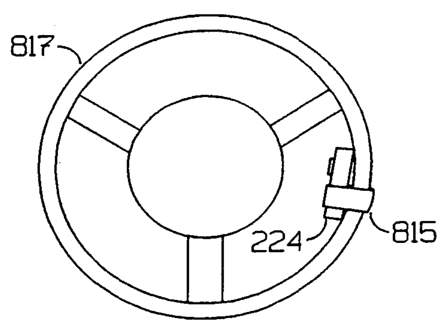


FIG. 12

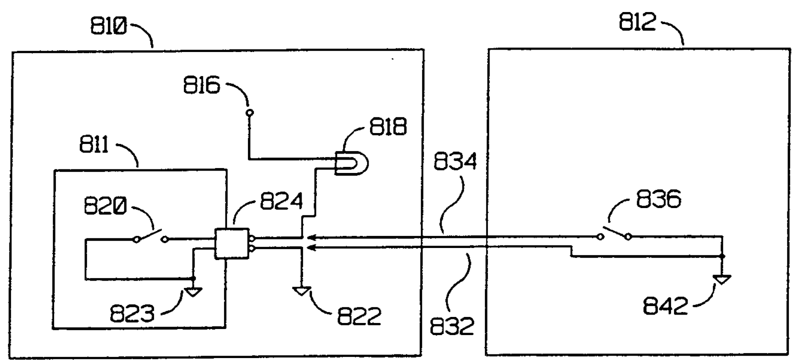

810
812
816
818
811
834
820
824
836
823
822
832
842

FIG. 13

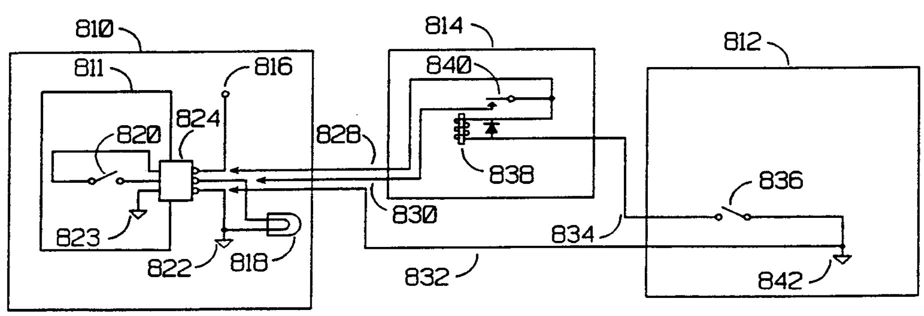

810
814
812
811
816
840
824
820
828
838
836
823
830
834
822
818
832
842

FIG. 14

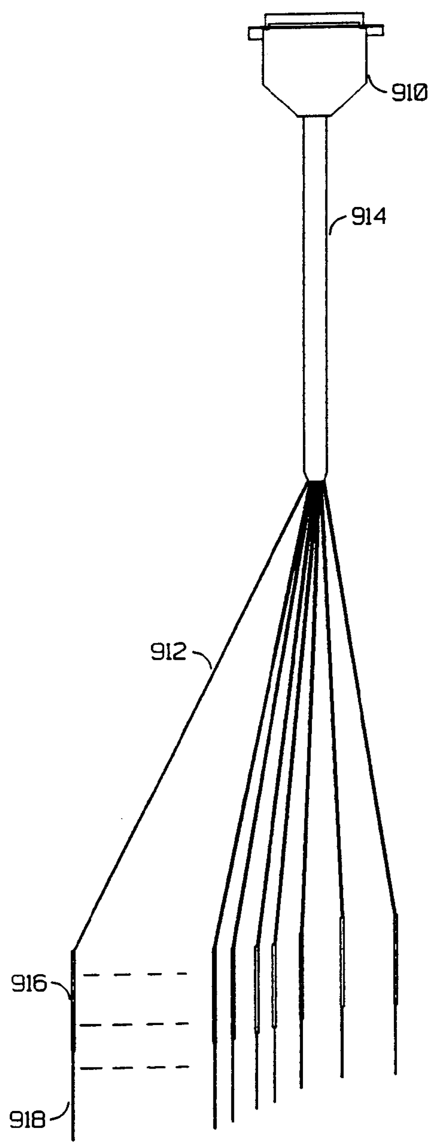


FIG. 15

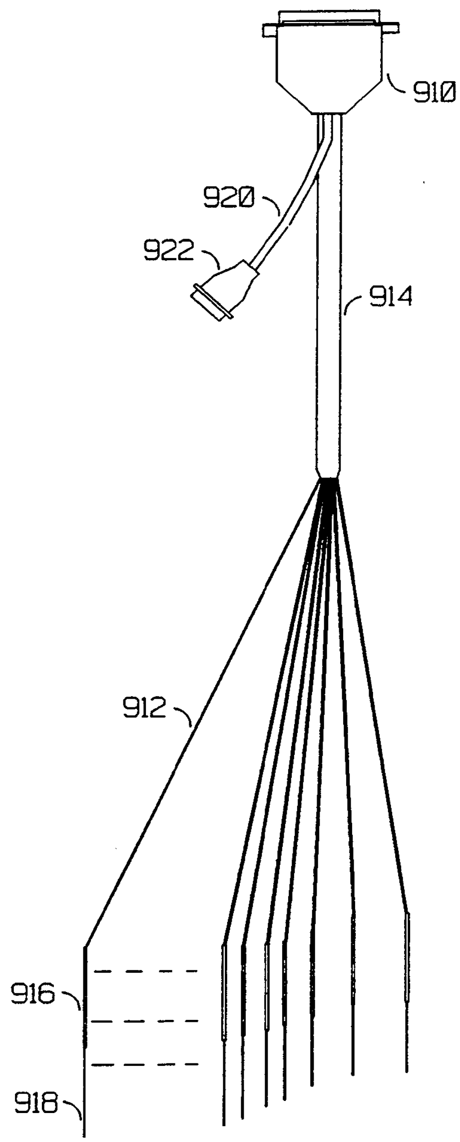


FIG. 16

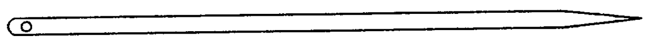


FIG. 17

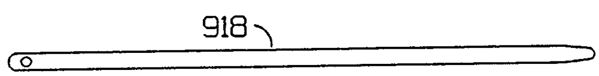


FIG. 18

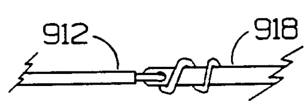


FIG. 19

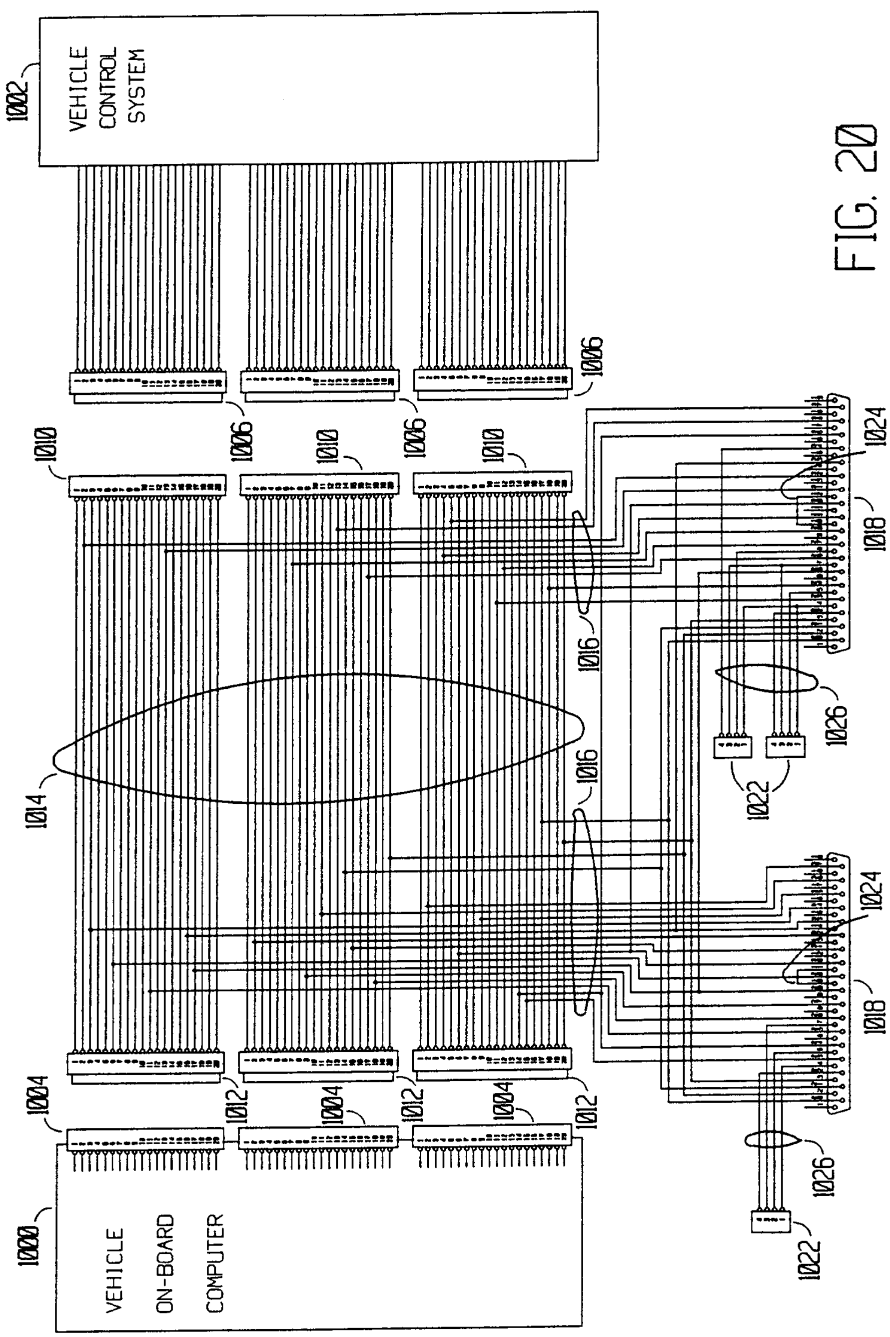

VEHICLE CONTROL SYSTEM
1002
1006
1010
1014
1016
1018
1024
1026
1022
1012
1004
1000
VEHICLE ON-BOARD COMPUTER

FIG. 20

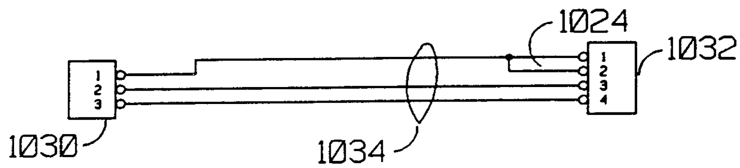


FIG. 21

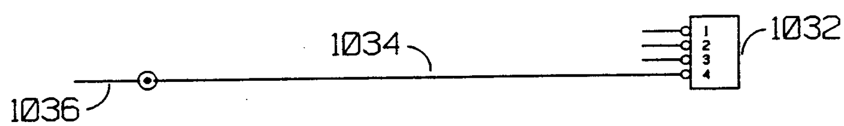


FIG. 22

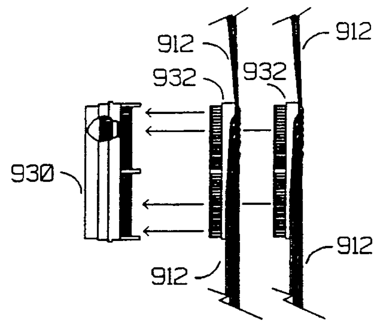


FIG. 23

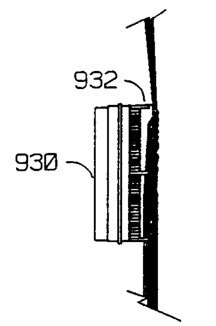


FIG. 24

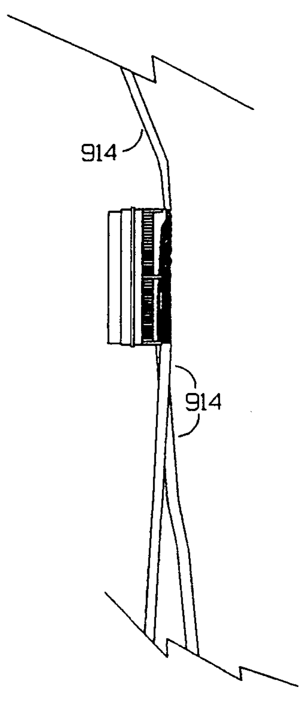


FIG. 25

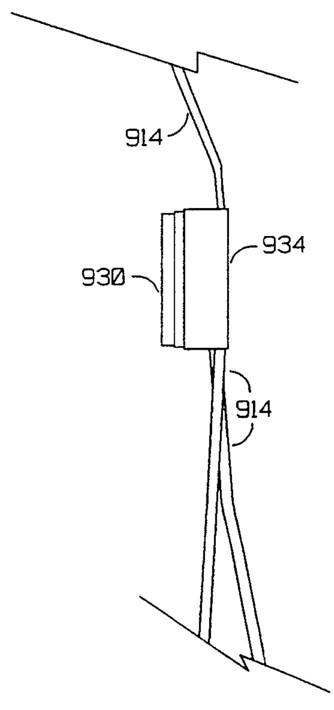


FIG. 26

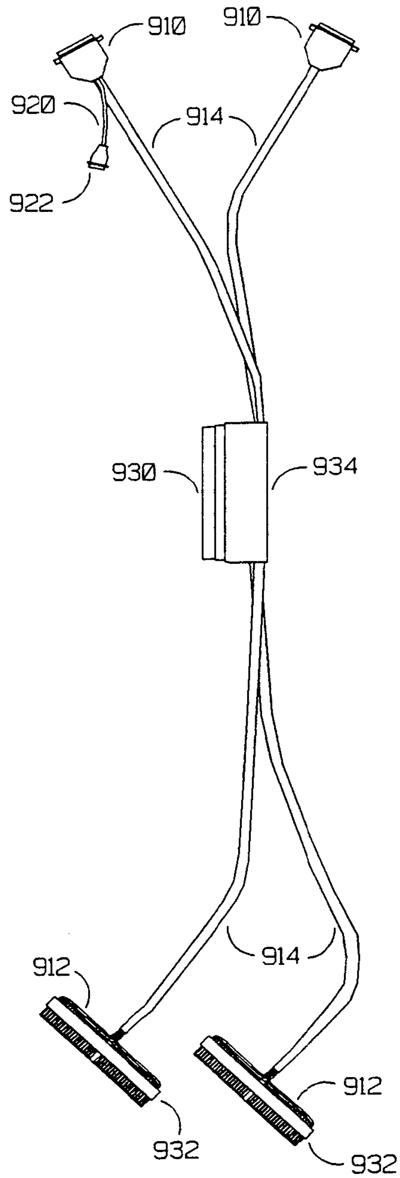


FIG. 27

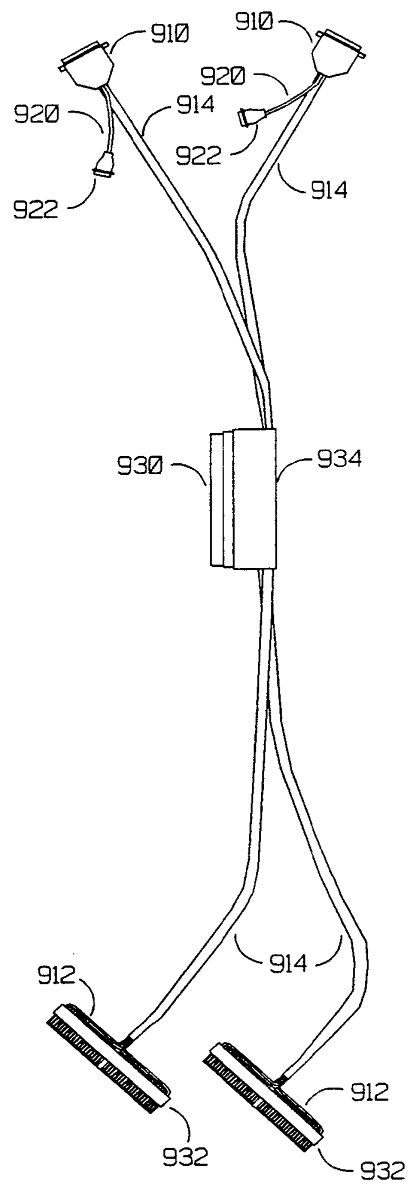


FIG. 28

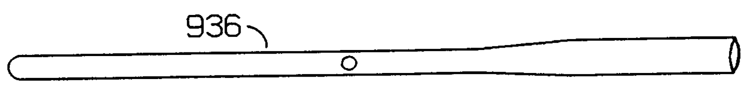


FIG. 29

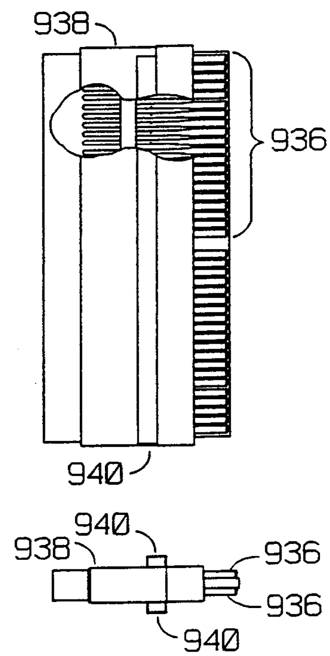


FIG. 30

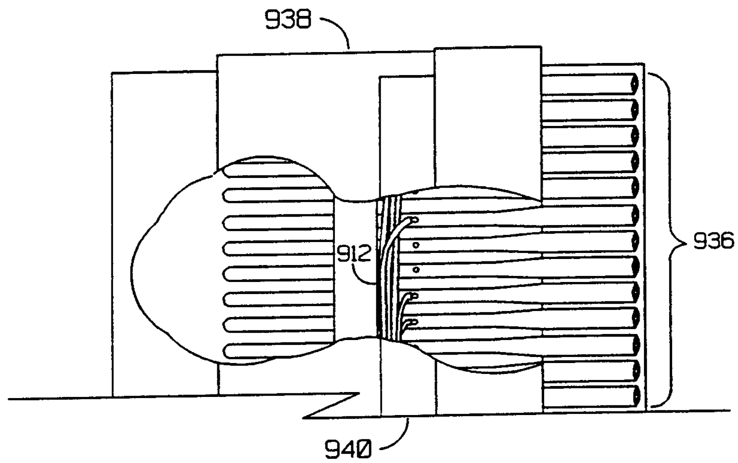


FIG. 31

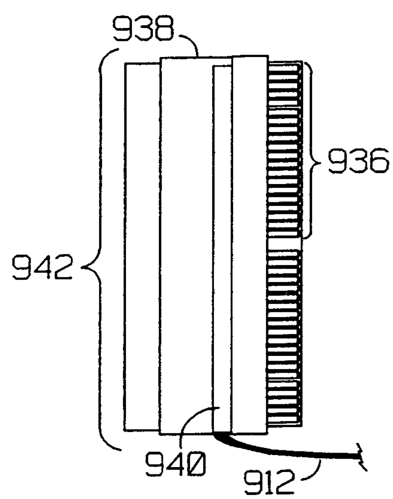


FIG. 32

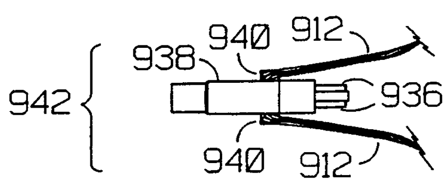


FIG. 33

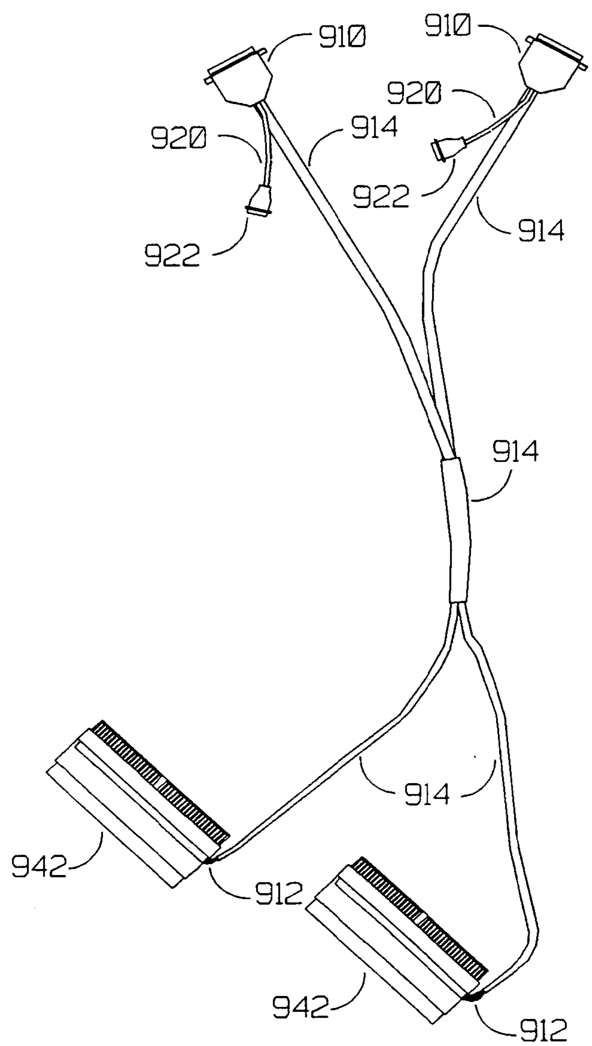


FIG. 34

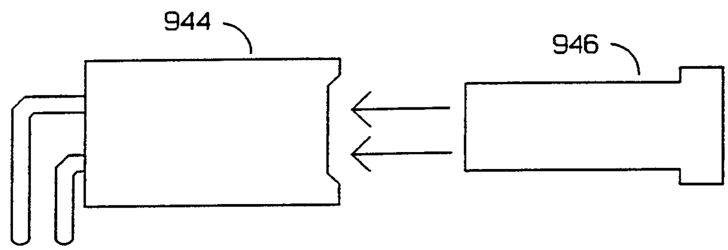


FIG. 35

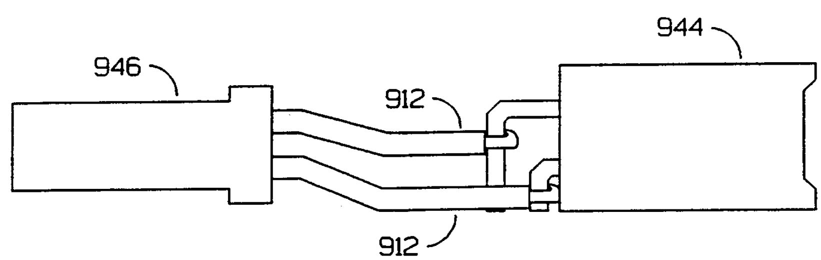


FIG. 36

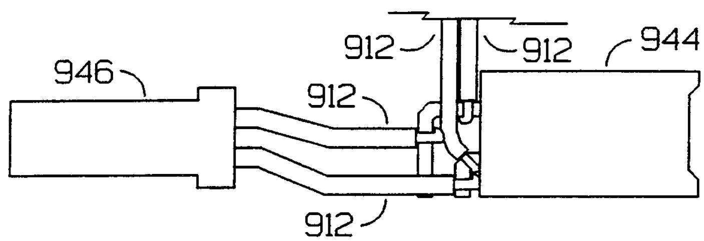


FIG. 37

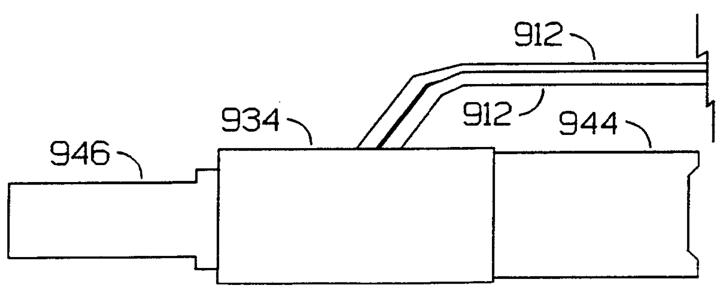


FIG. 38

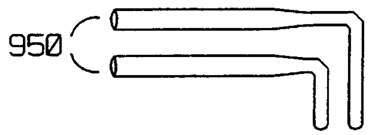


FIG. 39

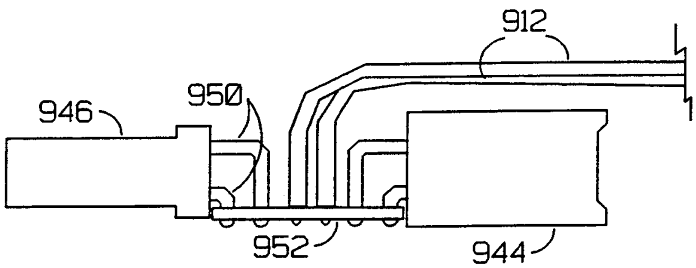


FIG. 40

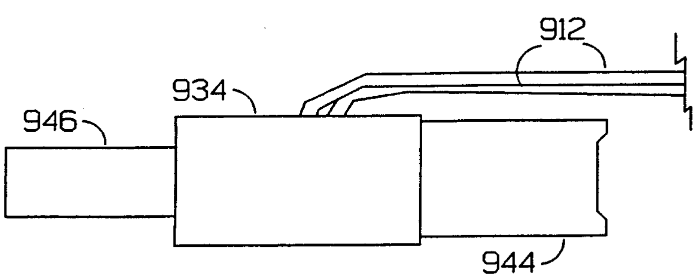


FIG. 41

CORRECTED VERSION*

CORRECTED VERSION**

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G06F 17/60 | A1

(11) International Publication Number: WO 00/17800

(43) International Publication Date: 30 March 2000 (30.03.00)

(21) International Application Number: PCT/US99/22020

(22) International Filing Date: 22 September 1999 (22.09.99)

(30) Priority Data:
09/159,058 | 23 September 1998 (23.09.98) | US

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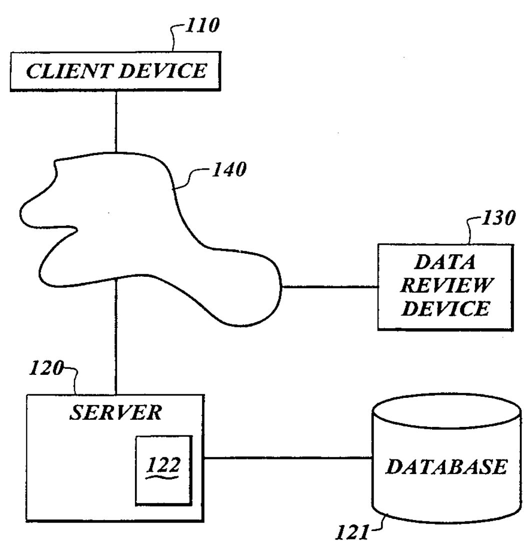
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: REDUCING RISK USING BEHAVIORAL AND FINANCIAL REWARDS



(57) Abstract

The invention provides a set of techniques and products in which one or more insured persons and one or more associated beneficiaries are monitored with regard to dynamic risk reassessment, given feedback information in response to that dynamic risk reassessment, and are encouraged to comply with the feedback. The insured persons and associated beneficiaries are coupled to a client–server system disposed for dynamic measurement of medical information, and the client–server system is disposed for alerting the insured persons and associated beneficiaries to suggested behaviors for reducing risk. The invention includes an insurance product in which portions of the insurance premium are allocated to one or more components, in response to compliance with the suggested behaviors.

*(Referred to in PCT Gazette No. 31/2000, Section II) **(Referred to in PCT Gazette No. 40/2000, Section II)

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REDUCING RISK USING BEHAVIORAL AND FINANCIAL REWARDS

Field of the Invention

These known methods increase the incentive for the insured entity to reduce the insured-against risk. However, these methods are subject to several drawbacks. Where the insured-against risk is relatively inevitable (such as with life insurance or long-term care insurance0, the insurance company finds it difficult to avoid the inevitability of a claim. Rather, it is in the underwriter's interest to stave off the claim for as long as possible.

Certain kinds of insurance (such as long-term care insurance) also have a substantial effect on the family of the insured person. For example, the insured person is often faced with the dilemma of either (1) reduction to penury to quality for government support, or (2) spending their entire estate on long-term care. The family of the insured person also has interests against these options.

Accordingly, it would be advantageous to provide a method and system to increase the incentive for the insured entity to reduce the insured-against risk, even when that insured-against risk is relatively inevitable. In the case of long-term care insurance, it is in the underwriter's interest to provide incentives for the insured person and their family to maintain the insured person's health and independence for as long as possible (quite apart from the emotional incentives they already have).

Application Serial No. __________, Express Mail Mailing No. EE 261 914 722 US, filed S September 23, 1998, in the name of Stephen J. Brown, titled "Dynamic

Modeling and Scoring Risk Assessment," assigned to the same assignee, attorney docket number HHN-003 describes techniques for modeling and scoring risk assessment that are time-dependent, and in one embodiment are responsive to progression of a disease or degenerative condition in a patient.

One aspect of this co-pending application is that the insurer can dynamically adjust the risk assessment of individual insured persons in response to action taken (or not taken) by those insured persons to maintain their own health. The underwriter can thus dynamically adjust the cost or the benefits of the insurance policy in response to those actions. By doing so, the underwriter, the insured person, and the insured person's family have the common goal of maximizing the useful life and independence of the insured person.

As described in the co-pending application, dynamic reassessment can be performed in conjunction with a monitoring and scoring system for determining risk assessment for populations and for individuals with regard to those populations.

It would also be desirable for the insured person (and associated others) to make use of dynamic risk are assessment to monitor and influence the behavior of the insured person, to reduce the risk. It would also be desirable to provide the insured person, and the insured person's family with information available to the underwriter, and to suggest particular prescribed or proscribed actions that would reduce short-term risk and provide a greater payoff for all concerned.

Accordingly, it would be advantageous to provide the insured person, and associated others, with feedback information from dynamic reassessment of the risk associated with the insured person, so that the insured person, and associated others, can act to minimize that risk. This advantage is achieved in an embodiment of the invention in which the insured person and their beneficiaries are provided with feedback information and instruction responsive to dynamic risk reassessment, and in which payments form an associated set of insurance products are allocated dependant on compliance with that feedback. For example, one such insurance product includes a long-term care component and a life insurance component, and devotes a fraction of the product premium to one or the other component in response to compliance with the feedback offered by the underwriter.

Summary of the Invention

The invention provides a set of techniques and products in which one or more insured persons and one or more associated beneficiaries are monitored with regard to dynamic risk reassessment, are given feedback information responsive to that dynamic risk reassessment, and are encouraged to comply with the feedback information. In a preferred embodiment, the insured persons and associated beneficiaries are coupled to a client-server system that is configured to obtain dynamic measurement of medical information (for example, using bio-medical devices or using a question and answer format), and the client-server system is configured to alert the insured persons and associated beneficiaries to suggested behaviors for reducing risk. The preferred embodiment includes an insurance product in which portions of the insurance premium are allocated to one or more components (such as a long-term care benefit or a life insurance benefit), in response to compliance with the suggested behaviors. Thus, the insured is provided with an incentive for compliance with the suggested behaviors for reducing risk by receiving a more beneficial allocation of the premium to the components of the insurance product.

In a preferred embodiment, an insured patient is examined at intervals by medical personnel, to determine medical information that can be used as factors for dynamically determining a risk assessment for that insured patient. The medical personnel can determine a medical regimen (possibly including diet, exercise, prescribed medication, or other factors) that are intended to reduce the insured-against risk. The insured patient, and where appropriate, associated beneficiaries or other close relations, use a client device with a client-server system to provide dynamic medical information regarding the condition of the insured. For example, the client device can periodically measure blood glucose, blood pressure, heart rate, weight, and the like. Similarly, the client device can periodically question the insured patient or the close relations for information about the insured, such as affect or mutation, diet or exercise, and the like.

In response to the prescribed medical regimen and information from the insured patient, a server device receiving that information from the client device can dynamically reassess risk factors associated with the insured patient, and can alert medical personnel or close relations in response thereto. In response to dynamic risk assessment, the server device can modify which portions of an insurance premium (or other financial product payments) are allocated to one or more components (such as a long-term care component or a life insurance component). The server device can use patient compliance with the suggested medical regimen as one measure to be factored into the dynamic risk assessment.

Brief Description of the Drawings

FIGURE 1A shows a diagram of a system for data collection and interpretation for a population;

FIGURE 1B shows details of the client device shown in **Fig. 1A**;

FIGURE 1C shows devices that may be connected to client device;

FIGURE 1D shows details of the data review device;

FIGURE 2 illustrates a data flow diagram indicating some of the data paths used in a preferred embodiment;

FIGURE 3A illustrates a process for determining dynamic risk assessment;

FIGURE 3B illustrates a process used to evaluate patient information;

FIGURE 4 illustrates a process used to respond to risk; and

FIGURE 5 illustrates a process used to determine feedback information.

Description of the Preferred Embodiments

In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. Embodiments of the invention can be implemented using general-purpose processors or special purpose processors operating under program control, or other circuits, adapted to particular process steps and data structures described herein. Other embodiments include computer program products that contain computer code embodied in a computer readable media for causing a computer to perform the process steps. Implementation of the process steps and data structures described herein would not require undue experimentation or further invention.

Related Applications

Inventions described herein can be used in combination or conjunction with inventions described in the following patent applications. These patent applications are hereby incorporated by reference as if fully set forth herein:

Application Serial No. 09/041,809, filed November 21, 1997 in the name of Stephen J. Brown titled "Phenoscope and Phenobase," assigned to the same assignee, attorney docket number RYA-136.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "Health Management Process Control System," assigned to the same assignee, attorney docket number RYA-114.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown and Erik K. Jensen, titled "On-Line Health Education and Feedback System Using Motivational Driver Profile Coding and Automated Content Fulfillment," assigned to the same assignee, attorney docket number RYA-115.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "Multiple Patient Monitoring System for Proactive Health Management," assigned to the same assignee, attorney docket number RYA-116.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "On-Line Health Education Using Composites of Entertainment and Personalized," assigned to the same assignee, attorney docket number RYA-116.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "On-Line Health Education Using Composites of Entertainment and Personalized Health Information," assigned to the same assignee, attorney docket number RYA-119a.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "Monitoring System for Remotely Querying Individuals," assigned to the same assignee, attorney docket number RYA-126.

Application Serial No. ______________, filed ______________, in the name of Stephen J. Brown titled "Multi-User Remote Health System," assigned to the same assignee, attorney docket number RYA-131a.

Application Serial No. ______________, Express Mail Mailing No. EE 261 914 722 US, filed September 23, 1998, in the name of Stephen J. Brown titled "Dynamic Modeling and Scoring Risk Assessment," assigned to the same assignee, attorney docket number HHN-003.

System for Reducing Risk

The invention enables dynamic risk determination of an insured's condition. An example of when the invention can be used is if the insured has a progressive condition, whichwill eventually require long-term care (such as diabetes), but for which in-home care is currently appropriate. Another example where dynamic risk determination can be used is if the insured is at risk for a medical setback (such as an MI or a stroke) but currently is capable of self-care. Yet another example is when the insured is currently being cared for by family, but the care burden is increasing and the insured will eventually require long-term care. The invention allows the underwriter to dynamically determine the current risk to the insured and to provide incentives to the insured to reduce that risk.

Fig. 1A shows a block diabram of a system for data collection and interpretation for a population.

Referring to **Fig. 1A**, a system 100 includes a client device **110**, a server device **120** including a database of information **121** and a program memory **122**, and a data review element **130**. These devices are connected via a communication channel **140**, such as a communication network as is well known in the art, and as more fully described in the Phenoscope and Phenobase patent application (serial no. 90/041,809).

The communication channel **140** may be a simple point-to-point network (for example a wire connecting the client device **110** with the server device **120**), or a complex network such as the Internet.

Referring to **Fig. 1B**, the client device **110** is disposed locally to a patient **111** (the insured), and includes an output element **112** for presenting information to the patient **111**, and an input element **113** for entering information from the patient **111**. As used herein, "locally" refers to a logical relationship to the patient **111**, and does not have any necessary implication with regard to actual physical position. In a preferred embodiment, the client device **110** is relatively small or compact, and can be disposed on a night table or otherwise near the patient **111**.

The output element **112** includes a display screen **114**, on which questions and suggested answers can be displayed for the patient **111**, to facilitate information entry, or on which instructions can be displayed for the patient **111**, to instruct the patient **111**. The output element **112** can also include a speaker **115**, to present information in conjunction with or in alternative to the display screen **114**. The output element **112** can also include a bell or other sound element, or a bright light **119** or a flag, to alert the patient **111** that the client device **110** has questions or information for the patient **111**.

The input element **113** includes a plurality of buttons **116A-D** for entering information.

The input element **113** can also include one or more data ports **117A-D** for entering information from other devices. Referring to **Fig. 1C**, such other devices **118** can include a medical measurement device, such as a blood glucose meter or a blood pressure monitor. Such other devices **118** can also include a general purpose or special purpose client workstation, such as a personal computer or a hand-held digital calendar.

The server device **120** is disposed logically remotely from the patient **111**, and includes a database **121** of information about the patient **111** and about other patients in a related population thereof. As used herein "remotely" refers to a logical relationship to the patient **111**, and does not have any necessary implication with regard to actual physical position.

The database **121** includes medical history, medical regimen, and risk progression information for the insured and a similarly situated population. The database **121** also includes the compliance background for the insured indicating how well the insured follows the prescribed medical regimen and avoids the proscribed activities.

The server device **120** also includes the program memory **122** that contains program code and data to cause the server device **120** to perform subsequently described processes.

In a preferred embodiment, the server **120** and database **121** are preferably accessible using a standard network connection (such as a world wide web connection). The server **120** and database **121** may include single stand-alone computers or multiple computers distributed throughout a network.

The data review element **130** is disposed logically remotely from the patient **111**, and includes an interface **131** disposed for use by an operator **132**. The operator **132** can comprise medical personnel, a device operated by medical personnel, or a similar device, capable of interacting with the interface **131** to receive information from the data review element **130** and possibly to enter information into the data review element **130**. Information entered into the data review element **130** can be entered for ultimate transmission to the server device 120 or to the client device **110**.

The date review element **130** is preferably a personal computer remote terminal, web TV unit, Palm Pilot unit, interactive voice response system, or any other communication technique. The data review element **130** functions as a remote interface for entering server **120** or client device **110** messages and queries to be communicated to the individuals. The data review element **130** also functions to provide the professional to evaluate the progression of the insured and to monitor the insured's medical regimen.

Other and further information regarding the system **100** is shown in Application Serial No. 09/041,809, titled "Phenoscope and Phenobase," attorney docket number RYA-136 and Application Serial No. ____________, titled "Dynamic Modeling and Scoring Risk Assessment," attorney docket number HHN-003.

Fig. 2 illustrates a data flow diagram, indicated by general reference character **200**, that indicates how data flows within a preferred embodiment. The nodes include an insured **201**, a client device **203**, a server device **205**, an accounting server **207**, a workstation **209**, and a professional **211**. These nodes are connected by data flows that include an 'insured-client device' data stream **221**, a client device-insured data stream **223**, a client-server data stream **225**, a server-client data stream **227**, a server-workstation data stream **229**, a workstation-server data stream **231**, a workstation-professional data stream **233**, a professional-workstation data stream **235**, a 'workstation-accounting server' data stream **237**, an 'accounting server-insured' data stream **239**, and an 'accounting server-server device' data stream **241**. Each of these data streams transfer data between the nodes connected by the data stream.

In particular the server device sends patient protocol and interrogatories to the insured by sending this information across the server-client data stream **227** to the client device **203**. The client device **203** then instructs or queries the insured **201** utilizing the client device-insured data stream **223**. The insured **201** responds to the queries, instructions, or through bio-medical input devices to the client device **203** using the 'insured-client device' data stream **221**. The client device **203** passes this acquired information to the server device **205** over the client-server data stream **225**. The server device **205** stores the information acquired from the insured **201**.

Feedback is provided to the insured **201** by sending feedback information from the server device **205** to the client device **203**. This feedback information can include additional medical regimens for the insured **201** to timely follow (for example, additional tests that are determined by the server device **205** responsive to the information just gathered from the insured).

The professional **211** uses the workstation **209** (passing data over both the workstation-professional data stream **233** and the professional-workstation data stream **235**) to access and/or modify data received by, stored on or created on the server device **205**. This data is access using the server-workstation data stream **229**. The professional **211** can also modify the medical regimen for the insured or provide other information for the insured. These modifications are sent to the server device **205** over the workstation-server data stream **231** and then to the insured using the ever-client data stream **227**, the client device **203**, and the client device-insured data stream **223**. The professional **211**, using the workstation 209 can send information (reflecting benefits to the insured) to the accounting server **207** using the 'workstation-accounting server' data stream **237**. The status of benefits can be sent directly to the insured using the 'accounting server-insured' data stream **239** (for example by using postal mail, FAX or other traditional mechanism) or the information can be sent over the 'accounting server-server device' data stream **241** to the server device **205** and on to the insured sing previously discussed paths.

The professional **211** assesses the insured-against risk using both the static data most recently collected from the insured, the progression over time of the data collected from the insured and information known to, or accessible by the professional **211**. this assessment includes the insured's compliance with the prescribed medical regimens and other environmental and behavioral factors. This assessment can also include information and recommendations provided by artificial intelligence expert systems that are accessible to the professional **211** through the workstation **209**.

Fig. 3A illustrates a dynamic risk assessment process, indicated by general reference character 300, for determining dynamic risk assessment. The dynamic risk assessment process 300 is cyclic in normal circumstances. A 'gather patient information' step 301 obtains medical information (such as bio-medical information) from the insured (using the client device 110) by using a series of questions or by using bio-medical sensors. The medical information is gathered according to a protocol provided by the server device 120. This medical information is sent to a server device that performs an 'evaluate patient information' step 303 that determines one or more risk factors for the insured as is subsequently described with respect to

Fig. 3B. Next, the dynamic risk assessment process 300 delays for an appropriate time at a delay step 305. This delay can be varied as appropriate for the insured, the insured's condition, the caregivers, and the insurance provider. The delay step 305 determines the time interval between gathering information from the insured and is appropriately set to be (for example and without limitation) some number of days, weeks or months. Eventually, the delay ends at a 'delay complete' step 307 and the dynamic risk assessment process 300 repeats at the 'gather patient information' step 301 to re-determine the insured-against risk for the insured.

The medical information gathered by the 'gather patient information' step **301** is specific to the insured's current risk and progression of the condition. For example, the insured or caregiver may be periodically instructed to check for sores on extremities if the insured is diabetic. In addition, the caregiver can provide information about affect or mentation. If the insured interacts with the client device **110**, the response time to questions can also be gathered.

The 'gather patient information' step **301** and the evaluate patient information step **303** can be repeated dependent on the data acquired from the insured by the previous iteration. Thus, if the previous iteration returned data that indicates that a subsequent test should be performed, the server device **120** can send the client device **110** a protocol to cause the client device **110** to obtain the new information from the insured, caregiver, or other person.

Fig. 2B illustrates an 'evaluate patient information' process, indicated by general reference character **320** that reassesses the risk based on the gathered information and responds to that risk. The 'evaluate patient information' process **320** is invoked by the evaluate patient information' step **303** of **Fig. 3A** and initiates at a 'start' terminal **321**. The 'evaluate patient information' process **320** continues to a 'send data to server device' procedure **323**, performed by the client device **110**, that sends the medical information gathered by the client device **110** to the server device **120**. The medical information is stored on the database **121** by a 'store data' procedure **325**.

Once the medical information is stored, a 'reassess risk' procedure **327** (as disclosed in Application Serial No. ___________, attorney docket number HHN-003) can use the medical information, a risk-assessment model and the database **121** to determine the current risk of the insured. The risk includes one or more risk factors. These risk factors are used to determine an insured-against risk.

Example risk factors include information such as "patient smokes," "patient has diabetes," "patient has diabetes and doesn't bother to check his blood sugar regularly," etc.

Once the insured-against risk has been determined, the 'evaluate patient information' process **320** continues to a 'respond to risk' procedure **329** (subsequently described with respect to **Fig. 4**). The 'respond to risk' procedure **329** determines one or more medical regimens for the insured. These medical regimens are selected to reduce the risk factors and thus to reduce the insured-against risk of the insured. The 'respond to risk' procedure **329** can also adjust the proportion of the insurance cost allocated to components of the financial product used by the insured. The 'reassess risk' procedure **327** and the 'respond to risk' procedure **329** need not be performed every time data is received by the server device **120**. These procedures can be executed independent of the following procedures.

Once the medical information is stored by the 'store data' procedure **325** the dynamic risk assessment process **300**, can also continue to a 'determine feedback information' procedure **331** that develops feedback for the insured that can include one or more medical regimens, display of bio-medical information, encouragement to follow the suggested medical regimen or follow-on protocols. The feedback information is sent back to the client device **110** by a 'send feedback information' procedure **333**. A 'resent feedback information' procedure **335** then presents the feedback information to the insured and/or the caregiver. The 'evaluate patient information' process **320** completes through an 'end' terminal **337**.

The 'determine feedback information' procedure **331** can also provide the client device **110** with additional data gathering protocols that are dependent on the just-gathered information -- to obtain additional information. In addition, the 'determine feedback information' procedure **331** checks to determine whether the just gathered information is out-to-limit, indicates a trend, or should be forwarded to a medical professional.

Other preferred embodiments can allocate these processes between the client device **110** and the server device **120** in a different manner. For example as the relative cost/performance ratio changes for the client device **110** and the server device **120**, more of these procedures can be moved to the client device **110**.

Fig. 4 illustrates a 'respond to risk' process, indicated by general reference character **400**, that is configured to adjust the cost of the financial product between the components of the financial product for the insured. The 'respond to risk' process **400** is invoked by the 'respond to risk' procedure **329** and initiates at a 'start' terminal **401**. The 'respond to risk' process **400** then continues to a 'risk change' decision procedure **403** that determines whether the current insured-against risk has sufficiently changed from the existing insured-against risk retrieved from the database **121**. If the insured-against risk has not sufficiently changed, the 'responded to risk' process **400** completes through an 'end' terminal **405**. Otherwise, the 'respond to risk' process **400** continues to an 'allocate benefits' procedure **407** that reallocates the cost to the insured between the components of the financial product to correspond to the new insured-against risk. Where the insured-against risk is reduced, the new allocation rewards the insured. However, if the insured-against risk has increased, the insured is penalized. Next, an 'inform' procedure **409** generates information that will be provided to the insured and/or the caregiver either using postal mail or as information provided to the insured by the 'present feedback information' procedure **335**. This procedure also provides the new allocations to an accounting database and/or the payout system for the financial product. Next, the 'respond to risk' process **400** completes through the 'end' terminal **405**.

In a financial product that has at least two components (such as a long-term car component and a life insurance component) the 'allocate benefits' procedure **407** determines a cost for the long-term car component and allocates a first payment to that component of the financial product. The 'allocate benefits' procedure **407** then allocates a second payment to the life insurance component of the financial product, to any annuity, or to another benefit for the insured (such as a refund). The second payment is a function of the first payment. T his payment allocation is structured to provide an incentive to the insured to conform to the currently suggested medical regimen.

Fig. 5 illustrates a 'determine feedback information' process, indicated by general reference character **500**, used to assemble the feedback information. The "determine feedback information' process **500** is invoked by the 'determine feedback information' procedure **331** and initiates at a 'start' terminal **501**. A 'correlate regimen with risk factors' procedure **503** uses the risk factors determined by the 'reassess risk' procedure **327** to select one or m ore medical regimens that can be provided to the insured. An 'evaluate regimen history' procedure **505** then uses the history of medical regimens suggested to the insured and stored on the database **121**

to determine the preferred selection of medical regimens. Then a 'modify regimen' procedure **507** modifies the existing medical regimen if the existing medical regimen is different from the preferred medical regimen. The 'modify regimen' procedure **507** may change the data collection protocol used by the client device **110**. These procedures **503, 505,** and **507** are all dynamic in that they use historical information collected from the insured and are responsive to the progressive nature of the information collected about the insured. This is particularly important for those having a progressive condition or degenerative disease (for example, diabetes, and CHD).

Next, a 'select feedback language' procedure **509** selects the language used to present the feedback information to the insured. Often, the selected language is a natural language such as English. However, the 'select feedback language' procedure **509** can also control how much technical jargon is to be included. Thus, the language can be customized for the educational and experience level of the insured and/or the caregiver. A 'prepare feedback information' procedure **511** assembles the feedback information including the suggested medical regimens coded for the language of the insured. The 'determine feedback information' process **500** completes through an 'end' terminal **513**.

The 'correlate regimen with risk factors' procedure **503** evaluates the risk factors, the insured's progression and the information gathered from the insured to identify medical regimens best suited to gather additional information from the insured or to help the insured to reduce the insured-against risk. One embodiment of the invention uses Bayesian statistical techniques to perform this correlation.

Alternative Embodiments

Although preferred embodiments are disclosed herein, many variations are possible which remain within the concept, scope, and spirit of the invention, and these variations would become clear to those skilled in the art after perusal of this application.

Claims

What is claimed is:

1. A method including steps of:

Dynamically determining an insured-against risk associated with an insured;

Providing feedback information to said insured responsive to said insured-against risk; and

Providing an incentive to said insured to reduce said insured-against risk.

2. The computer controlled method of claim 1 wherein the step of providing an incentive further includes steps of:

Dynamically determining a cost for a first component of a financial product responsive to said insured-against risk;

Allocating a first payment to said first component in response to said cost; and

Allocating a second payment, responsive to said first payment, to a second component of said financial product.

Whereby said first component and second component have different values to said insured.

3. The computer controlled method of claim 1 wherein the step of dynamically determining further includes steps of:

Determining one or more risk factors associated with said insured at a plurity of times; and

Re-determining said insured-against risk associated with said insured responsive to the step of determining one or more risk factors.

4. The computer controlled method of claim 3 wherein the step of determining one or more risk factors further includes steps of:

Gathering, at a client device, medical information of said insured at a said plurality of times;

Sending said medical information from said client device to a server device remote from said insured; and

Comparing, at said server device, said medical information with a risk assessment model.

5. The computer controlled method of claim 3 wherein the step of providing feedback information further includes steps of:

Associating, at said server device, a medical regimen with at least one of said one or more risk factors;

Sending said medical regimen from said server device to said client device; and

Presenting said medical regimen at said client device.

6. An apparatus including:

A client-server system having a client device and having a server device that is logically remote from an insured;

Wherein said client device is configured for collecting medical information regarding said insured and for sending said medical information to said service device;

Wherein said server device is configured to dynamically assess a risk value associated with said insured in response to said medical information, and to allocate an incentive responsive to said risk value;

Whereby said incentive is responsive to said medical information regarding said insured.

7. A financial product including:

A first component having a cost responsive to a dynamic assessment of risk associated with an insured, said first component having a first benefit associated with said insured; and

A second component having a second benefit associated with said insured, said second benefit responsive to said cost;

Whereby changes in said dynamic assessment of risk determine a relative allocation of said first benefit and said second benefit.

8. The financial product of claim 7 wherein the first component includes long-term care policy having a long-term care benefit.

9. The financial product of claim 7 wherein the second component includes a life insurance policy having a life insurance benefit.

10. A method including:

Providing a financial product that includes a first component and a second component, said first component having a cost responsive to a dynamic assessment of risk associated with an insured, said first component having a first benefit associated with said insured, said second component having a second benefit associated with said insured, said second benefit responsive to said cost;

Obtaining medical information about said insured;

Determining said dynamic assessment of risk using said information; and changing said first benefit and said second benefit responsive to said dynamic assessment of risk.

11. The method of claim 10 wherein the first component includes a long-term care policy having a long-term care benefit.

12. The method of claim 10 wherein the second component includes a life insurance policy having a life insurance benefit.

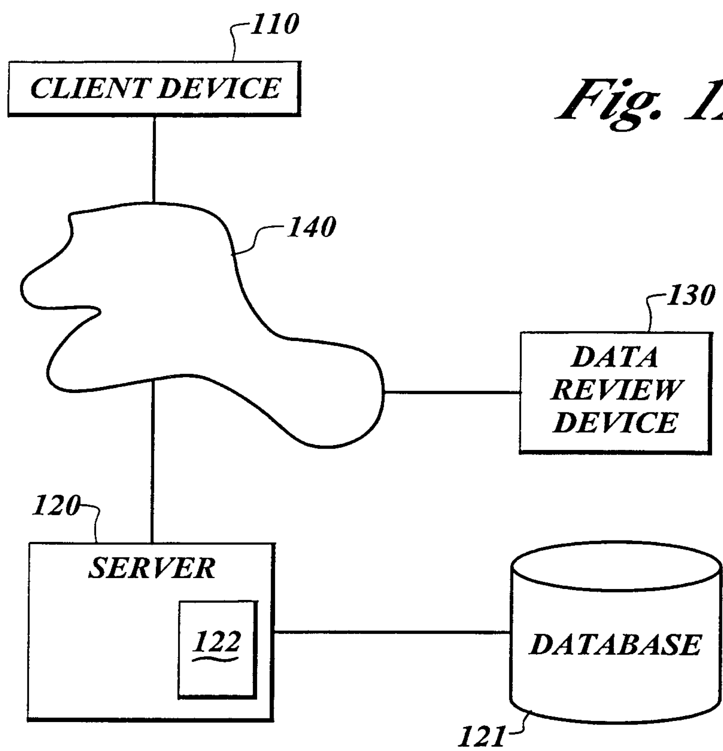

Fig. 1A

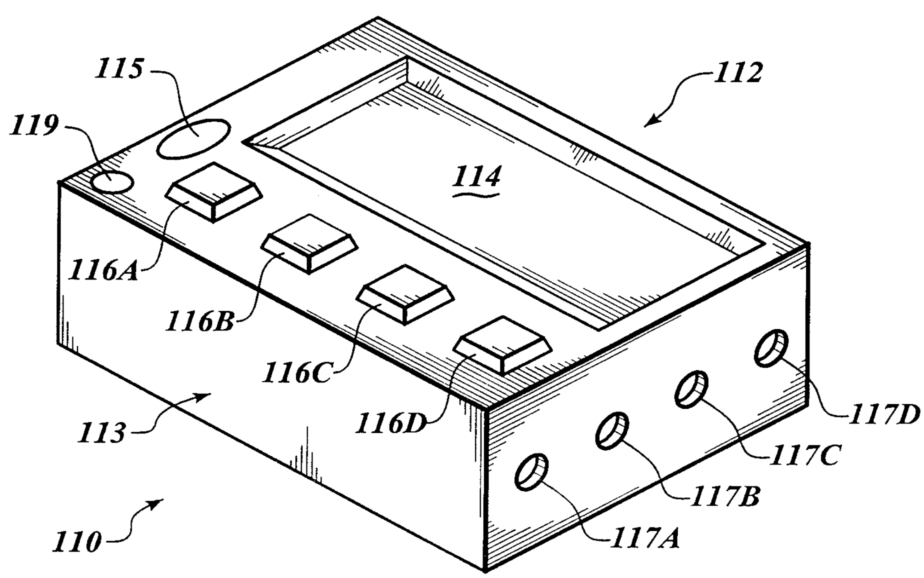

Fig. 1B

SUBSTITUTE SHEET (RULE 26)

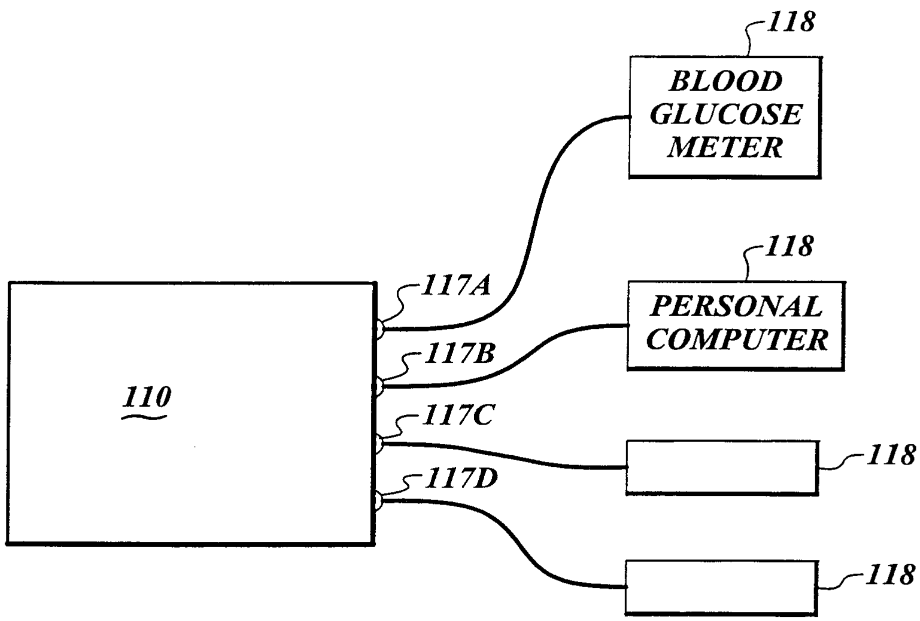
118
BLOOD GLUCOSE METER
118
PERSONAL COMPUTER
117A
117B
110
117C
118
117D
118

Fig. 1C

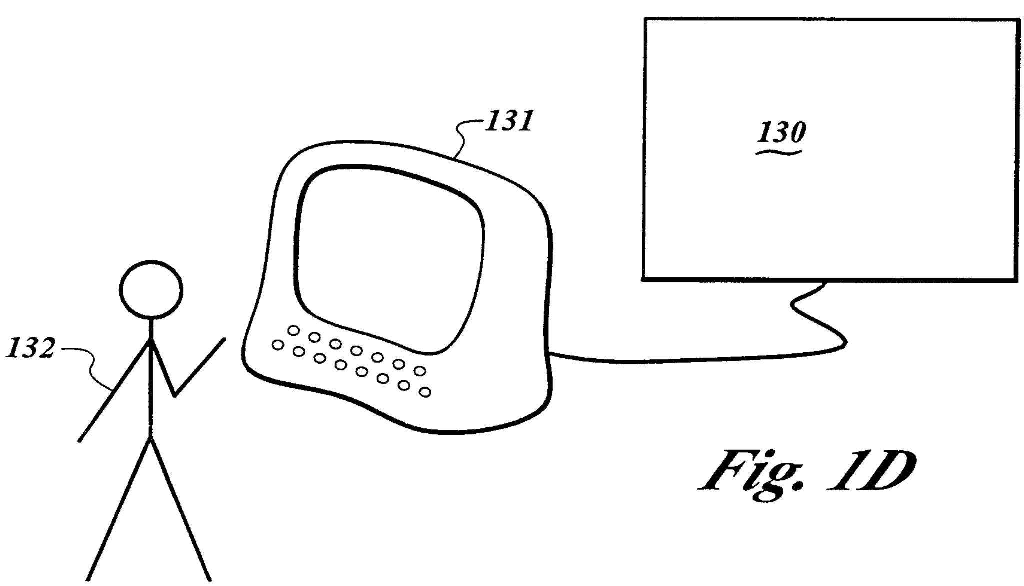
131
130
132

Fig. 1D

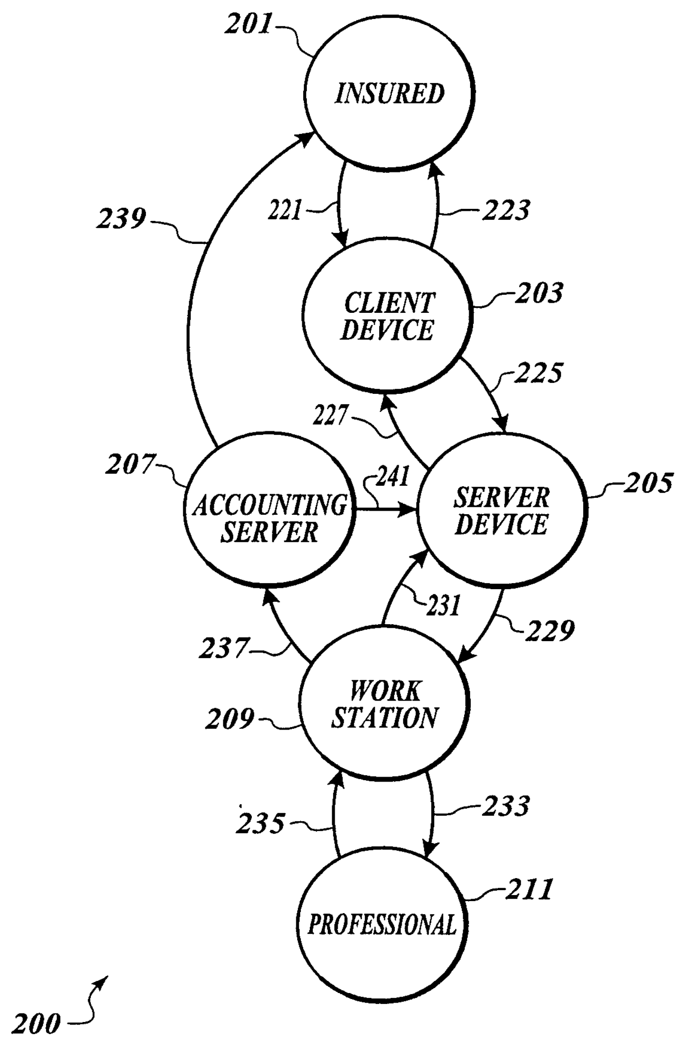
201
INSURED
221
223
239
CLIENT DEVICE
203
225
227
207
241
ACCOUNTING SERVER
SERVER DEVICE
205
231
229
237
WORK STATION
209
235
233
PROFESSIONAL
211
200

Fig. 2

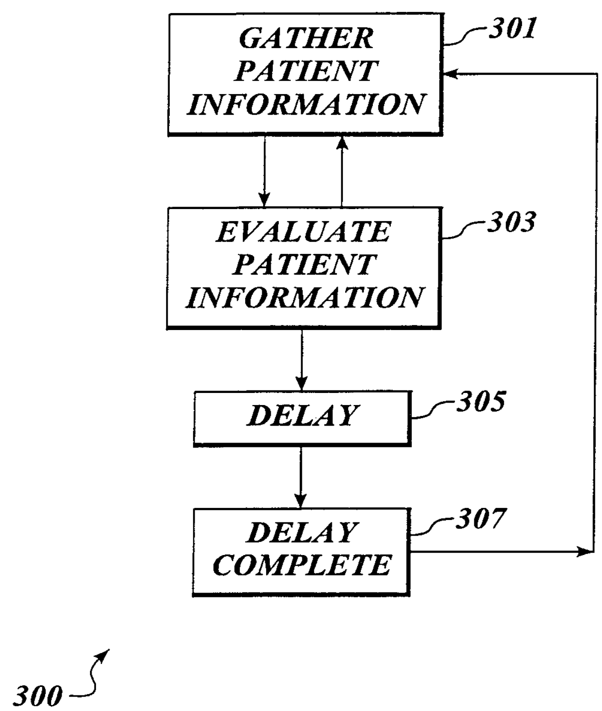
GATHER PATIENT INFORMATION
301
EVALUATE PATIENT INFORMATION
303
DELAY
305
DELAY COMPLETE
307
300

Fig. 3A

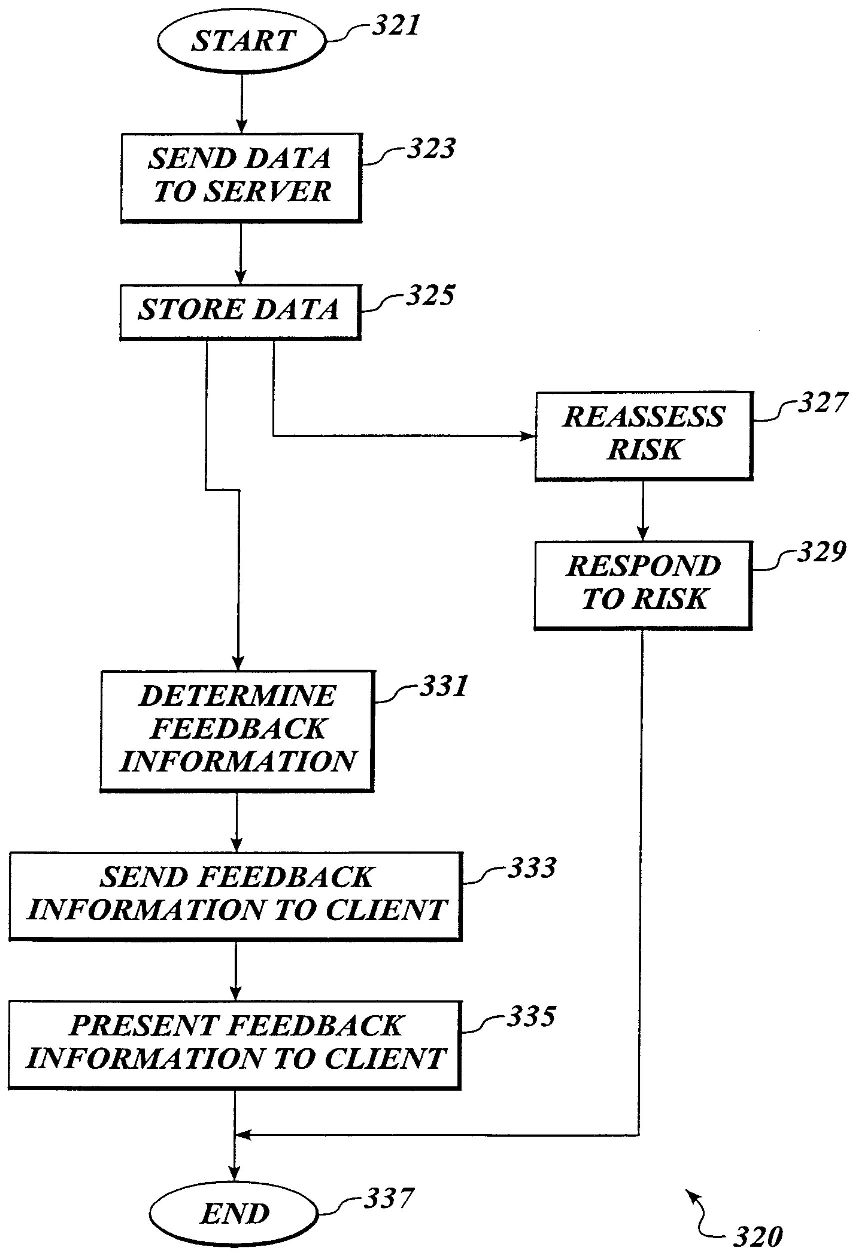
START
321
SEND DATA TO SERVER
323
STORE DATA
325
REASSESS RISK
327
RESPOND TO RISK
329
DETERMINE FEEDBACK INFORMATION
331
SEND FEEDBACK INFORMATION TO CLIENT
333
PRESENT FEEDBACK INFORMATION TO CLIENT
335
END
337
320

Fig. 3B

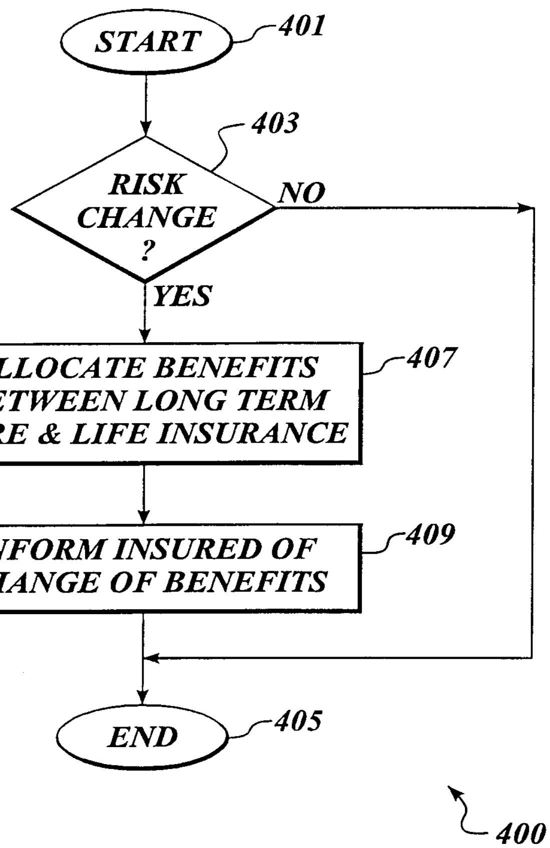
START
401
403
RISK
CHANGE
?
NO
YES
ALLOCATE BENEFITS
BETWEEN LONG TERM
CARE & LIFE INSURANCE
407
INFORM INSURED OF
CHANGE OF BENEFITS
409
END
405
400

Fig. 4

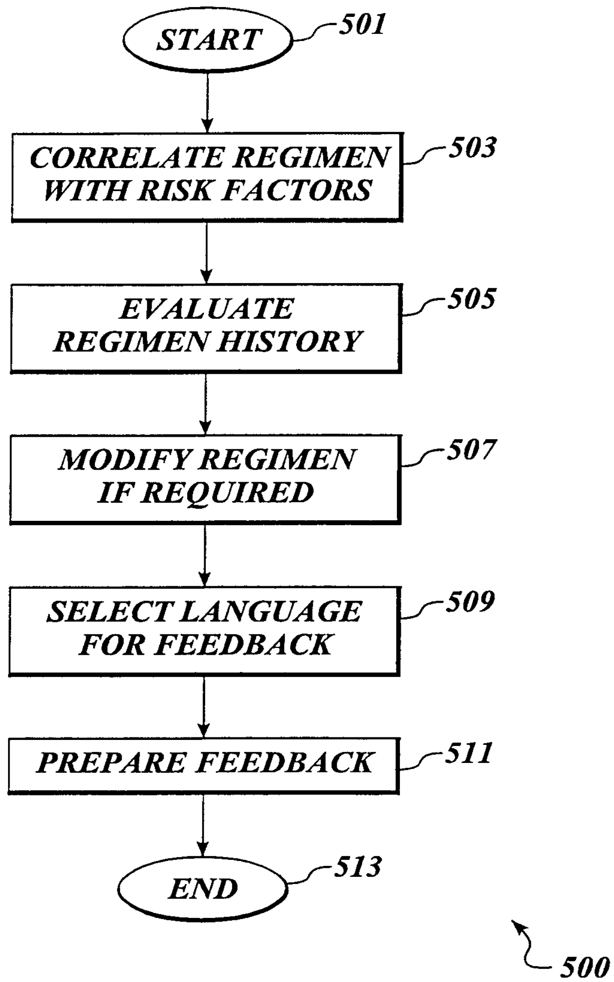
START
501
CORRELATE REGIMEN WITH RISK FACTORS
503
EVALUATE REGIMEN HISTORY
505
MODIFY REGIMEN IF REQUIRED
507
SELECT LANGUAGE FOR FEEDBACK
509
PREPARE FEEDBACK
511
END
513
500

Fig. 5

INTERNATIONAL SEARCH REPORT

Inte onal Applica. No
PCT/US 99/22020

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F17/60

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BAEHRING T U ET AL: "Using the World Wide Web--a new approach to risk identification of diabetes mellitus" INTERNATIONAL JOURNAL OF MEDICAL INFORMATICS,IR,ELSEVIER SCIENTIFIC PUBLISHERS, SHANNON, vol. 46, no. 1, 1 August 1997 (1997-08-01), pages 31-39, XP004085528 ISSN: 1386-5056	1,3-6
Y	page 34, column 2, line 1 -page 35, column 1, line 12 ---	2
Y	US 5 752 236 A (SEXTON FRANK M ET AL) 12 May 1998 (1998-05-12) column 4, line 18 -column 6, line 19 ---	2,7-12
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 February 2000	25/02/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Pedersen, N

1

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INTERNATIONAL SEARCH REPORT

Inte onal Applic. No
PCT/US 99/22020

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 700 009 A (MINGUIJON PEREZ SALVADOR) 6 March 1996 (1996-03-06) column 1, line 55 -column 2, line 54	7-12
X	PALFREY T R ET AL: "Repeated insurance contracts and learning" RAND JOURNAL OF ECONOMICS, AUTUMN 1985, USA, vol. 16, no. 3, pages 356-367, XP000878736 ISSN: 0741-6261 page 356, line 17 -page 357, line 6	1,3
A	CLEMONS E K ET AL: "Information technology and information asymmetry: the future of private individual health insurance" PROCEEDINGS OF THE THIRTIETH HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES (CAT. NO.97TB100234), PROCEEDINGS OF THE THIRTIETH HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES, WAILEA, HI, USA, 7-10 JAN. 1997, pages 240-248 vol.3, XP002130528 1997, Los Alamitos, CA, USA, IEEE Comput. Soc. Press, USA ISBN: 0-8186-7743-0 page 240, column 2, line 40 -page 241, column 1, line 27 page 242, column 1, line 9 - line 27	1-12
A	GB 2 231 420 A (AGENCY MANAGEMENT SERVICES INC) 14 November 1990 (1990-11-14) page 8, line 18 -page 9, line 5	1-12

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte   onal Applica   No
PCT/US 99/22020

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5752236	A	12-05-1998	NONE	
EP 0700009	A	06-03-1996	ES 2108613 A	16-12-1997
GB 2231420	A	14-11-1990	NONE	

Form PCT/ISA/210 (patent family annex) (July 1992)

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 March 2001 (15.03.2001)

PCT

(10) International Publication Number
WO 01/18491 A1

(51) International Patent Classification⁷: G01C 22/00

(21) International Application Number: PCT/KR00/01007

(22) International Filing Date: 4 September 2000 (04.09.2000)

(25) Filing Language: Korean

(26) Publication Language: English

(30) Priority Data:
1999/37396 3 September 1999 (03.09.1999) KR

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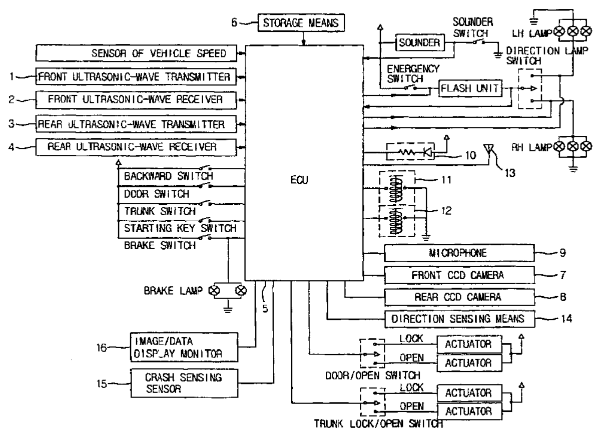
(81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELECTRONIC CONTROL APPARATUS FOR VEHICLE



(57) Abstract: There is disclosed an electronic control apparatus for a vehicle which can provide data necessary to clear up the cause of the accident and to find out who is responsible for the accident, by which a warning is automatically given and images and sound around the vehicle are recorded in real-time by an electronic control, when prevention of traffic and burglar accidents are required. For this, the electronic control apparatus for a vehicle according to the present is characterized in that it comprises front/rear signal transmitters/receivers for transmitting/receiving given signals to measure the speed of front/rear vehicles and the distance between his/her own vehicle and the front/rear vehicles, an image pick-up means for picking up images of the front/rear vehicles or the visual field within his/her own vehicle, a microphone for collecting sound around his/her own vehicle, an electronic control unit connected to control the front/rear signal transmitters/receivers, the image pick-up means and the microphone, respectively, and a storage means for storing respective information calculated under the control of the electronic control unit.

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ELECTRONIC CONTROL APPARATUS FOR VEHICLE

TECHNICAL FIELD

The invention relates generally to an electronic control apparatus for a vehicle capable of preventing a traffic accident and a burglar accident. More particularly, the present invention relates to an electronic control apparatus for a vehicle which can provide data necessary to clear up the cause of the accident and to find out who is responsible for the accident, in a way that an electronic control unit mounted on the vehicle automatically gives a warning and records in real-time images and sound around the vehicle, when prevention of the traffic and burglar accident is required.

BACKGROUND OF THE INVENTION

A conventional unit for preventing a vehicle burglar can give a warning against intrusion of the vehicle. However, when the owner of the vehicle is at a long distance, there is a problem that the owner does not know instantly the intrusion when it occurred.

Also, the vehicle's traveling recording apparatus for recording the traveling of the vehicle can record only the operational state data on his/her own vehicle's internal system traveling state data on depending on the record of the vehicle. Thus, when an unexpected accident occurred, it is impossible to know the situation of other vehicles and the surrounding road situation.

Accordingly, only with his/her own vehicle's record, it is insufficient to prevent an unexpected accident and to find out who is responsible for the accident. Further, the misjudgment on who is responsible for the accident will cause not only an unfair economic damage but also the loss of manpower.

SUMMARY OF THE INVENTION

The present invention is to solve the problems of the above conventional vehicle burglar prevention apparatus and the vehicle traveling recording apparatus. The purpose of the present invention is to provide an electronic control apparatus for preventing a traffic accident and a burglar accident, capable of performing the functions of measuring the speed and distance of front/rear vehicle, monitoring rear objects, recording images and sound of the front/rear visual field and preventing a burglar accident.

In order to accomplish the above object, an electronic control apparatus for a vehicle according to the present invention is characterized in that it comprises front/rear signal transmitters/receivers for transmitting/receiving given signals to measure the speed of front/rear vehicles and the distance between his/her own vehicle and the front/rear vehicles, an image pick-up means for picking up images of the front/rear vehicles or the visual field within his/her own vehicle, a microphone for collecting sound around his/her own vehicle, an electronic control unit (ECU) connected to control the front/rear signal transmitters/receivers, the image pick-up means and said microphone, respectively, and a storage means for storing respective information calculated under the control of the electronic control unit.

Preferably, the electronic control apparatus for the vehicle according to the present invention further includes a direction sensing means for sensing in real-time the direction where the vehicle is located, wherein the direction sensing means is controlled by the electronic control unit and the direction information calculated by the electronic control unit is recorded on the storage means.

More preferably, the electronic control apparatus for the vehicle according to the present invention further includes an image/sound recording reset switch for resetting the image and sound information recorded on the storage means.

Further, the electronic control apparatus for the vehicle according to the present invention further includes a burglar alarm means for preventing a burglar accident.

Preferably, the burglar alarm means includes a lamp or a sounder for alarming the intrusion by foreigners, and a burglar alarm function reset switch for resetting a burglar alarm function.

More preferably, the burglar alarm means further includes a burglar-alarm transmit antenna for transmitting, by wireless, the signal alarming the intrusion by the foreigners to the driver located at a long distance.

Also, the signals of the front/rear signal transmitters/receiver are ultrasonic waves more than 20,000 Hz.

Especially, the storage means is attachable from the electronic control unit, and the storage means may be a HDD (Hard Disk Driver).

Preferably, the storage means is compatible with PCs, and the information recorded on the storage means can be reproduced at the PC.

More preferably, the electronic control apparatus for the vehicle according to the present invention further includes a vehicle speed sensor, a backward switch, a door switch, a trunk switch, a start key switch, a brake switch, a sounder switch, a door lock/open switch, a trunk lock/open switch, a direction indicating light switch, a stop light, LH/RH lamps, sounders and flash units.

Also, the electronic control apparatus for the vehicle according to the present invention may further include a crash sensor for sensing a crash, and an image/data display monitor for displaying images picked up by the image puck-up means.

BRIEF DESCRIPTION OF THE DRAWINGS

The aforementioned aspects and other features of the present invention will be explained in the following description, taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a block diagram of an electronic control apparatus for a vehicle according to a preferred embodiment of the present invention; and

Fig. 2 shows the locations where the components are mounted on a vehicle according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be described in detail by way of a preferred embodiment with reference to accompanying drawings, in which like reference numerals are used to identify the same or similar parts.

Referring now to Fig. 1, there is shown a block diagram of an electronic control apparatus for a vehicle according to a preferred embodiment of the present invention.

The electronic control apparatus includes front/rear ultrasonic-wave transmitters 1 and 3 for transmitting ultrasonic waves to measure the speed of the front/rear vehicle and the distance between his/her own vehicle and the front/rear vehicle; front/rear ultrasonic-wave receivers 2 and 4 for receiving the ultrasonic waves transmitted by the front/rear ultrasonic-wave transmitters 1 and 3; image pick-up means 7 and 8 for picking up images of the front/rear vehicle or the visual field within his/her own vehicle; a microphone 9 for collecting sound around his/her own vehicle; an electronic control unit (ECU) 5 connected to control the front/rear ultrasonic-wave transmitters 1 and 3; the front/rear ultrasonic-wave receivers 2 and 4, the image pick-up means 7 and 8 and the microphone 9, respectively, for performing the functions of measuring the speed of the front/rear vehicles and the distance between them, monitoring the rear object, preventing a burglar accident, picking up images of the front/rear and the visual field within the vehicle and recording the sound; and a storage means 6 for storing individual information calculated under the control of the electronic control unit 5.

Also, the electronic control apparatus further includes a direction sensing means 14 for sensing in real-time the direction at which the vehicles are located, an image/sound recording reset switch 12 for resetting image and sound information recorded on the storage means 6, a burglar alarm means for preventing a burglar, consisted of a lamp 10 or a sounder for alarming the intrusion by foreigners and a reset switch 11 for resetting a burglar alarm function, a burglar-alarm transmit antenna 13 for alarming by wireless the intrusion by the foreigners to the driver located at a long distance, a crash sensing sensor 15 and an image/data display monitor 16 for displaying the picked up images.

The components to which reference numerals and a detailed description are not given include a vehicle speed sensor, various switches (backward motion, doors, trunk, starting key, brake, sounder, door lock/open, trunk lock/open, direction lamp switches, etc.), brake lamps, LH/RH lamps, sounders, flash units etc., which are also controlled by the ECU and are not important for the present invention. Thus, a detailed description thereof will be not given for simplicity.

Further, though not shown in the drawing, the components such as a handle steering angle sensor, a throttle body flap, an open angle sensor, an emergency light, a switch for an emergency light, a brake pedal angle switch and a headlight switch etc., may be controlled by the ECU.

It is preferred that the above-mentioned components are mounted at the positions shown in Fig. 2.

In other words, the front ultrasonic-wave transmitter 1/ the front ultrasonic-wave receiver 2 for measuring the speed and distance of the front vehicle are installed on the fascia board in front of the driver's seat. Also, the front ultrasonic-wave transmitter 3/ the front ultrasonic-wave receiver 4 for measuring the speed and distance of the rear vehicle are installed on the license plate behind the vehicle.

Further, the ECU 5 and the storage means 6 are installed on the seal within the trunk and may be also installed at the bottom of the driver's seat (not shown).

The image pick-up means for picking up images of the front visual field, for example, a front infrared CCD camera 7 is mounted in the upper middle of the front window shield within the vehicle room from which the front visual field can be obtained. Also, the image pick-up means for picking up images of the rear visual field, for example, a rear infrared CCD camera 8 is mounted in the upper middle of the rear window shield within the vehicle room from which the front visual field can be obtained. Each of the image pick-up means may be mounted on the right of the driver-seat head support and on the left of the assistant-seat head support (not shown). By allowing the image pick-up means to focus the rear mirror, the front and rear visual fields of the vehicle can be picked up.

Also, the microphone 9 for collecting sound around the vehicle is mounted on the upper of the driver' seat. The microphone 9 may include "on" and "off" function switches. The driver could adjust automatically or manually the front/rear infrared CCD cameras 7 and 8.

Further, the lamp 10 for informing whether the burglar alarm function must be operated or not is mounted on the fascia board, and the burglar alarm function reset switch 11 and the image/sound recording reset switch 12 are mounted near the driver around the fascia board.

The antenna 13 for alarming by wireless the intrusion by the foreigners to the driver located at a long distance may be mounted around the window shield or the rear window shield within the vehicle room. The direction sensing means 14 for sensing the direction at which the vehicle is currently located is mounted on the fascia board. The direction information sensed by the direction sensing means may be displayed on an additional display means.

Also, it is preferred that the crash sensing sensor 15 is mounted at the bottom of the driver' seat. The image/data display monitor 16 is mounted on the fascia board or at a given region on the fascia board so that the driver can easily view.

The electronic control apparatus having the above components mainly have a front vehicle speed sensing function, a rear vehicle speed sensing function, a front vehicle near-distance measuring function, a rear vehicle near-distance measuring function, a rear object monitoring function, a burglar prevention sensing function, a front/rear visual field image and sound recording function, a vehicle direction function, and various vehicle data recording functions and image display monitoring functions. Placing the focus on those functions, the effects of the present invention will be below explained in detail.

1. Front vehicle speed sensing function

The ECU 5 periodically controls the front ultrasonic-wave transmitter 1 to transmit the ultrasonic wave signal. When the front ultrasonic-wave receiver 2 receives the ultrasonic-wave signal that is transmitted by the front ultrasonic-wave transmitter 3 and is then reflected by the front vehicle, the ECU 5 uses the received ultrasonic-wave signal and the signal inputted at the vehicle speed sensor to calculate the speed of the front vehicle.

Then, it records the calculated speeds of his/her own vehicle and of the front vehicle on the storage means 6.

For this, the ECU 5 is consisted of a power regulator, an analog-to-digital converter, a shift register, a digital signal processor (DSP), a program processor, a random access memory (RAM), a read only memory (ROM), a battery and a flash memory, etc.

2. Rear vehicle speed sensing function

The ECU 5 periodically controls the rear ultrasonic-wave transmitter 3 to transmit the ultrasonic wave signal. When the rear ultrasonic-wave receiver 4 receives the ultrasonic-wave signal that is transmitted by the rear ultrasonic-wave transmitter 3 and is then reflected by the rear vehicle, the ECU 5 uses the received ultrasonic-wave signal and the signal inputted at the vehicle speed sensor to calculate the speed of the rear vehicle.

Then, it records the calculated speeds of his/her own vehicle and of the rear vehicle on the storage means 6.

3. Front vehicle near-distance measuring function

If the ECU 5 determines that the rear switch on the rear gear side is "off", it controls the front ultrasonic-wave transmitter 1 to transmit the ultrasonic wave signal. Thus, when the front ultrasonic-wave receiver 2 receives the ultrasonic wave signal that is transmitted by the front ultrasonic wave transmitter 1 and is then reflected by the front vehicle, the ECU 5 uses the received ultrasonic-wave signal to calculate the distance with the front vehicle and then to record the calculated data on the storage means 6.

At this time, the recorded data is compared with the reference value previously set. Thus, if danger of an accident is sensed, an alarm is operated to ring, thus inducing the driver into a safe driving. For example, if the near-distance with the front vehicle is below 10m, both the speed of his/her own vehicle and the front vehicle is over 50km/h and the speed of his/her own vehicle is faster 10km/h than that of the front vehicle, the sounder or the emergency light is operated to warn that the driver can keep a safe distance.

On the other hand, if the brake switch in his/her own vehicle is "on" while the speed of the front vehicle is below 100km/h, the ECU 5 automatically performs the rear vehicle near-distance measuring mode that will be described later.

4. Rear vehicle near-distance measuring function

If the ECU 5 determines that the backward switch on the rear gear side is "off", it controls the rear ultrasonic-wave transmitter 3 to transmit the ultrasonic wave signal. Thus, if the rear ultrasonic-wave receiver 4 receives the ultrasonic wave signal that is transmitted by the rear ultrasonic wave transmitter 3 and is then reflected by the rear vehicle, the ECU 5 uses the received ultrasonic-wave signal to calculate the distance between his/her own vehicle and the rear vehicle and then to record the calculated data on the storage means 6.

Using the calculated distance and speed, the ECU 5 controls the emergency light for a safe driving as follows:

For example, if the near-distance with the rear vehicle is below 10m and the speed of the rear vehicle is over 100km/h, the emergency light switch of his/her own vehicle is operated for a given time period (i.e., several - tens of seconds), so that the driver can keep a safe distance with the rear vehicle.

Then, if the ECU 5 determines that the brake switch of his/her own vehicle is "on" while sensing the rear vehicle, it continues to operate the emergency light switch. Then, if the ECU 5 determines that the distance with the rear vehicle is below 10m and the speed of the rear vehicle is below 30km/h, it operates the emergency light switch for a given time period (i.e., several - tens of seconds) and then stops the operation of the emergency light.

Also, if the ECU 5 determines that the speed of the rear vehicle is below 10km/h, the brake switch is "on" and the distance with the rear vehicle is below 3m, it determines that a traffic jam has occurred and thus operates the emergency light switch for a given time period (i.e., several - tens of seconds).

However, there is given priority to the direction indicator lamp switch or the emergency light switch operation by the driver over the emergency light control by the ECU.

In other words, if the direction indicator lamp switch or the emergency light switch is "on" while the starting key switch is "on", there is given priority to the direction indicator lamp switch or the emergency light switch operation by the driver over the emergency light control by the ECU. If the operation by the driver is finished, the ECU 5 resumes the emergency light control function.

While performing (1) the front vehicle speed sensing function, (2) the rear vehicle speed sensing function, (3) the front vehicle near-distance measuring function and (4) the rear vehicle near-distance measuring function, if the ultrasonic waves same with his/her own vehicle's ultrasonic waves are continuously received from other vehicles, the transmit/receive ultrasonic wave signals of his/her own vehicle can be changed or decoded into different signals so that the ultrasonic wave signal of his/her own vehicle can be discriminated from those of the other vehicles.

5. Rear object monitoring function

If the ECU 5 determines that the backward switch of his/her own vehicle is "on", that is, if the vehicle moves backwardly, it controls the rear ultrasonic-wave transmitter 3 to transmit the ultrasonic wave signal. Thus, if the rear ultrasonic-wave receiver 4 receives the ultrasonic wave signal that is transmitted by the rear ultrasonic wave transmitter 3 and is then reflected by the rear objects or persons, the ECU 5 uses the ultrasonic-wave signal to calculate the distance between the objects or persons and his/her own vehicle and then to record the calculated data on the storage means 6.

In the same manner, if there is any danger of an accident, for example if the calculated distance is below 2m, the ECU 5 operates the sounder in a given times and operates the emergency light for a given time period (i.e., several - tens of seconds), thus inducing the driver into a safe driving.

6. Burglar prevention sensing function

If the driver switches the door lock/open switch into a lock state within a given time (i.e., 3 minutes) after turning "on" the burglar alarm function reset switch 11 one times and then turns "off" all the switches while the vehicle's starting key is "off" and respective door switches (four in a four door vehicle) are "off", the ECU 5 operates the burglar prevention sensing function. At this time, the ECY 5 outputs a control signal to flicker the burglar alarm function lamp 10.

It is preferred that when the driver operates the burglar prevention monitoring function, the front/rear infrared CCD cameras 7 and 8 are oriented toward the doors so that intrusion by the foreigners can be easily picked up.

During the operation of the burglar prevention monitoring function, if the ECU 5 senses, for example, that any of the vehicle's door switches is "on" while not sensing the open signal of the door lock/open switch or that the trunk switch 15 is "on" while not sensing the open signal of the trunk lock/open switch, it continuously operates the sounder to warn that the foreigners has intruded.

At this time, the ECU 5 continuously transmits the telephone-originating signal to the telephone, the hone automation system, cellular phones of the driver via the antenna 13.

Upon a burglar alarm, for example, if the vehicle's door switch is "on" and there is no any door lock/open switch signal while the starting key switch is "off" and the burglar alarm function switch is "on" one times, the front/rear infrared CCD cameras 7 and 8 and the microphone 9 are operated to collect the images and sound around the vehicle and then to record the collected data on the storage means 6. As it is the infrared camera, the images around the vehicle can be clearly picked up when the foreigners intrude into the vehicle even at night.

Also, in a parking state, if there is any shock given to his/her vehicle by persons or vehicles, for example, when the crash sensing sensor 15 transmits the signal indicting that the crash has occurred to the ECU 5 while the starting key switch is "off", the front/rear infrared CCD cameras 7 and 8 and the microphone 9 are operated to collect the images and sound around the vehicle and then to record the collected data on the storage means 6.

If the driver wants to cancel the burglar prevention monitoring function, he/she can turns "on" the reset switch 11 twice. Then, the ECU 5 stops the burglar prevention monitoring function, turns "off" the burglar alarm function lamp 10 and stops operating the front/rear infrared CCD cameras 7 and 8 and the microphone 9.

7. Front/rear visual field image and sound recording function

As a result of performing the front vehicle speed sensing function and the front vehicle near-distance measuring function while the vehicle travels (for example, the starting key is "on", or when the generated vehicle speed sensor signal is sensed or the backward switch is "off"), if the distance between the front vehicle and his/her own vehicle is below a given distance (for example, 10 m), the ECU 5 operates the front/rear infrared CCD cameras 7 and 8 and the microphone 9 to record the traveling state of the front vehicle and the images of the traveling lane and its surrounding sound on the storage means 6. At this time, the speed and near-distance of the front vehicle are also recorded.

Also, as a result of performing the rear vehicle speed sensing function and the rear vehicle near-distance measuring function, if the distance between the rear vehicle and his/her own vehicle is below a given distance (for example, 10m), the ECU 5 operates the front/rear infrared CCD cameras 7 and 8 and the microphone 9 to record the traveling state of the rear vehicle and the images of the traveling line and its surrounding sound on the storage means 6. At this time, the speed and near-distance of the rear vehicle are also recorded.

Also, if the burglar alarm sensing function is operated to warn that the foreigners have intruded into the vehicle while the vehicle is parked (for example, the starting key is "off", or when it could not sense the generated vehicle speed sensor signal or the backward switch is "off"), the ECU 5 operates the front/rear infrared CCD cameras 7 and 8 and the microphone 9 to record the images of the front/rear visual field state and its surrounding sound on the storage means 6.

Also, as the storage capacity of the storage means 6 is limited, there is provided an image/sound recording reset switch 12 for allowing the users to reset the image and sound data recorded on the storage means 6, as necessary, when the images of the front/rear visual field state and its surrounding sound are recorded on the storage means 6 for a long time.

For example, if the user turns "on" the image/sound recording reset switch 12 one times, the ECU 5 recognizes it and then stops storing the images of the front/rear visual field state and its surrounding sound. Also, if the user turns "on" the image/sound recording reset switch 12 twice, the ECU

5 recognizes it and then resumes writing the images of the front/rear visual field state and its surrounding sound. At this time, the ECU 5 invalidates the contents shift-registered from the start point of the image/sound record region on the storage means 6 and then controls the image and sound to be recorded from the start point of the image/sound record region on the storage means 6.

Also, during the operation of performing the images of the front/rear visual field state and its sound recording, if there is no any region on which the images and sound are recorded since the image/sound regions to be recorded on the storage means 6 are full, the ECU 5 controls the storage means 6 to shift-register the image and sound on the image and sound recording region on the storage means 6 from the start point.

As another example, if the image/sound recording reset switch 12 is turned "on" three times in a row, the ECU recognizes it and then shift-registers the state around the vehicle (front and rear visual fields) on the storage means 6. At this time, for example, the image memory can record one frame per second at the velocity of below 60 km. Also, as the speed of the vehicle become over 60 km, the image memory will increase the number of the frame to be recorded per second. Thus, the image memory records up to 15 frames per second over 150 km. If a traffic accident has occurred, the image/sound along with the time when the accident occurred is recorded on the ECU 5 or the storage means 6 based on the time when the crash sensor 15 senses the accident by classifying before- and after-the accident into a given time (for example, ECU recording: record during 20 seconds before the accident and during 20 seconds after the accident and then stop, storage means: continuous recording before the accident, record during 10 seconds after the accident and then stop).

As another example, if the image/sound recording reset switch 12 is turned "on" four times continuously, the images picked up by the CCD cameras 7 and 8 when the vehicle travels and when it is parked is instantly displayed on the image/data display monitor 16.

It is preferred that the storage means 6 is attachable from the ECU 5 and may be also connected to personal computers for reproducing the recording. In particular, all the information recorded on the storage means is attached with year/month/day and time information. Preferably, the storage means 6 may be a HDD (Hard Disk Drive).

Therefore, while the vehicle travels, the images of the front/rear visual field state and its surrounding sound data recorded on the storage means 6 can be utilized as an important data to clear up the cause of the accident and to find out who is responsible for the accident. Also, while the vehicle is parked, the images and sound of its surrounding state recorded on the storage means 6 under the control of the burglar alarm sensing function allow the vehicle owner to easily ascertain who intruded into the vehicle when a burglar accident has occurred.

8. Vehicle direction function

While the ECU 5 performs the function of recording the vehicle's traveling state or the image and sound of the front/rear visual field state as mentioned above, it receives the direction data on the current vehicle inputted from the direction sensing means 14 and records the received data on the storage means 6 along with the image and sound data. The direction data of the current vehicle allows clearing up the cause of the accident and finding out who is responsible for the accident. The direction information sensed by the direction sensing means 14 may be displayed on an additional display apparatus.

In addition to the above functions, various data recorded on the ECU 5 and the storage means 6 can be used to have the function by which the data can be deleted by the input of password by the driver and the function by which additional password can be coded in order to prevent cheating of the data. Also, for the purpose of protecting the recorded data from the vehicle's fire, the function of blocking the power supply of the vehicle after the crash sensor 15 senses the crash can be added. At this time, it should be understood that even through the power supply in the vehicle is block, an assistant power supply (i.e., battery) may perform the above functions.

As can be understood from above description, the present invention uses the data (image on the vehicle's front/rear visual fields, the driver's voice and sound around the vehicle, the speed and direction of his/her own vehicle, the speed of the front/rear vehicle, the distance with the front/rear vehicle etc.) recorded on the recording medium when a traffic accident has occurred. Thus, it can prevent damages due to unfair misjudgment on the accident.

Also, the present invention calculates the speed of the front/rear vehicles and his/her own vehicle and the distance between the front/rear vehicle and his/her own vehicle. Thus, the present invention can prevent a traffic accident in advance by warning the calculated data to the driver, thus inducing the driver into a safe driving.

Further, the present invention can detect the intrusion into the vehicle by the foreigners and then inform it to the driver located at a long distance by wireless, along with the sound alarm. Thus, the driver can take an adequate action since he/she can remotely confirm the intrusion by the foreigners. Also, the driver can easily confirm the invasion after the burglar accident has occurred, using the data (image on the vehicle's front/rear visual field, the driver's voice and sound around the vehicle, direction of his/her own vehicle) recorded on the recording medium.

In particular, as the present invention adopts an infrared CCD camera, the surrounding state when the accident occurred could be easily confirmed even though the traffic or burglar accident occurred at night.

The present invention has been described with reference to a particular embodiment in connection with a particular application. Those having ordinary skill in the art and access to the teachings of the present invention will recognize additional modifications and applications within the scope thereof.

It is therefore intended by the appended claims to cover any and all such applications, modifications, and embodiments within the scope of the present invention.

CLAIMS

What is claimed is:

1. An electronic control apparatus for a vehicle comprising:

front/rear signal transmitters/receivers for transmitting/receiving given signals to measure the speed of front/rear vehicles and the distance between his/her own and said front/rear vehicles,

an image pick-up means for picking up images of said front/rear vehicles or the visual field within his/her own vehicle,

a microphone for collecting sound around his/her own vehicle,

an electronic control unit (ECU) connected to control said front/rear signal transmitters/receivers, said image pick-up means and said microphone, respectively, and

a recording means for recording respective information calculated under the control of said electronic control unit.

2. The electronic control apparatus for a vehicle according to claim 1, further including a direction sensing means for sensing in real-time the direction where the vehicles are located, and wherein said direction sensing means is controlled by said electronic control unit and said direction information calculated by said electronic control unit is recorded on said storage means.

3. The electronic control apparatus for a vehicle according to claim 1, further including an image/sound recording reset switch for resetting the image and sound information recorded on said storage means.

4. The electronic control apparatus for a vehicle according to claim 1, further including a burglar alarm means for preventing a burglar accident.

5. The electronic control apparatus for a vehicle according to claim 4, wherein said burglar alarm means includes a lamp or a sounder for alarming the intrusion by the foreigners and a burglar alarm function reset switch for resetting a burglar alarm function,

6. The electronic control apparatus for a vehicle according to claim 4, wherein said burglar alarm means further includes a burglar-alarm transmit antenna for transmitting, by wireless, the signal alarming the intrusion by the foreigners to the driver located at a long distance.

7. The electronic control apparatus for a vehicle according to claim 1, wherein the signals of said front/rear signal transmitters/receiver are ultrasonic waves.

8. The electronic control apparatus for a vehicle according to claim 7, wherein the ultrasonic waves are more than 20,000 Hz.

9. The electronic control apparatus for a vehicle according to claim 1, wherein said storage means is attachable from said electronic control unit.

10. The electronic control apparatus for a vehicle according to claim 1, wherein said storage means is a HDD (Hard Disk Driver).

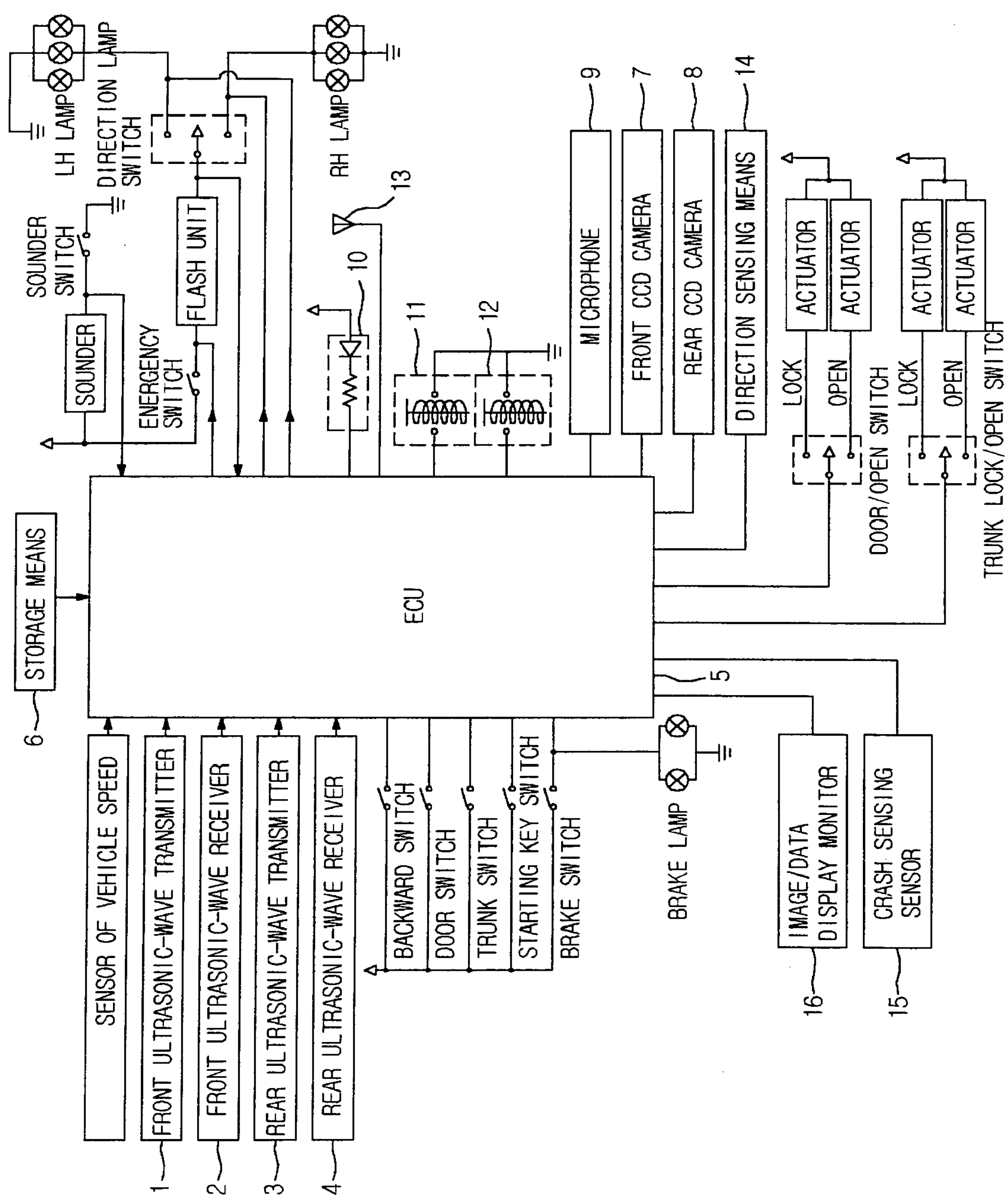
11. The electronic control apparatus for a vehicle according to claim 10, wherein said storage means is compatible with PCs and information recorded on the storage means is reproducible at said PC.

12. The electronic control apparatus for a vehicle according to claim 1, further including a vehicle speed sensor, a backward switch, a door switch, a trunk switch, a starting key switch, a brake switch, a sounder switch, a door lock/open switch, a trunk lock/open switch, a direction indicating light switch, a stop light, LH/RH lamps, sounders and flash units.

13. The electronic control apparatus for a vehicle according to claim 1, further including a crash sensor for sensing a crash.

14. The electronic control apparatus for a vehicle according to claim 1, further including an image/data display monitor for displaying images picked up by said image puck-up means.

FIG. 1


STORAGE MEANS
ECU
SENSOR OF VEHICLE SPEED
FRONT ULTRASONIC-WAVE TRANSMITTER
FRONT ULTRASONIC-WAVE RECEIVER
REAR ULTRASONIC-WAVE TRANSMITTER
REAR ULTRASONIC-WAVE RECEIVER
BACKWARD SWITCH
DOOR SWITCH
TRUNK SWITCH
STARTING KEY SWITCH
BRAKE SWITCH
BRAKE LAMP
IMAGE/DATA DISPLAY MONITOR
CRASH SENSING SENSOR
SOUNDER
SOUNDER SWITCH
EMERGENCY SWITCH
FLASH UNIT
DIRECTION LAMP SWITCH
LH LAMP
RH LAMP
MICROPHONE
FRONT CCD CAMERA
REAR CCD CAMERA
DIRECTION SENSING MEANS
ACTUATOR
ACTUATOR
ACTUATOR
ACTUATOR
LOCK
OPEN
DOOR/OPEN SWITCH
LOCK
OPEN
TRUNK LOCK/OPEN SWITCH
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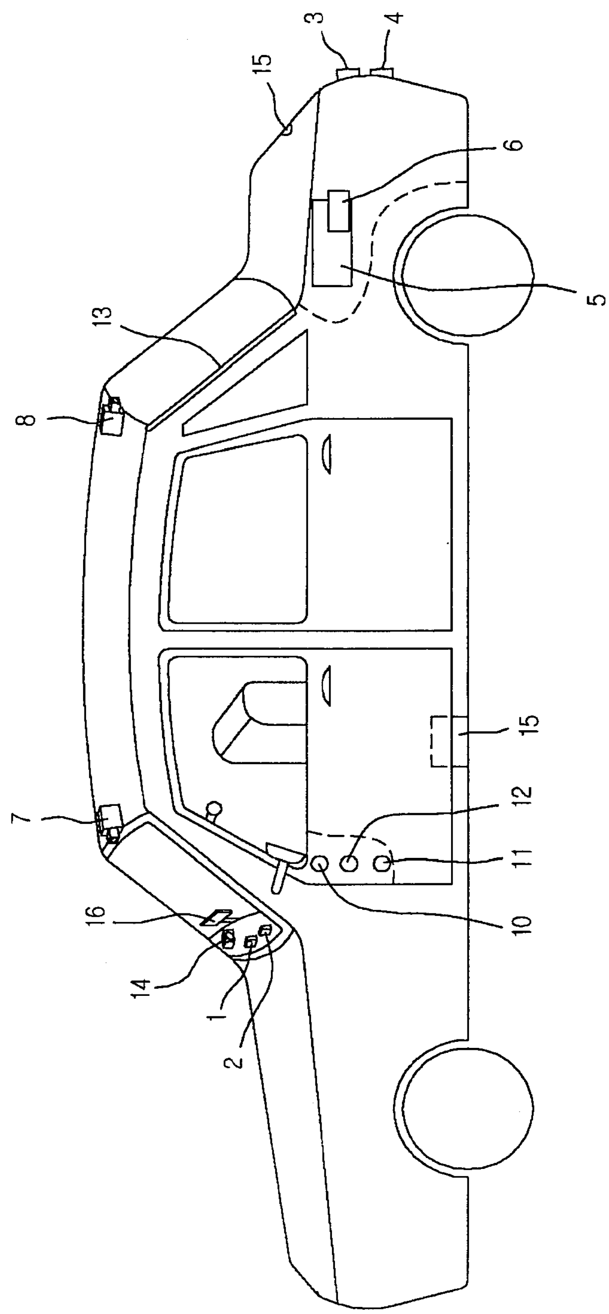
16

FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/01007

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G01C 22/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 99-201888 B (HYUNDAI MOTOR. CORP.) 17 MARCH 1999	1 - 14
Y	KR 94-3077 B (LEE, SANG MOON) 13 APRIL 1994	12
Y	KR 97 - 770 B (LEE, JUNG JAE) 18 JANUARY 1997	3, 13, 14
Y	KR 98-61482 A (KIM, BONG TAK) 7 OCTOBER 1998	2
Y	KR 99-242203 B (HYUNDAI MOTOR CORP.) 9 NOVEMBER 1999	4-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"X" document of particular relevence; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevence; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 DECEMBER 2000 (19.12.2000)	21 DECEMBER 2000 (21.12.2000)

Name and mailing address of the ISA/KR	Authorized officer
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Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5499

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

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 October 2001 (04.10.2001)

PCT

(10) International Publication Number
WO 01/73693 A2

(51) **International Patent Classification**[7]: **G07B 15/02**, G07F 7/00

(21) **International Application Number:** PCT/IL01/00155

(22) **International Filing Date:** 19 February 2001 (19.02.2001)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**

60/192,199	27 March 2000 (27.03.2000)	US
140047	3 December 2000 (03.12.2000)	IL
09/731,643	7 December 2000 (07.12.2000)	US

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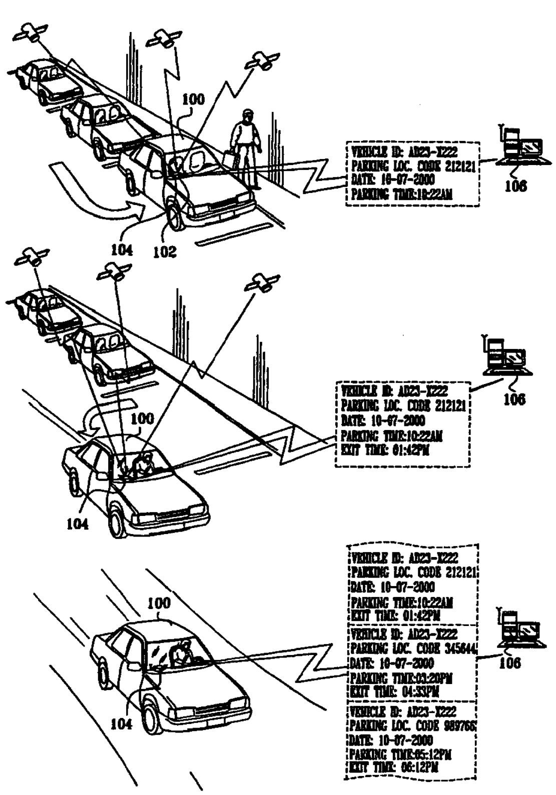
(81) **Designated States** *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) **Title:** VEHICLE RELATED SERVICES SYSTEM AND METHODOLOGY



(57) Abstract: A vehicle-related services system and methodology employing at least one sensor automatically sensing at least one of the time during which a vehicle is not being operated and where the vehicle is located when it is not being operated and at least one data processor receiving information sensed by the sensor, indicating at least one of the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated and providing a billing data output in respect of a vehicle-related service which is dependent on at least one of the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated.

WO 01/73693 A2

patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

VEHICLE RELATED SERVICES SYSTEM AND METHODOLOGY

FIELD OF THE INVENTION

The present invention relates to systems and methodologies for providing, and effecting payment for, vehicle-related services in general and particularly for vehicle parking services.

BACKGROUND OF THE INVENTION

The U.S. patent literature contains a great number of patents related to systems and methodologies for providing and effecting payment for vehicle-related services.

The following U.S. patents and published PCT applications are believed to represent the state of the art with regard to systems and methodologies for providing and effecting payment for vehicle parking services:

4,555,618; 4,876,540; 4,908,500; 4,958,064; 5,029,094; 5,034,739; 5,072,380; 5,153,559; 5,173,833; 5,266,947; 5,283,622; 5,339,000; 5,351,187; 5,414,624; 5,432,508; 5,442,348; 5,659,306; 5,710,557; 5,710,743; 5,737,710; 5,745,052; 5,748,107; 5,751,973; 5,796,084; 5,809,480; 5,819,234; 5,845,268; 5,877,704; 5,905,247; 5,910,782; 5,914,654; 5,926,546; 5,940,481; 5,980,185; 5,991,749; 6,028,550; 6,037,880; 6,061,002; 6,085,124.

WO 93/20539; WO 97/13222A1.

The following U.S. Patents are believed to represent the state of the art with regard to systems and methodologies for providing and effecting payment for other types of vehicle-related services:

4,533,962; 4,843,463; 5,210,702; 5,223,844; 5,319,374; 5,359,528; 5,422,624; 5,499,181; 5,499,182; 5,550,551; 5,583,765; 5,612,875; 5,621,166; 5,635,693; 5,642,484; 5,694,322; 5,717,374; 5,742,915; 5,797,134; 5,831,742; 5,862,500; 5,864,831; 5,914,654; 5,954,773; 5,963,129; 5,970,481; 5,974,356; 5,995,898; 6,006,148; 6,064,970; 6,067,008; 6,112,152.

SUMMARY OF THE INVENTION

The present invention seeks to provide improved, simplified and highly cost effective systems and methodologies for providing and effecting payment for vehicle-related services.

There is thus provided in accordance with a preferred embodiment of the present invention a vehicle-related services system including:

at least one sensor automatically sensing at least one of the time during which a vehicle is not being operated and where the vehicle is located when it is not being operated; and at least one data processor receiving information sensed by the at least one sensor, indicating at least one of the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated and providing a billing data output in respect of a vehicle-related service which is dependent on at least one of the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated.

The data processor may include a vehicle insurance billing data processor. In such a case, the billing data includes vehicle insurance billing data wherein the only variables, sensed by the on-board vehicle sensor, which are considered in the billing data are duration of vehicle operation and time of day or night of vehicle operation. The billing data may include vehicle insurance billing data wherein the billing data is not dependent on vehicle speed.

In accordance with a preferred embodiment of the present invention, the at least one sensor automatically senses the time during which a vehicle is not being operated and where the vehicle is located when it is not being operated and the at least one data processor receives information sensed by the sensor, indicating the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated and provides a billing data output in respect of a vehicle-related service which is dependent on the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated.

Preferably, the at least one sensor automatically senses the time during which a vehicle is parked and where the vehicle is located when it is parked and the at least one data processor receives information sensed by the at least one sensor, indicating the time during which the vehicle is parked and where the vehicle is parked and provides a parking data output in respect of parking, which is dependent on the time during which the vehicle is parked and where the vehicle is parked.

In accordance with a preferred embodiment of the present invention. the at least one sensor and the at least one data processor are operative without vehicle operator initiative to provide an indication of at least one of the time during which the vehicle is parked and where the vehicle is parked.

Preferably, the sensor is on-board the vehicle.

In accordance with a preferred embodiment of the present invention, the vehicle-related services system also includes:

at least one communicator on-board the vehicle providing an output indicating the time during which vehicle is parked and where the vehicle is parked; and

a receiver associated with the at least one data processor for receiving a communication from the at least one communicator and employing the communication for providing the information to the at least one data processor.

Preferably, the communicator communicates with the receiver at least partially not in real time.

In accordance with a preferred embodiment of the present invention, the communicator communicates with an intermediate storage and communication unit only when a vehicle in which the communicator is located is at one of a plurality of predetermined locations.

Preferably, the intermediate storage and communication unit is located at a vehicle fueling station. In accordance with a preferred embodiment of the present invention, the information includes identification of a street parking location in which the vehicle is stationary for at least a predetermined amount of time.

Preferably, the sensor is operative to sense the time during which a vehicle is not being operated without requiring interaction with an indicating device fixed in propinquity to the location.

In accordance with a preferred embodiment of the present invention, the at least one sensor is operative using triangulation to determine where a vehicle is parked.

In accordance with a preferred embodiment of the present invention, the data processor may include a vehicle insurance billing data processor. In such a case, the billing data includes vehicle insurance billing data wherein the only variables, sensed by the at least one on-board vehicle sensor, which are considered in the billing data are duration of vehicle operation and time of day or night of vehicle operation. The billing data may include vehicle insurance billing data wherein the billing data is not dependent on vehicle speed.

Preferably, the vehicle-related services system also includes an at least one on-board vehicle potential additional parking space sensor which is operative when a vehicle is stationary at a street parking place for indicating whether at least one potential additional adjacent parking place is unoccupied.

Preferably, the at least one on-board vehicle sensor provides an output indicating the existence of at least one potential unoccupied additional adjacent parking place, the system also includes

a street parking map database indicating legal street parking spaces;

a correlator receiving the output indicating existence of at least one potential unoccupied additional adjacent parking place and correlating it with the legal street parking spaces; and

an available parking communicator providing information regarding unoccupied legal street parking places to at least one driver.

There is also provided in accordance with a preferred embodiment of the present invention a vehicle-related services system including:

a plurality of on-board potential additional parking space sensors located on a plurality of vehicles, which sensors each provide an output indicating existence of at least one potential unoccupied additional adjacent parking place adjacent a vehicle located in a street parking location; and an available parking communicator employing information received from the plurality of sensors and providing information regarding unoccupied street parking places to at least one driver.

Preferably, the vehicle-related services system also includes:

a street parking map database indicating legal street parking spaces; and

a correlator receiving the output indicating existence of at least one potential unoccupied additional adjacent parking place and correlating it with the legal street parking spaces.

There is additionally provided in accordance with a preferred embodiment of the present invention a vehicle-related services system including:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated;

at least one communicator on-board the vehicle providing an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

at least one data processor receiving a communication from the at least one communicator, indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related service which is dependent only one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated.

There is further provided in accordance with a preferred embodiment of the present invention a vehicle-related services system including:

at least one sensor on-board a vehicle and automatically sensing only at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated;

at least one communicator on-board the vehicle providing an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

at least one data processor receiving a communication from the at least one communicator, indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related service which is dependent on at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated.

Preferably, the sensor on-board a vehicle automatically sensing only at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated.

Preferably, the data processor includes a vehicle insurance billing data processor.

In accordance with a preferred embodiment of the present invention, the communicator communicates with an intermediate storage and communication unit only when a vehicle in which the communicator is located is at one of a plurality of predetermined locations.

Preferably, the intermediate storage and communication unit is located at a vehicle fueling station.

In accordance with a preferred embodiment of the present invention, the billing data includes vehicle insurance billing data wherein the only variables, sensed by the on-board vehicle sensor, which are considered in the billing data are duration of vehicle operation and time of day or night of vehicle operation.

Alternatively, the billing data may include vehicle insurance billing data wherein the only variables, sensed by the on-board vehicle sensor, which are considered in the billing data are duration of vehicle operation and location of the vehicle during the vehicle operation.

As a further alternatively, the billing data may include vehicle insurance billing data wherein the only variables sensed by the on-board vehicle sensor, which are considered in the billing data are duration of vehicle use and time of day or night of vehicle use.

Preferably, the vehicle-related services system includes:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated;

at least one communicator on-board the vehicle providing an output indicating at least one of the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated; and

at least one data processor receiving a communication from the at least one communicator, indicating at least one of the time during which the vehicle is being operated and/or the distance traveled by the vehicle while it is being operated; and

providing a billing data output in respect of a vehicle-related service which is dependent only on at least one of the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated.

Preferably, the at least one data processor includes a vehicle insurance billing data processor.

In accordance with a preferred embodiment of the present invention, the billing data includes vehicle insurance billing data wherein the only variables, sensed by the on-board vehicle sensor, which are considered in the billing data are time of day and date of vehicle operation and distance covered during the vehicle operation.

Preferably, the communicator communicates with an intermediate storage and communication unit only when a vehicle in which the communicator is located is at one of a plurality of predetermined locations.

In accordance with a preferred embodiment of the present invention, the intermediate storage and communication unit is located at a vehicle fueling station.

Preferably, the billing data includes vehicle insurance billing data wherein the billing data is not dependent on vehicle speed.

In accordance with a preferred embodiment of the present invention, the at least one data processor includes a vehicle parking billing data processor.

Preferably, the at least one sensor and the at least one data processor are operative without vehicle operator initiative to provide an indication at least one of the time during which the vehicle is parked and where the vehicle is parked.

In accordance with a preferred embodiment of the present invention, the at least one sensor is operative to sense the time during which a vehicle is being operated without requiring interaction with an indicating device fixed in propinquity to the location.

Preferably, the communicator communicates with the at least one data processor at least partially not in real time.

There is also provided in accordance with a preferred embodiment of the present invention a vehicle-related fee payment system including:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated;

at least one communicator on-board the vehicle providing an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

at least one data processor receiving a communication from the at least one communicator, indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the time during which the vehicle is being operated.

Preferably, the communicator communicates with the at least one data processor at least partially not in real time.

In accordance with a preferred embodiment of the present invention, the communicator communicates with an intermediate storage and communication unit only when a vehicle in which the communicator is located is at one of a plurality of predetermined locations, such as a vehicle fueling station.

In accordance with a preferred embodiment of the present invention, the data processor provides a billing data output in respect of a vehicle-related use fee which is dependent on the duration of vehicle operation and time of day of vehicle operation.

Preferably, the at least one data processor provides a billing data output in respect of a vehicle-related use fee which is also dependent on where the vehicle is located during vehicle operation.

In accordance with a preferred embodiment of the present invention, the billing data output is dependent on the time during which the vehicle is being operated and on a level of pollution being created by the vehicle.

There is additionally provided in accordance with a preferred embodiment of the present invention a vehicle-related fee payment system including:

at least one sensor for automatically sensing the passage of a vehicle along a given road;

at least one data processor receiving a communication from the at least one sensor, indicating the passage of the vehicle along a given road at a given time and providing a billing data output in respect of a vehicle-related use fee which is dependent only on the time during which the vehicle is passing along the given road.

There is further provided in accordance with a preferred embodiment of the present invention a vehicle-related fee payment system including:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which the vehicle is being operated;

at least one communicator on-board the vehicle providing an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

at least one data processor receiving a communication from the at least one communicator, indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the region in which a vehicle is operating and the time of day during which the vehicle is being operated in the region.

There is additionally provided a vehicle-related services method including:

automatically sensing the time during which a vehicle is not being operated and where the vehicle is located when it is not being operated and receiving information indicating the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated and providing a parking data output in respect of a vehicle-related service which is dependent on the time during which the vehicle is not being operated and where the vehicle is located when it is not being operated.

Preferably, the method also includes providing an indication of the time during which the vehicle is parked and where the vehicle is parked substantially without operator intervention.

The above method preferably also includes communicating an indication of the time during which the vehicle is parked and where the vehicle is parked to a receiver at least partially not in real time.

Preferably, the automatic sensing takes place without requiring interaction with an indicating device fixed in propinquity to a parking location.

There is additionally provided in accordance with a preferred embodiment of the present invention a vehicle-related services method including:

providing outputs indicating existence of at least one potential unoccupied additional adjacent parking place adjacent a plurality of vehicles located in street parking locations and employing the outputs received from the plurality of vehicles and providing information regarding unoccupied street parking places to at least one driver.

Further in accordance with a preferred embodiment of the present invention there is provided a vehicle-related services method including:

automatically sensing at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated;

communicating an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

receiving a communication indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing an insurance billing data output in respect of vehicle insurance which is dependent only on at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated.

Preferably, communicating takes place only when a vehicle is at one of a plurality of predetermined locations.

In accordance with a preferred embodiment of the present invention, the billing data includes vehicle insurance billing data wherein the only automatically sensed variables which are considered in the billing data are duration of vehicle operation and time of day or night of vehicle operation.

There is additionally provided in accordance with a preferred embodiment of the present invention a vehicle-related fee payment method including:

automatically sensing at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated;

providing an output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated; and

receiving the output indicating at least one of the time during which the vehicle is being operated and where the vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the time during which the vehicle is being operated.

Preferably, the billing data output in respect of a vehicle-related use fee is dependent on the duration of vehicle operation and time of day of vehicle operation.

In accordance with a preferred embodiment of the present invention the billing data output is dependent on the time during which the vehicle is being operated and on a level of pollution being created by the vehicle.

There is additionally provided in accordance with a preferred embodiment of the present invention a vehicle-related services method including:

automatically sensing the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated;

communicating an output indicating the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated; and

receiving a communication indicating the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated and providing an insurance billing data output in respect of vehicle insurance which is dependent only on
the time during which the vehicle is being operated and the distance traveled by the vehicle while it is being operated.

Preferably, the billing data includes vehicle insurance billing data wherein the only automatically sensed variables which are considered in the billing data are the distance traveled by the vehicle while it is being operated and time of day or night of vehicle operation.

Preferably in all embodiments of the invention, the sensor automatically senses the time of day and date when the vehicle is not being operated.

Additionally or alternatively in all embodiments of the invention, the sensor automatically senses the time duration during which the vehicle is not being operated.

It is appreciated that the various embodiments described hereinabove may be employed individually or alternatively any suitable combination of such embodiments may be employed.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Figs. 1A, 1B and 1C are simplified pictorial illustrations of three alternative embodiments of parking payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 2 is a simplified pictorial illustration of a preferred embodiment of a parking location and payment system and methodology constructed and operative in accordance with a preferred embodiment of the present invention;

Figs. 3A, 3B and 3C are simplified block diagram illustrations of three alternative embodiments of parking payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 1A, 1B and 1C, respectively;

Figs. 4A, 4B and 4C are simplified flow charts illustrating the operation of the three alternative embodiments of parking payment systems and methodologies of Figs. 1A and 3A, 1B and 3B and 1C and 3C respectively;

Fig. 5 is a simplified block diagram illustration of an embodiment of a parking location and payment system and methodology constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Fig. 2;

Fig. 6 is a simplified flow chart illustrating an embodiment of the parking location and payment system and methodology of Figs. 2 and 5;

Figs. 7A, 7B and 7C are simplified pictorial illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention;

Figs. 8A, 8B and 8C are simplified block diagram illustrations of three alternative embodiments of payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 7A, 7B and 7C respectively;

Figs. 9A, 9B and 9C are simplified flow charts illustrating the operation of the three alternative embodiments of payment systems and methodologies of Figs. 7A and 8A, 7B and 8B and 7C and 8C respectively;

Figs. 10A, 10B and 10C are simplified pictorial illustrations of preferred embodiments of vehicle fee payment systems and methodologies constructed and operative in accordance with three alternative preferred embodiments of the present invention;

Figs. 11A, 11B and 11C are simplified block diagram illustrations of preferred embodiments of vehicle fee payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 10A, 10B and 10C respectively;

Figs. 12A, 12B and 12C are simplified flow charts illustrating the operation of preferred embodiments of vehicle fee payment systems and methodologies of Figs. 10A and 11A, 10B and 11B and 10C and 11C respectively;

Figs. 13A, 13B and 13C are simplified pictorial illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with another preferred embodiment of the present invention;

Figs. 14A, 14B and 14C are simplified block diagram illustrations of three alternative embodiments of payment systems and methodologies constructed and operative in accordance with another preferred embodiment of the present invention and corresponding to Figs. 13A, 13B and 13C respectively; and

Figs. 15A, 15B and 15C are simplified flow charts illustrating the operation of the three alternative embodiments of payment systems and methodologies of Figs. 13A and 14A, 13B and 14B and 13C and 14C respectively.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Reference is now made to Figs. 1A, 1B and 1C, which are simplified pictorial illustrations of three alternative embodiments of parking payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention.

Fig. 1A illustrates a GPS-based system for effecting payment for parking without requiring any driver intervention. As shown in Fig. 1A, a vehicle 100 equipped with a GPS receiver 102 or similar location determining device is parked by a driver. Without requiring any intervention by the driver, a parking communicator 104, receiving a location input from GPS receiver 102, transmits a message in a wireless manner to a central unit 106, which in turn provides data used for effecting payment for parking.

The message typically includes data relating to the identity of the vehicle parked, the parking location, the date and the start time of parking.

In the illustrated embodiment, when the driver removes the vehicle 100 from the parking location, the parking communicator 104 transmits a further message in a wireless manner to central unit 106. This message typically includes data relating to the identity of the vehicle parked, the parking location, the date, the start time of parking and the finish time of parking, i.e. the time that the vehicle 100 exits the parking location.

As illustrated in Fig. 1A, additionally or alternatively to transmittal of a message when the vehicle enters and/or exits the parking location, a composite message may be transmitted at any time from the vehicle 100 to the central unit 106. Such a composite message may include messages relating to a plurality of parking events. In respect of each parking event, the message typically includes data relating to the identity of the vehicle parked, the parking location, the date, the start time of parking and the finish time of parking.

Composite messages may be transmitted, for example, at predetermined times or upon accumulation of data relating to a predetermined number of parking events or based on any other suitable criterion or combination of criteria.

It is appreciated that no message need be sent at the time of parking or at the termination of parking. It is also appreciated that when a message is sent at the time of parking, the message sent at the termination of parking need not include data relating to the start time of parking.

In the embodiment of Fig. 1A, wireless communication is preferably effected via a cellular communication system, but may alternatively be effected by any other suitable wireless communication facility.

Fig. 1B also illustrates a GPS-based system for effecting payment for parking without requiring any driver intervention. As shown in Fig. 1B, a vehicle 200 equipped with a GPS receiver 202 or similar location determining device is parked by a driver. Without requiring any intervention by the driver, a parking recorder 204, receiving a location input from GPS receiver 202, records data relating to the parking location, the date and the start time of parking.

In the illustrated embodiment, when the driver removes the vehicle 200 from the parking location, the parking recorder 204 records data relating to the parking location, the date, the finish time of parking.

As illustrated in Fig. 1B, when the vehicle 200 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, for example, a gasoline station or an electric vehicle recharging station, the parking recorder 204 downloads data relating to a plurality of parking events over a time period extending from the preceding download, via a suitable communicator 206, typically in a wireless manner, to an intermediate storage and communication unit 208, typically located at the filling station. The intermediate storage and communication unit 208 preferably receives and stores data relating to a plurality of parking events in respect of a multiplicity of vehicles and communicates this data, in a composite message, preferably in a wireless manner, to a central unit 210. Alternatively or additionally, download locations may be found at other places, such as road intersections, parking lots and malls.

Typically, the composite message may be transmitted at any time from the intermediate storage and communication unit 208 to the central unit 210. Such a composite message typically includes messages relating to a plurality of parking events for a multiplicity of different vehicles. In respect of each parking event, the message typically includes data relating to the identity of the vehicle parked, the parking location, the date, the start time of parking and the finish time of parking.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of parking events or based on any other suitable criterion or combination of criteria.

Fig. 1C illustrates a further alternative embodiment of a system for effecting payment for parking without requiring any driver intervention. As shown in Fig. 1C, a vehicle 300, equipped with a transmitter 302, which transmits a wireless coded signal identifying the vehicle, is parked. Without requiring any intervention by the driver, the coded signal transmitted by transmitter 302 is received by at least two and preferably three angular sensitive receivers 304, which are located in general propinquity to the parking location of the vehicle 300 and communicate with a central unit 306.

Typically, the receipt of outputs from the receivers 304 enables the location of the vehicle 300 to be determined using conventional triangulation technology. The timing of receipt of the coded signals as well as sensed change or lack of change in the vehicle location provides an indication of the parking start time and parking finish time, which, when received by the central unit 306, together with vehicle identification data, enable payment for parking to be effected.

Preferably communication between the various receivers 304 and the central unit 306 takes place intermittently rather than continuously, for enhanced economy. Such communication preferably includes composite messages including messages relating to a plurality of parking events for a multiplicity of different vehicles. In respect of each parking event, the message typically includes data relating to the identity of the vehicle parked, parking location triangulation information, the date, the start time of parking and the finish time of parking.

Reference is now made to Fig. 2, which is a simplified pictorial illustration of a preferred embodiment of a parking location and payment system and methodology constructed and operative in accordance with a preferred embodiment of the present invention.

Fig. 2 illustrates a GPS-based system for finding available parking locations and for effecting payment for parking without requiring any driver intervention. Similarly to the system shown in Fig. 1A, a vehicle 400, equipped with a GPS receiver 402 or similar location determining device, is parked by a driver. Without requiring any intervention by the driver, a parking communicator 404, receiving a location input from

GPS receiver 402, transmits a message in a wireless manner to a central unit 406, which in turn provides data used for effecting payment for parking.

The message typically includes data relating to the identity of the vehicle parked, the parking location, the date and the start time of parking. As described hereinabove with reference to Fig. 1A, messages are sent thereafter indicating parking finish time in one of a number of alternative manners.

In the embodiment of Fig. 2, in addition to the functionality described hereinabove with reference to Fig. 1A, the vehicle is preferably provided with at least one sensor 408 indicating existence of at least one potential unoccupied additional adjacent parking place. The sensor 408 is typically a laser, radar or ultrasonic range finder and is typically mounted so as to be either front facing or rearward facing so as to identify the existence of an empty parking space. The output of sensor 408 is communicated while the vehicle is parked, preferably in a wireless manner, to a parking location center 410, which may integrated with the central unit 406 or may employ all or part of the same computer hardware.

The parking location center 410 typically maintains a street parking map database indicating legal street parking spaces and includes functionality providing a correlator. The correlator receives an output from sensor 408 indicating the existence of at least one potential unoccupied additional adjacent parking place and correlates it with legal street parking spaces, using the database. An available parking communicator 412, associated with the parking location center 410, provides information regarding unoccupied legal street parking places to at least one driver, preferably in a wireless manner. Preferably communicator 412 broadcasts data indicating the availability of parking spaces at given locations either by direct wireless communication, wireless broadcast or via the Internet.

In the embodiment of Fig. 2, wireless communication from sensors 408 to parking location center 410 is preferably effected via communicator 404 and a cellular communication system, but may alternatively be effected by any other suitable wireless communication facility. Wireless communication from parking communicator 404 to central unit 406 may also be effected via a cellular communication facility. The communication from sensors 408 is preferably immediate upon a change of status from a status of availability to a status of unavailability and vice versa, while the communication from parking communicator 404 is normally intermittent, for reasons of economy.

It is appreciated that although the vehicle location functionality of Fig. 2 is shown in combination with a parking payment system, it is also possible that the vehicle location functionality be provided in a stand-alone form, such as without a parking payment system or with a parking payment system other than that of the type described hereinabove with reference to Fig. 1A. For example the vehicle location functionality of Fig. 2 may be provided in association with a parking payment system of the type described hereinabove with reference to either of Figs. 1B and 1C.

Reference is now made to Figs. 3A, 3B and 3C, which are simplified block diagram illustrations of three alternative embodiments of parking payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 1A, 1B and 1C respectively.

Fig. 3A illustrates, in block diagram form, the GPS-based system for effecting payment for parking shown in Fig. 1A. Vehicle 100 is equipped with GPS receiver 102, which receives inputs from GPS satellites 500. GPS receiver 102 outputs vehicle location data to a CPU 502, which preferably but not necessarily interfaces with a memory 504 and a display 506. Parking communicator 104 receives the location input from GPS receiver 102 via CPU 502 and transmits a message in a wireless manner to central unit 106, which in turn provides data used for effecting payment for parking to a billing system 508. It is appreciated that the billing system may employ various criteria in addition to the data received from central unit 106.

The central unit 106 typically includes a wireless receiver or transceiver 510, which interfaces with a CPU 512. CPU 512 preferably interfaces with a database 514. The CPU 512 and the database 514 preferably cooperate for processing the data received from the vehicle 100 into a form useful by the billing system 508.

Fig. 3B illustrates, in block diagram form, the GPS-based system for effecting payment for parking shown in Fig. 1B. Vehicle 200 is equipped with GPS receiver 202, which receives inputs from GPS satellites 600. GPS receiver 202 outputs vehicle location data to parking recorder 204, which typically includes a CPU 602 which interfaces with a memory 604 and optionally with a display 606. Communicator 206 receives all relevant parking information, stored in memory 604, for each parking event via CPU 602 and transmits a message including this information in a wireless manner to intermediate storage and communication unit 208, typically including a wireless receiver or transceiver 608, which outputs to a memory 610 via a CPU 611.

Intermediate storage and communication unit 208 also includes a communicator 612 which typically transmits a composite message in respect of multiple parking events of multiple vehicles to central unit 210.

Additionally, a facility optionally may be provided for enabling direct communication between vehicle mounted communicator 206 and central unit 210.

The central unit 210 typically includes a wireless receiver or transceiver 613, which interfaces with a CPU 614. Alternatively, communication between communicator 612 and receiver 613 may be wired rather than wireless. CPU 614 preferably interfaces with a database 616. The CPU 614 and the database 616 preferably cooperate for processing the data received from a multiplicity of vehicles 200 into a form useful by a billing system 618.

Fig. 3C illustrates, in block diagram form, the triangulation-based system for effecting payment for parking shown in Fig. 1C. Vehicle 300 includes transmitter 302, which transmits a wireless coded signal identifying the vehicle, without requiring any intervention by the driver.

The coded signal transmitted by transmitter 302 is received by at least two and preferably three receivers 304 which are located in general propinquity to the parking location of the vehicle 300 and communicate with a central unit 306.

Each receiver 304 preferably includes a directional receiver 700 which interfaces with a CPU 702. CPU 702 interfaces with a memory 704 and with a communicator 706.

Central unit 306 typically includes a communicator 708 which interfaces with a CPU 710. CPU preferably interfaces with a database 712 and outputs to a billing system 714. Communication between communicators 706 and 708 may be wired or wireless.

Each receiver 304 intermittently provides outputs indicating the start time and the finish time for each parking event of each identified vehicle, as well as the angular direction from which it was received.

As noted above with reference to Fig. 1C, using conventional triangulation technology, the receipt of the outputs of the receivers 304 enables the location of the vehicle 300 to be determined by central unit 306. The timing of receipt of the coded signals by receivers 304 as well as sensed change or lack of change in the vehicle location provides an indication of the parking start time and parking finish time, which, when received by the central unit 306 together with vehicle identification data, enable payment for parking to be effected.

Reference is now made to Figs. 4A, 4B and 4C, which are simplified flow charts illustrating the operation of the three alternative embodiments of parking payment systems and methodologies of Figs. 3A, 3B and 3C respectively.

Referring now to Fig. 4A, it is seen that an initial determination is made retroactively as to whether a vehicle has parked. This determination is typically made by sensing whether a vehicle has been motionless for at least a predetermined time, such as, for example five minutes. If a vehicle is determined to have been parked, the start time of parking is determined. The start time normally is earlier than the time that the determination was made. The system may or may not send a start parking message to central unit 106 at this stage.

The start time of parking is typically stored in memory 504 (Fig. 3A).

A determination is made of when the vehicle first moves from its parking location. Once such movement is sensed, the exit time of parking is determined. The exit time may be communicated to the central unit 106 upon exit. If the start time has not yet been communicated to the central unit 106, both the start time and exit time may be communicated together. As a further alternative, the start and exit time of each parking event may be stored in memory 504 for later transmittal to the central unit 106.

Referring now to Fig. 4B, which describes the system of Figs. 1B and 3B, it is seen that an initial determination is also made retroactively as to whether a vehicle has parked. This determination is typically made by sensing whether a vehicle has been motionless for at least a predetermined time, such as, for example five minutes. If a vehicle is determined to have been parked, the start time of parking is determined. The start time normally is earlier than the time that the determination was made.

The start time of parking is typically stored in memory 604 (Fig. 3B).

A determination is made of when the vehicle first moves from its parking location. Once such movement is sensed, the exit time of parking is determined. The start and exit time of each parking event are stored in memory 604 for later transmittal to the intermediate storage and communication unit 208.

When the vehicle reaches a download location, such as a filling station, the contents of memory 604 are preferably downloaded in a composite message to intermediate storage and communication unit 208.

Communicator 612 of intermediate storage and communication unit 208 typically transmits a composite message in respect of multiple parking events of multiple vehicles to central unit 210.

Optionally direct communication between vehicle mounted communicator 206 and central unit 210 may be provided.

Referring now to Fig. 4C, which describes the operation of the embodiment of Figs. 1C and 3C, it is seen that an initial determination is made by each receiver 304 retroactively as to whether a vehicle has parked. This determination is typically made by sensing whether a vehicle has been motionless for at least a predetermined time, such as, for example five minutes. If a vehicle is determined to have been parked, the start time of parking is determined. The start time normally is earlier than the time that the determination was made.

The start time of parking is typically stored in memory 704 (Fig. 3C) of each receiver.

A determination is made by each receiver of when the vehicle first moves from its parking location. Once such movement is sensed, the exit time of parking is determined. The start and exit time of each parking event are stored in memory 704.

Intermittently the start and exit times of a plurality of vehicles are transmitted to central unit 306 by receivers 304. The central unit, by employing triangulation techniques, determines the location of each vehicle and associates it with the corresponding start and exit times for each parking event.

Reference is now made to Fig. 5, which is a simplified block diagram illustration of an embodiment of a parking location and payment system and methodology constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Fig. 2.

Fig. 5 illustrates, in block diagram form, the GPS-based system for finding available parking locations and for effecting payment for parking without requiring any driver intervention shown in Fig. 2.

Vehicle 400 is equipped with GPS receiver 402, which receives inputs from GPS satellites 800. GPS receiver 402 outputs vehicle location data to a CPU 802, which preferably but not necessarily interfaces with a memory 804 and a display 806. Parking communicator 404 receives the location input from GPS receiver 402 via CPU 802 and transmits a message in a wireless manner to central unit 406, which in turn provides data used for effecting payment for parking to a billing system 808.

In the embodiment of Figs. 2 and 5, in addition to the functionality described hereinabove, the vehicle is preferably provided with at least one sensor 408 indicating existence of at least one potential unoccupied additional adjacent parking place. As noted hereinabove with reference to Fig. 2, the sensor 408 is typically a laser range finder, a radar device or an ultrasonic range finder and is typically mounted so as to be either front facing or rearward facing so as to identify the existence of an empty parking space.

The output of sensor 408 is communicated while the vehicle is parked, preferably in a wireless manner, preferably via communicator 404 to parking location center 410, which may be identical to central unit 406 or may employ all or part of the same computer hardware.

The central unit 406 typically includes a wireless receiver or transceiver 810, which interfaces with a CPU 812. CPU 812 preferably interfaces with a database 814. The CPU 812 and the database 814 preferably cooperate for processing the data received from the vehicle 400 into a form useful by the billing system 808.

As noted hereinabove with reference to Fig. 2, parking location center 410 typically maintains a street parking map database indicating legal street parking spaces and includes functionality providing a correlator. The correlator, here embodied in a CPU 816 receives an output from sensor 408 via communicator 817, indicating the existence of at least one potential unoccupied additional adjacent parking place and correlates it with legal street parking spaces, using a central database 818.

An available parking communicator 412, associated with the parking location center 410, provides information regarding unoccupied legal street parking places to at least one driver, preferably in a wireless manner. Preferably communicator 412 broadcasts data indicating the availability of parking spaces at given locations either by direct wireless communication, wireless broadcast or via the Internet.

It is appreciated that although the vehicle location functionality of Figs. 2 and 5 is shown in combination with a parking payment system, it is also possible that the vehicle location functionality be provided in a stand-alone form, such as without a parking payment system or with a parking payment system other than that of the type described hereinabove with reference to Figs. 1A, 3A and 4A. For example, the vehicle location functionality of Figs. 2 and 5 may be provided in association with a parking payment system of the type described hereinabove with reference to either of Figs. 1B and 1C.

Reference is now made to Fig. 6, which is a simplified flow chart illustrating an embodiment of the parking location and payment system and methodology of Figs. 2 and 5. As seen in Fig. 6, the embodiment of Figs. 2 and 5 provides parking payment functionality. which may be identical to that of Fig. 4A. In addition to the parking payment functionality, the embodiment of Figs. 2 and 5 provides parking location functionality as described hereinbelow:

A determination is made whether vehicle 400 has parked. If so, a determination is made, using sensor 408, whether an adjacent parking space is empty. If so, a message is transmitted forthwith to parking location center 410. The parking space center 410, makes a determination as to whether the sensed empty parking space is a legal parking space. If so, it notifies other drivers by any suitable technique.

Thereafter, if the vehicle remains parked and the sensed empty parking space remains empty, no further message is transmitted to parking location center 410. If, however, the previously empty parking space is subsequently filled, a suitable message is sent to parking location center 410, preferably causing an appropriate notification to be broadcast thereby to other vehicles.

Reference is now made to Figs. 7A, 7B and 7C, which are simplified pictorial illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and which preferably are characterized in that the payment in respect of a vehicle-related service is dependent on at least one of whether and when the vehicle is being operated.

Important examples of such systems and methodologies include vehicle insurance billing and vehicle fee payment systems wherein the only variables sensed by an on-board vehicle sensor, which are considered in the billing data are duration of vehicle use and time of day or night of vehicle use. Other types of such systems and methodologies are also within the scope of the present invention.

Turning now to Fig. 7A, there is seen a vehicle 900 equipped with a vehicle movement or other vehicle operation determining sensor 902. Sensor 902 is typically a vibration sensor, an electrical or acoustic motor operation sensor or a driver presence sensor. Sensor 902 need not necessarily be connected to the electrical system of the vehicle 900.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 900 and subsequently parks the vehicle 900 are recorded in a memory 904, which may store a series of vehicle operation start and stop records.

As illustrated in Fig. 7A, when the vehicle 900 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, an on-board communicator 906 downloads data stored in memory 904 and relating to a plurality of vehicle operation start and stop events, typically in a wireless manner, to an intermediate storage and communication unit 908, typically located at the filling station. The intermediate storage and communication unit 908 preferably receives and stores data relating to a plurality of vehicle operation start and stop events in respect of a multiplicity of vehicles and communicates this data, in a composite message, preferably in a wireless manner, to a central unit 910. Alternatively or additionally, download locations may be found at other locations, such as road intersections, parking lots and malls.

Typically, the composite message may be transmitted at any time from the intermediate storage and communication unit 908 to the central unit 910. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events for a multiplicity of different vehicles. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation and the stop time of vehicle operation.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Turning now to Fig. 7B, there is seen a vehicle 1000 equipped with a movement or operation determining sensor 1002. Sensor 1002 is typically a vibration sensor, an electrical or acoustic motor operation sensor or a driver presence sensor. Sensor 1002 need not necessarily be connected to the electrical system of the vehicle 1000.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 1000 and subsequently parks the vehicle 1000 are recorded in a memory 1004, which may store a series of vehicle operation start and stop records.

As illustrated in Fig. 7B, an on-board communicator 1006 downloads data stored in memory 1004 and relating to a plurality of vehicle operation start and stop events, in a composite message, preferably in a wireless manner to a central unit 1010.

Typically, the composite message may be transmitted at any time from the communicator 1006 to the central unit 1010. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation and the stop time of vehicle operation.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Turning now to Fig. 7C, there is seen a vehicle 1100 equipped with a GPS receiver 1102 receiving inputs from satellites 1103 or a similar location determining devices. The GPS receiver 1102 senses when the location of the vehicle changes.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 1100 and subsequently parks the vehicle 1100 are recorded in a memory 1104, which may store a series of vehicle operation start and stop records.

As illustrated in Fig. 7C, an on-board communicator 1106 downloads data stored in memory 1104 and relating to a plurality of vehicle operation start and stop events, in a composite message, preferably in a wireless manner to a central unit 1110.

Typically, the composite message may be transmitted at any time from the communicator 1106 to the central unit 1110. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation and the stop time of vehicle operation.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Additionally or alternatively, communicator 1106 may communicate with the central unit 1110 via an intermediate storage and communication unit 1108, much in the same way as described hereinabove with reference to Fig. 7A.

Reference is now made to Figs. 8A, 8B and 8C, which are simplified block diagram illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 7A, 7B and 7C respectively.

Turning now to Fig. 8A, it is seen that vehicle 900 includes a CPU 1202, which interfaces with movement or operation determining sensor 902, memory 904 and on-board communicator 906.

As illustrated in Fig. 8A, when the vehicle 900 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 906 downloads data stored in memory 904 relating to a plurality of vehicle operation start and stop events, typically in a wireless manner, to intermediate storage and communication unit 908. The intermediate storage and communication unit 908 includes a receiver or transceiver 1204 which interfaces with a CPU 1206. The CPU 1206 interfaces with a memory 1208 which stores data relating to a plurality of vehicle operation start and stop events in respect of a multiplicity of vehicles and with a communicator 1210, which communicates this data, in a composite message, preferably in a wireless manner to central unit 910.

Central unit 910 preferably includes a receiver or transceiver 1212 which interfaces with a CPU 1214. The CPU 1214 in turn interfaces with a database 1216. The database 1216 accumulates the content of the composite messages received by the central unit 910 and supplies this content in an appropriate form to a billing system 1218. The billing system 1218 may take into account appropriate additional criteria, such as, for example in the case of insurance, the age and driving experience of a driver and various characteristics of the vehicle or in the case of vehicle-related fees, the type and weight of the vehicle.

Turning now to Fig. 8B, it is seen that vehicle 1000 includes a CPU 1302, which interfaces with movement or operation determining sensor 1002, memory 1004 and on-board communicator 1006.

As illustrated in Fig. 8B, on-board communicator 1006 downloads data stored in memory 1004 and relating to one or more vehicle operation start and stop events, typically in a wireless manner, to central unit 1010. Central unit 1010 preferably includes a receiver or transceiver 1312 which interfaces with a CPU 1314. The CPU 1314 in turn interfaces with a database 1316. The database 1316 accumulates the content of the composite messages received by the central unit 1010 and supplies this content in an appropriate form to a billing system 1318.

Turning now to Fig. 8C, it is seen that vehicle 1100 includes a GPS receiver 1102 receiving inputs from satellites 1103. GPS receiver 1102 outputs to a CPU 1402 which interfaces with memory 1104 and with an optional display 1404. CPU also interfaces with on-board communicator 1106.

As illustrated in Fig. 8C, when the vehicle 1100 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 1106 downloads data stored in memory 1104 and relating to a plurality of vehicle operation start and stop events, typically in a wireless manner, to intermediate storage and communication unit 1108. The intermediate storage and communication unit 1108 includes a receiver or transceiver 1404 which interfaces with a CPU 1406. The CPU 1406 interfaces with a memory 1408 which stores data relating to a plurality of vehicle operation start and stop events in respect of a multiplicity of vehicles and with a communicator 1410, which communicates this data, in a composite message, preferably in a wireless manner to central unit 1110. Central unit 1110 preferably includes a receiver or transceiver 1412 which interfaces with a CPU 1414. The CPU 1414 in turn interfaces with a database 1416. The database accumulates the content of the composite messages received by the central unit 1110 and supplies this content in an appropriate form to a billing system 1418.

Additionally or alternatively, communicator 1106 may communicate directly with the central unit 1110, bypassing the intermediate storage and communication unit 1108. In such a case, units 1108 may be obviated.

Reference is now made to Figs. 9A, 9B and 9C, which are simplified flow charts illustrating the operation of the three alternative embodiments of payment systems and methodologies of Figs. 7A and 8A, 7B and 8B and 7C and 8C, respectively.

Turning now to Fig. 9A, it is seen that a determination of whether vehicle 900 is being operated is made repeatedly. If the vehicle is being operated, a determination of the start time of vehicle operation is made and the start time is stored in memory 904.

While the vehicle is operating, a determination of whether vehicle 900 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time is stored in memory 904.

At any suitable time when the vehicle is located at a suitable download location, whether the vehicle is operating or not operating, the contents of the memory 904 may be downloaded to the intermediate storage and communication unit 908 and thence to the central unit 910.

Turning now to Fig. 9B, it is seen that a determination of whether vehicle 1000 is being operated is made repeatedly. If the vehicle is being operated, a determination of the start time of vehicle operation is made and the start time is stored in memory 1004.

While the vehicle is operating, a determination of whether vehicle 1000 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time is stored in memory 1004.

At any suitable time, whether the vehicle is operating or not operating, the contents of the memory 1004 may be downloaded to the central unit 1010.

Turning now to Fig. 9C, it is seen that a determination of whether vehicle 1100 is being operated is made repeatedly. If the vehicle is being operated, a determination of the start time of vehicle operation is made and the start time is stored in memory 1104.

While the vehicle is operating, a determination of whether vehicle 1100 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time is stored in memory 1104.

At any suitable time, whether the vehicle is operating or not operating, the contents of the memory 1104 may be downloaded directly to central unit 1110.

Alternatively, the contents of memory 1104 may be downloaded via the intermediate storage and communication unit 1108 to the central unit 1110 when the vehicle is at a suitable download location.

Reference is now made to Figs. 10A, 10B and 10C, which are simplified pictorial illustrations of preferred embodiments of vehicle fee payment systems and methodologies constructed and operative in accordance with three alternative preferred embodiments of the present invention.

The embodiment of Figs. 10A - 10C may be employed for modulating traffic over given roads at given times or on given days. Thus, as appropriate, travel over certain routes may require payment of a fee, whereas travel over other alternative routes may require payment of a lesser fee or no fee at all.

It will be appreciated that the embodiment of Figs. 10A - 10C may also be employed for collecting user fees on toll roads. The embodiment of Figs. 10A - 10C may additionally be employed for collecting fees for entry into certain regions, such as areas of a city. Such fees may apply only at certain times or days and may vary from time to time or day to day.

Additionally in accordance with a preferred embodiment of the present invention, the embodiment of Figs. 10A - 10C may be employed for collecting fees that are duration-based solely or in combination with other time, date and/or location criteria. Thus, for example the fees payable may be a function not only of the time of day or date of entry, but also of the time duration that the vehicle is operating within a restricted area.

Fig. 10A shows a GPS based system wherein vehicles 1500 are each equipped with a GPS receiver 1502 which receives location inputs from satellites 1503. GPS receiver 1502 senses the location of each vehicle 1500 over time and provides an output indication of vehicle location as a function of time, which is preferably stored in a memory 1504 located in the vehicle 1500. The contents of the memory 1504 thus provide a record of whether the vehicle is being operated and where it has been traveling, without requiring or permitting driver intervention.

One or more of vehicles 1500 may also include vehicle operation monitors, such as a pollution monitor 1505. The output of the vehicle operation monitor, such as pollution monitor 1505 may also be stored in memory 1504.

As illustrated in Fig. 10A, an on-board communicator 1506 downloads data stored in memory 1504 and relating to vehicle operations over a time period extending from the preceding download, in a composite message, preferably in a wireless manner to a central unit 1510.

Typically, the composite message may be transmitted at any time from the communicator 1506 to the central unit 1510. The message typically includes data relating to the identity of the vehicle and the location of the vehicle during vehicle operation.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Additionally or alternatively, communicator 1506 may communicate with the central unit 1510 via an intermediate storage and communication unit 1508, much in the same way as described hereinabove with reference to Fig. 7A.

It is appreciated that the functionality of Fig. 10A may also be applicable in vehicle insurance payment systems.

Fig. 10B shows a fixed infrastructure based system wherein vehicles 1600 are each equipped with a transmitter 1602, which transmits a wireless coded signal identifying the vehicle. Without requiring any intervention by the driver, the coded signal transmitted by transmitter 1602 is received by suitably located travel monitors 1604 which are preferably located in general propinquity to entrances to and exits from restricted or fee bearing locations. Such locations may be, for example, roads as shown in Fig. 10B or alternatively regions of a city where access is restricted or requires the payment of a fee.

The travel monitor 1604 senses the identity of each vehicle 1600 in suitable propinquity thereto and provides an output indication of the sensed vehicle presence at a given time, which is preferably stored in a memory 1606, preferably located at the travel monitor 1604. The combined contents of memories 1606 at suitably located travel monitors 1604 thus provide a record of where and when a vehicle has been or is traveling in a monitored travel space, without requiring or permitting driver intervention.

It may be appreciated that suitable location of travel monitors 1604 at the entrances and exits of roads may enable accurate and efficient collection of fees on roads and suitable location of travel monitors 1604 on access arteries to given regions may enable accurate and efficient collection of fees for access to such restricted or fee bearing areas.

As illustrated in Fig. 10B, a communicator 1608 associated with each travel monitor 1604 downloads data stored in memory 1606 and relating to vehicle operations over a time period extending from the preceding download, in a composite message, preferably in a wireless manner to a central unit 1610.

Typically, the composite message may be transmitted at any time from the communicator 1608 to the central unit 1610. The message typically includes data relating to the identity of the vehicle, the date and the time vehicle presence is sensed as well as the identity of the travel monitor 1604, which, of course, indicates its location.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

The central unit 1610 preferably employs the information contained in the composite messages received by it from various travel monitors 1604 to compute fees chargeable to individual vehicles, which are based, inter alia, on time duration of vehicle presence within given regions.

Fig. 10C shows a system wherein vehicles 1700 are each equipped with a receiver 1702 which receives coded location input signals from fixed local transmitters 1703. Receivers 1702 thus sense the presence of the vehicle 1700 at a given location at a given time.

The coded signals are transmitted by transmitters 1703 which are preferably located in general propinquity to entrances and exits from restricted or fee bearing locations. Such locations may be, for example, roads as shown in Fig. 10C or alternatively regions of a city where access is restricted or requires the payment of a fee.

The receiver 1702 senses the identity of each transmitter 1703 as the vehicle 1700 passes in suitable propinquity thereto and provides an output indication of the sensed vehicle presence at a given location at a given time, which is preferably stored in a memory 1706, located on-board the vehicle 1700. The contents of memory 1706 thus provide a record of where and when a vehicle has been or is traveling in a monitored travel space, without requiring or permitting driver intervention.

One or more of vehicles 1700 may also include vehicle operation monitors, such as a pollution monitor 1707. The output of the vehicle operation monitor, such as pollution monitor 1707 may also be stored in memory 1706. Vehicle operation monitors may be any suitable vehicle operation monitors, such as, for example, an on-board vehicle pollution monitor such as that described in U.S. Patent 5,583,765, the disclosure of which is hereby incorporated by reference. It is appreciated that vehicle pollution over a given level may involve payment of a fee, which may be collected automatically by means of the system of Figs. 10A and 10C.

As illustrated in Fig. 10C, an on-board communicator 1708 downloads data stored in memory 1706 and relating to vehicle operations over a time period extending from the preceding download, in a composite message, preferably in a wireless manner to a central unit 1710.

Typically, the composite message may be transmitted at any time from the communicator 1708 to the central unit 1710. The message typically includes data relating to the identity of the vehicle, the date and the time that the vehicle 1700 passes within predetermined propinquity of each of transmitters 1703.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Additionally or alternatively, communicator 1706 may communicate with the central unit 1710 via an intermediate storage and communication unit 1712, much in the same way as described hereinabove with reference to Fig. 7A.

Reference is now made to Figs. 11A, 11B and 11C which are simplified block diagram illustrations of preferred embodiments of vehicle fee payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 10A, 10B and 10C respectively.

Turning now to Fig. 11A, it is seen that vehicle 1500 includes a GPS receiver 1502 receiving inputs from satellites 1503. GPS receiver 1502 outputs to a CPU 1802 which interfaces with memory 1504 and with an optional display 1804. CPU also interfaces with on-board communicator 1506 and with a vehicle operation monitor, such as pollution monitor 1505.

As illustrated in Fig. 11A. when the vehicle 1500 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 1506 downloads data stored in memory 1504 and relating to vehicle operations over a time preferably extending since a previous download, typically in a wireless manner, to intermediate storage and communication unit 1508. The intermediate storage and communication unit 1508 includes a receiver or transceiver 1804 which interfaces with a CPU 1806. The CPU interfaces with a memory 1808 which stores data relating to vehicle operations in respect of a multiplicity of vehicles and with a communicator 1810, which communicates this data, in a composite message, preferably in a wireless manner, to central unit 1510.

Central unit 1510 preferably includes a receiver or transceiver 1812 which interfaces with a CPU 1814. The CPU 1814 in turn interfaces with a database 1816. The database accumulates the content of the composite messages received by the central unit 1510 and supplies this content in an appropriate form to a billing system 1818.

Additionally or alternatively, communicator 1506 may communicate directly with the central unit 1510, bypassing the intermediate storage and communication unit 1508. In such a case, units 1508 may be obviated.

Fig. 11B shows that vehicle 1600 includes transmitter 1602, which transmits a wireless coded signal identifying the vehicle, without requiring any intervention by the driver.

The coded signal transmitted by transmitter 1602 is received by travel monitors 1604 which are located in general propinquity to entrances and exits from restricted or fee bearing locations. Such locations may be, for example, roads as shown in Fig. 10B or alternatively regions of a city where access is restricted or requires the payment of a fee.

Each travel monitor 1604 preferably includes a receiver 1900 which interfaces with a CPU 1902. CPU 1902 interfaces with memory 1606 and with communicator 1608.

As illustrated in Fig. 11B, communicator 1608 associated with each travel monitor 1604 downloads data stored in memory 1606 and relating to vehicle operations over a time period extending from the preceding download, in a composite message, preferably in a wireless manner, to central unit 1610.

Typically, the composite message may be transmitted at any time from the communicator 1608 to the central unit 1610. The message typically includes data relating to the identity of the vehicle, the date and the time vehicle presence is sensed as well as the identity of the travel monitor 1604, which, of course, indicates its location.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

The central unit 1610 preferably employs the information contained in the composite messages received by it from various travel monitors 1604 to compute fees chargeable to individual vehicles, which are based, inter alia, on time duration of vehicle presence within given regions.

Central unit 1610 typically includes a communicator 1908 which interfaces with a CPU 1910. CPU 1910 preferably interfaces with a database 1912 and outputs to a billing system 1914. Communication between communicators 1608 and 1908 may be wired or wireless.

Turning now to Fig. 11C, it is seen that vehicle 1700 includes a receiver 1702 receiving inputs from transmitters 1703. Receiver 1702 outputs to a CPU 2002 which interfaces with memory 1706 and with an optional display 2004. CPU 2002 also interfaces with on-board communicator 1708 and with a vehicle operation monitor, such as pollution monitor 1707.

As illustrated in Fig. 10C, when the vehicle 1700 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 1708 downloads data stored in memory 1706 relating to vehicle operations over a time preferably extending since a previous download, typically in a wireless manner, to intermediate storage and communication unit 1712. The intermediate storage and communication unit 1712 includes a receiver or transceiver 2006 which interfaces with a CPU 2008. The CPU 2008 interfaces with a memory 2010 which stores data relating to vehicle operations in respect of a multiplicity of vehicles and with a communicator 2012, which communicates this data, in a composite message, preferably in a wireless manner to central unit 1710.

Central unit 1710 preferably includes a receiver or transceiver 2014 which interfaces with a CPU 2016. The CPU 2016 in turn interfaces with a database 2018. The database accumulates the content of the composite messages received by the central unit 1710 and supplies this content in an appropriate form to a billing system 2020.

Additionally or alternatively, communicator 1708 may communicate directly with the central unit 1710, by passing the intermediate storage and communication unit 1712. In such a case, units 1712 may be obviated.

Reference is now made to Figs. 12A, 12B and 12C which are simplified flow charts illustrating the operation of preferred embodiments of vehicle fee payment systems and methodologies of Figs. 10A and 11A, 10B and 11B and 10C and 11C.

Turning now to Fig. 12A, it is seen that a determination of the location of vehicle 1500 is made repeatedly and the location of the vehicle 1500 as a function of time is stored in memory 1504 for such times as the vehicle 1500 is being operated. Preferably, an output from a vehicle operation monitor such as pollution monitor 1505 is also stored in the memory.

At any suitable time when the vehicle is located at a suitable download location, whether the vehicle is operating or not operating, the contents of the memory 1504 may be downloaded to the intermediate storage and communication unit 1508 and thence to the central unit 1510. Alternatively or additionally, the contents of memory 1504 may be downloaded directly to the central unit 1510.

Turning now to Fig. 12B, it is seen that the travel monitors 1604 continuously record the identity of vehicles in predetermined propinquity thereto as well as the time of such propinquity. This information is stored in memories 1606 of monitors 1604.

At any suitable time, the contents of the memories 1606 may be downloaded to the central unit 1610, which processes them into vehicle specific information useful for billing functionality and supplies the contents of memory 1604 to billing system 1914.

Turning now to Fig. 12C, it is seen that receiver 1702 records instances when vehicle 1700 is in predetermined propinquity to a transmitter 1703 as well as the time of such propinquity. This information is stored in memory 1706.

At any suitable time, the contents of the memories 1706 of vehicles 1700 may be downloaded to the intermediate storage and communication unit 1712 and thence to the central unit 1710. Alternatively or additionally, the contents of memory 1706 may be downloaded directly to the central unit 1710.

Reference is now made to Figs. 13A, 13B and 13C, which are simplified pictorial illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with another preferred embodiment of the present invention and which preferably are characterized in that the payment in respect of a vehicle-related service is dependent on at least one of the mileage traveled by a vehicle and the time of day that the vehicle is being operated and preferably is dependent on both.

Important examples of such systems and methodologies include vehicle insurance billing and vehicle fee payment systems wherein the only variables, sensed by an on-board vehicle sensor, which are considered in the billing data are vehicle mileage and time of day or night of vehicle use. Other types of such systems and methodologies are also within the scope of the present invention.

Turning now to Fig. 13A, there is seen a vehicle 2100 equipped with a vehicle movement or other vehicle operation determining sensor 2102. Sensor 2102 is typically a mileage sensor of any suitable design or principle of operation. Sensor 2102 need not necessarily be connected to the electrical system of the vehicle 2100.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 2100 and subsequently parks the vehicle 2100 as well as the accrued mileage are recorded in a memory 2104, which may store a series of vehicle operation start and stop records as well as mileage records.

As illustrated in Fig. 13A, when the vehicle 2100 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, an on-board communicator 2106 downloads data stored in memory 2104 and relating to a plurality of vehicle operation start and stop events as well as mileage records, typically in a wireless manner, to an intermediate storage and communication unit 2108, typically located at the filling station. The intermediate storage and communication unit 2108 preferably receives and stores data relating to a plurality of vehicle operation start and stop events as well as mileage records in respect of a multiplicity of vehicles and communicates this data, in a composite message, preferably in a wireless manner to a central unit 2110. Alternatively or additionally, download locations may be found at other locations, such as road intersections, parking lots and malls.

Typically, the composite message may be transmitted at any time from the intermediate storage and communication unit 2108 to the central unit 2110. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events and corresponding mileage records for a multiplicity of different vehicles. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation, the stop time of vehicle operation and the mileage.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Turning now to Fig. 13B, there is seen a vehicle 2200 equipped with a movement or operation determining sensor 2202. Sensor 2202 is typically a mileage sensor of any suitable design or principle of operation. Sensor 2202 need not necessarily be connected to the electrical system of the vehicle 2200.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 2200 and subsequently parks the vehicle 2200 as well as the accrued mileage are recorded in a memory 2204, which may store a series of vehicle operation start and stop records as well as mileage records.

As illustrated in Fig. 13B, an on-board communicator 2206 downloads data stored in memory 2204 and relating to a plurality of vehicle operation start and stop events and corresponding mileage records, in a composite message, preferably in a wireless manner to a central unit 2210.

Typically, the composite message may be transmitted at any time from the communicator 2206 to the central unit 2210. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events and corresponding mileage records. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation and the stop time of vehicle operation as well as mileage records.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Turning now to Fig. 13C, there is seen a vehicle 2300 equipped with a GPS receiver 2302 receiving inputs from satellites 2303 or similar location determining device. The GPS receiver 2302 senses when the location of the vehicle changes.

Without requiring any intervention by the driver, the times when a driver moves the vehicle 2300 and subsequently parks the vehicle 2300 as well as the corresponding accrued mileage are recorded in a memory 2304, which may store a series of vehicle operation start and stop records as well as mileage records.

As illustrated in Fig. 13C, an on-board communicator 2306 downloads data stored in memory 2304 and relating to a plurality of vehicle operation start and stop events and accrued mileage, in a composite message, preferably in a wireless manner to a central unit 2310.

Typically, the composite message may be transmitted at any time from the communicator 2306 to the central unit 2310. Such a composite message typically includes messages relating to a plurality of vehicle operation start and stop events and accrued mileage. In respect of each such event, the message typically includes data relating to the identity of the vehicle, the date, the start time of vehicle operation and the stop time of vehicle operation as well as the accrued mileage.

Composite messages may be transmitted at predetermined times or upon accumulation of data relating to a predetermined number of events or based on any other suitable criterion or combination of criteria.

Additionally or alternatively, communicator 2306 may communicate with the central unit 2310 via an intermediate storage and communication unit 2308, much in the same way as described hereinabove with reference to Fig. 13A.

Reference is now made to Figs. 14A, 14B and 14C, which are simplified block diagram illustrations of three alternative embodiments of vehicle-related services payment systems and methodologies constructed and operative in accordance with a preferred embodiment of the present invention and corresponding to Figs. 13A, 13B and 13C respectively.

Turning now to Fig. 14A, it is seen that vehicle 2100 includes a CPU 2402, which interfaces with sensor 2102, memory 2104 and on-board communicator 2106.

As illustrated in Fig. 14A, when the vehicle 2100 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 2106 downloads data stored in memory 2104 and relating to a plurality of vehicle operation start and stop events and corresponding mileage records, typically in a wireless manner, to intermediate storage and communication unit 2108. The intermediate storage and communication unit 2108 includes a receiver or transceiver 2404 which interfaces with a CPU 2406. The CPU interfaces with a memory 2408 which stores data relating to a plurality of vehicle operation start and stop events and corresponding accrued mileage in respect of a multiplicity of vehicles and with a communicator 2410, which communicates this data, in a composite message, preferably in a wireless manner, to central unit 2110.

Central unit 2110 preferably includes a receiver or transceiver 2412 which interfaces with a CPU 2414. The CPU 2414 in turn interfaces with a database 2416. The database accumulates the content of the composite messages received by the central unit 2110 and supplies this content in an appropriate form to a billing system 2418. The billing system 2418 may take into account appropriate additional criteria, such as, for example in the case of insurance, the age and driving experience of a driver and various characteristics of the vehicle or in the case of vehicle-related fees, the type and weight of the vehicle.

Turning now to Fig. 14B, it is seen that vehicle 2200 includes a CPU 2502, which interfaces with sensor 2202, memory 2204 and on-board communicator 2206.

As illustrated in Fig. 14B, on-board communicator 2206 downloads data stored in memory 2204 and relating to one or more vehicle operation start and stop events and accrued mileage records, typically in a wireless manner, to central unit 2210. Central unit 2210 preferably includes a receiver or transceiver 2512 which interfaces with a CPU 2514. The CPU 2514 in turn interfaces with a database 2516. The database accumulates the content of the composite messages received by the central unit 2210 and supplies this content in an appropriate form to a billing system 2518.

Turning now to Fig. 14C, it is seen that vehicle 2300 includes a GPS receiver 2302 receiving inputs from satellites 2303. GPS receiver 2302 outputs to a CPU 2602 which interfaces with memory 2304 and with an optional display 2604. CPU 2602 also interfaces with on-board communicator 2306.

As illustrated in Fig. 14C, when the vehicle 2300 is located at one of a multiplicity of predetermined download locations, such as a suitably equipped filling station, on-board communicator 2306 downloads data stored in memory 2304 and relating to a plurality of vehicle operation start and stop events as well as accrued mileage, typically in a wireless manner, to intermediate storage and communication unit 2308. The intermediate storage and communication unit 2308 includes a receiver or transceiver 2605 which interfaces with a CPU 2606. The CPU interfaces with a memory 2608 which stores data relating to a plurality of vehicle operation start and stop events as well as accrued mileage in respect of a multiplicity of vehicles and with a communicator 2610, which communicates this data, in a composite message, preferably in a wireless manner to central unit 2310.

Central unit 2310 preferably includes a receiver or transceiver 2612 which interfaces with a CPU 2614. The CPU 2614 in turn interfaces with a database 2616. The database accumulates the content of the composite messages received by the central unit 2310 and supplies this content in an appropriate form to a billing system 2618.

Additionally or alternatively, communicator 2306 may communicate directly with the central unit 2310, bypassing the intermediate storage and communication unit 2308. In such a case, units 2308 may be obviated.

Reference is now made to Figs. 15A, 15B and 15C, which are simplified flow charts illustrating the operation of the three alternative embodiments of payment systems and methodologies of Figs. 13A and 14A, 13B and 14B and 13C and 14C, respectively.

Turning now to Fig. 15A, it is seen that a determination of whether vehicle 2100 is being operated is made repeatedly. If the vehicle is being operated, a determination of the start time of vehicle operation is made, a mileage count is started and the start time is stored in memory 2104.

While the vehicle is operating, a determination of whether vehicle 2100 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time and accrued mileage are stored in memory 2104.

At any suitable time when the vehicle is located at a suitable download location, whether the vehicle is operating or not operating, the contents of the memory 2104 may be downloaded to the intermediate storage and communication unit 2108 and thence to the central unit 2110.

Turning now to Fig. 15B, it is seen that a determination of whether vehicle 2200 is being operated is made repeatedly. If the vehicle is being operated, a mileage count is started, a determination of the start time of vehicle operation is made and the start time is stored in memory 2204.

While the vehicle is operating, a determination of whether vehicle 2200 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time and accrued mileage are stored in memory 2204.

At any suitable time, whether the vehicle is operating or not operating, the contents of the memory 2204 may be downloaded to the central unit 2210.

Turning now to Fig. 15C, it is seen that a determination of whether vehicle 2300 is being operated is made repeatedly. If the vehicle is being operated, a mileage count is started, a determination of the start time of vehicle operation is made and the start time is stored in memory 2304.

While the vehicle is operating, a determination of whether vehicle 2300 is still being operated is made repeatedly. If the vehicle ceases operation for at least a predetermined time, typically 5 minutes, a determination of the stop time of vehicle operation is made and the stop time and accrued mileage are stored in memory 2304.

At any suitable time, whether the vehicle is operating or not operating, the contents of the memory 2304 may be downloaded directly to central unit 2310. Alternatively, the contents of memory 2304 may be downloaded via the intermediate storage and communication unit 2308 to the central unit 2310 when the vehicle is at a suitable download location.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove as well as variations and modifications which would occur to persons skilled in the art upon reading the specification and which are not in the prior art.

CLAIMS

1. A vehicle-related services system comprising:

at least one sensor automatically sensing at least one of the time during which a vehicle is not being operated and where said vehicle is located when it is not being operated; and

at least one data processor receiving information sensed by said at least one sensor, indicating at least one of the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated and providing a billing data output in respect of a vehicle-related service which is dependent on at least one of the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated.

2. A vehicle-related services system according to claim 1 and wherein said at least one sensor automatically senses the time of day and date when said vehicle is not being operated.

3. A vehicle-related services system according to any of the preceding claims and wherein said at least one sensor automatically senses the time duration during which said vehicle is not being operated.

4. A vehicle-related services system according to any of the preceding claims and wherein:

said at least one sensor automatically senses the time during which a vehicle is not being operated and where said vehicle is located when it is not being operated; and

said at least one data processor receives information sensed by said at least one sensor, indicating the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated and provides a billing data output in respect of a vehicle-related service which is dependent on the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated.

5. A vehicle-related services system according to any of the preceding claims and wherein:

said at least one sensor automatically senses the time during which a vehicle is parked and where said vehicle is located when it is parked; and said at least one data processor receives information sensed by said at least one sensor, indicating the time during which said vehicle is parked and where said vehicle is parked and provides a parking data output in respect of parking, which is dependent on the time during which said vehicle is parked and where said vehicle is parked.

6. A vehicle-related services system according to claim 5 and wherein said at least one sensor and said at least one data processor are operative without vehicle operator initiative to provide an indication of at least one of the time during which said vehicle is parked and where said vehicle is parked.

7. A vehicle-related services system according to claim 5 or claim 6 and wherein said sensor is on-board said vehicle.

8. A vehicle-related services system according to any of claims 5 to 7 and also comprising:

at least one communicator on-board said vehicle providing an output indicating the time during which vehicle is parked and where said vehicle is parked; and

a receiver associated with said at least one data processor for receiving a communication from said at least one communicator and employing said communication for providing said information to said at least one data processor.

9. A vehicle-related services system according to claim 8 and wherein said communicator communicates with said receiver at least partially not in real time.

10. A vehicle-related services system according to claim 8 or claim 9 and wherein said communicator communicates with an intermediate storage and communication unit only when a vehicle in which said communicator is located is at one of a plurality of predetermined locations.

11. A vehicle-related services system according to claim 10 and wherein said intermediate storage and communication unit is located at a vehicle fueling station.

12. A vehicle-related services system according to any of claims 5 to 11 and wherein said information includes identification of a street parking location in which said vehicle is stationary for at least a predetermined amount of time.

13. A vehicle-related services system according to any of the preceding claims and wherein said at least one sensor is operative to sense the time during which a vehicle is not being operated without requiring interaction with an indicating device fixed in propinquity to said location.

14. A vehicle-related services system according to claim 5 or claim 6 and wherein said at least one sensor is operative using triangulation to determine where a vehicle is parked.

15. A vehicle-related services system according to any of the preceding claims and also comprising at least one on-board vehicle potential additional parking space sensor which is operative when a vehicle is stationary at a street parking place for indicating whether at least one potential additional adjacent parking place is unoccupied.

16. A vehicle-related services system according to claim 15 and also comprising:

at least one on-board vehicle communicator providing an output indicating existence of at least one potential unoccupied additional adjacent parking place;

a street parking map database indicating legal street parking spaces;

a correlator receiving said output indicating existence of at least one potential unoccupied additional adjacent parking place and correlating it with said legal street parking spaces; and

an available parking communicator providing information regarding unoccupied legal street parking places to at least one driver.

17. A vehicle-related services system including:

a plurality of on-board potential additional parking space sensors located on a plurality of vehicles, which sensors each provide an output indicating existence of at least one potential unoccupied additional adjacent parking place adjacent a vehicle located in a street parking location; and

an available parking communicator employing information received from said plurality of sensors and providing information regarding unoccupied street parking places to at least one driver.

18. A vehicle-related services system according to claim 17 and also comprising:

a street parking map database indicating legal street parking spaces; and

a correlator receiving said output indicating existence of at least one potential unoccupied additional adjacent parking place and correlating it with said legal street parking spaces.

19. A vehicle-related services system comprising:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

at least one communicator on-board said vehicle providing an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

at least one data processor receiving a communication from said at least one communicator, indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related service which is dependent only on at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated.

20. A vehicle-related services system comprising:

at least one sensor on-board a vehicle and automatically sensing only at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

at least one communicator on-board said vehicle providing an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

at least one data processor receiving a communication from said at least one communicator, indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related service which is dependent on at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated.

21. A vehicle-related services system comprising:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated;

at least one communicator on-board said vehicle providing an output indicating at least one of the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated; and at least one data processor receiving a communication from said at least one communicator, indicating at least one of the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated; and providing a billing data output in respect of a vehicle-related service which is dependent only on at least one of the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated.

22. A vehicle-related services system according to any of claims 1 to 3 or claims 19 to 21 and wherein said at least one data processor comprises a vehicle insurance billing data processor.

23. A vehicle-related services system according to any of claims 19 to 21 and wherein said communicator communicates with an intermediate storage and communication unit only when a vehicle in which said communicator is located is at one of a plurality of predetermined locations.

24. A vehicle-related services system according to claim 23 and wherein said intermediate storage and communication unit is located at a vehicle fueling station.

25. A vehicle-related services system according to any of claims 1 to 3 or claims 19 to 24 and wherein said billing data comprises vehicle insurance billing data wherein the only variables, sensed by said on-board vehicle sensor, which are considered in said billing data are duration of vehicle operation and time of day or night of vehicle operation.

26. A vehicle-related services system according to any of claims 1 to 3 or claim 19 or claim 20 or claims 22 to 24 and wherein said billing data comprises vehicle insurance billing data wherein the only variables, sensed by said on-board vehicle sensor, which are considered in said billing data are duration of vehicle operation and location of the vehicle during said vehicle operation.

27. A vehicle-related services system according to claim 21 and wherein said billing data comprises vehicle insurance billing data wherein the only variables, sensed by said on-board vehicle sensor, which are considered in said billing data are time of day and date of vehicle operation and distance covered during said vehicle operation.

28. A vehicle-related services system according to any of claims 19 to 27 and wherein said billing data comprises vehicle insurance billing data wherein the said billing data is not dependent on vehicle speed.

29. A vehicle-related services system according to any of claims 19 to 20 and wherein said at least one data processor comprises a vehicle parking billing data processor.

30. A vehicle-related services system according to claim 29 and wherein said at least one sensor and said at least one data processor are operative without vehicle operator initiative to provide an indication of at least one of the time during which said vehicle is parked and where said vehicle is parked.

31. A vehicle-related services system according to any of claims 29 to 30 and wherein said at least one sensor is operative to sense the time during which a vehicle is being operated without requiring interaction with an indicating device fixed in propinquity to said location.

32. A vehicle-related services system according to any of claims 29 to 31 and wherein said communicator communicates with said at least one data processor at least partially not in real time.

33. A vehicle-related fee payment system comprising:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

at least one communicator on-board said vehicle providing an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

at least one data processor receiving a communication from said at least one communicator, indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the time during which said vehicle is being operated.

34. A vehicle-related fee payment system according to claim 33 and wherein said communicator communicates with said at least one data processor at least partially not in real time.

35. A vehicle-related fee payment system according to any of claims 33 to 34 and wherein said communicator communicates with an intermediate storage and communication unit only when a vehicle in which said communicator is located is at one of a plurality of predetermined locations.

36. A vehicle-related fee payment system according to claim 35 and wherein said intermediate storage and communication unit is located at a vehicle fueling station.

37. A vehicle-related fee payment system according to any of claims 33 to 36 and wherein said at least one data processor provides a billing data output in respect of a vehicle-related use fee which is dependent on the duration of vehicle operation and time of day of vehicle operation.

38. A vehicle-related fee payment system according to claim 37 and wherein said at least one data processor provides a billing data output in respect of a vehicle-related use fee which is also dependent on where said vehicle is located during vehicle operation.

39. A vehicle-related fee payment system according to any of claims 33 to 38 and wherein said billing data output is dependent on the time during which said vehicle is being operated and on a level of pollution being created by said vehicle.

40. A vehicle-related fee payment system comprising:

at least one sensor for automatically sensing the passage of a vehicle along a given road;

at least one data processor receiving a communication from said at least one sensor, indicating the passage of said vehicle along a given road at a given time and providing a billing data output in respect of a vehicle-related use fee which is dependent only on the time during which said vehicle is passing along said given road.

41. A vehicle-related fee payment system comprising:

at least one sensor on-board a vehicle and automatically sensing at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

at least one communicator on-board said vehicle providing an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

at least one data processor receiving a communication from said at least one communicator, indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the region in which a vehicle is operating and the time of day during which said vehicle is being operated in said region.

42. A vehicle-related services method comprising:

automatically sensing the time during which a vehicle is not being operated and where said vehicle is located when it is not being operated; and

receiving information indicating the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated and providing a parking data output in respect of a vehicle-related service which is dependent on the time during which said vehicle is not being operated and where said vehicle is located when it is not being operated.

43. A vehicle-related services method according to claim 42 and providing an indication of the time during which said vehicle is parked and where said vehicle is parked substantially without operator intervention.

44. A vehicle-related services method according to claim 43 and also comprising communicating an indication of the time during which said vehicle is parked and where said vehicle is parked to a receiver at least partially not in real time.

45. A vehicle-related services method according to claim 43 or claim 44 and wherein said automatic sensing takes place without requiring interaction with an indicating device fixed in propinquity to a parking location.

46. A vehicle-related services method including:

providing outputs indicating existence of at least one potential unoccupied additional adjacent parking place adjacent a plurality of vehicles located in street parking locations; and

employing said outputs received from said plurality of vehicles and providing information regarding unoccupied street parking places to at least one driver.

47. A vehicle-related services method comprising:

automatically sensing at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

communicating an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

receiving a communication indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing an insurance billing data output in respect of vehicle insurance which is dependent only on at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated.

48. A vehicle-related services method according to claim 47 and wherein said communicating takes place only when a vehicle is at one of a plurality of predetermined locations.

49. A vehicle-related services method according to claim 47 or claim 48 and wherein said billing data comprises vehicle insurance billing data wherein the only automatically sensed variables which are considered in said billing data are duration of vehicle operation and time of day or night of vehicle operation.

50. A vehicle-related fee payment method comprising:

automatically sensing at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated;

providing an output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated; and

receiving said output indicating at least one of the time during which said vehicle is being operated and where said vehicle is located when it is being operated and providing a billing data output in respect of a vehicle-related use fee which is dependent on the time during which said vehicle is being operated.

51. A vehicle-related fee payment method according to claim 50 and wherein said billing data output in respect of a vehicle-related use fee is dependent on the duration of vehicle operation and time of day of vehicle operation.

52. A vehicle-related fee payment method according to claim 50 to 51 and wherein said billing data output is dependent on the time during which said vehicle is being operated and on a level of pollution being created by said vehicle.

53. A vehicle-related services method comprising:

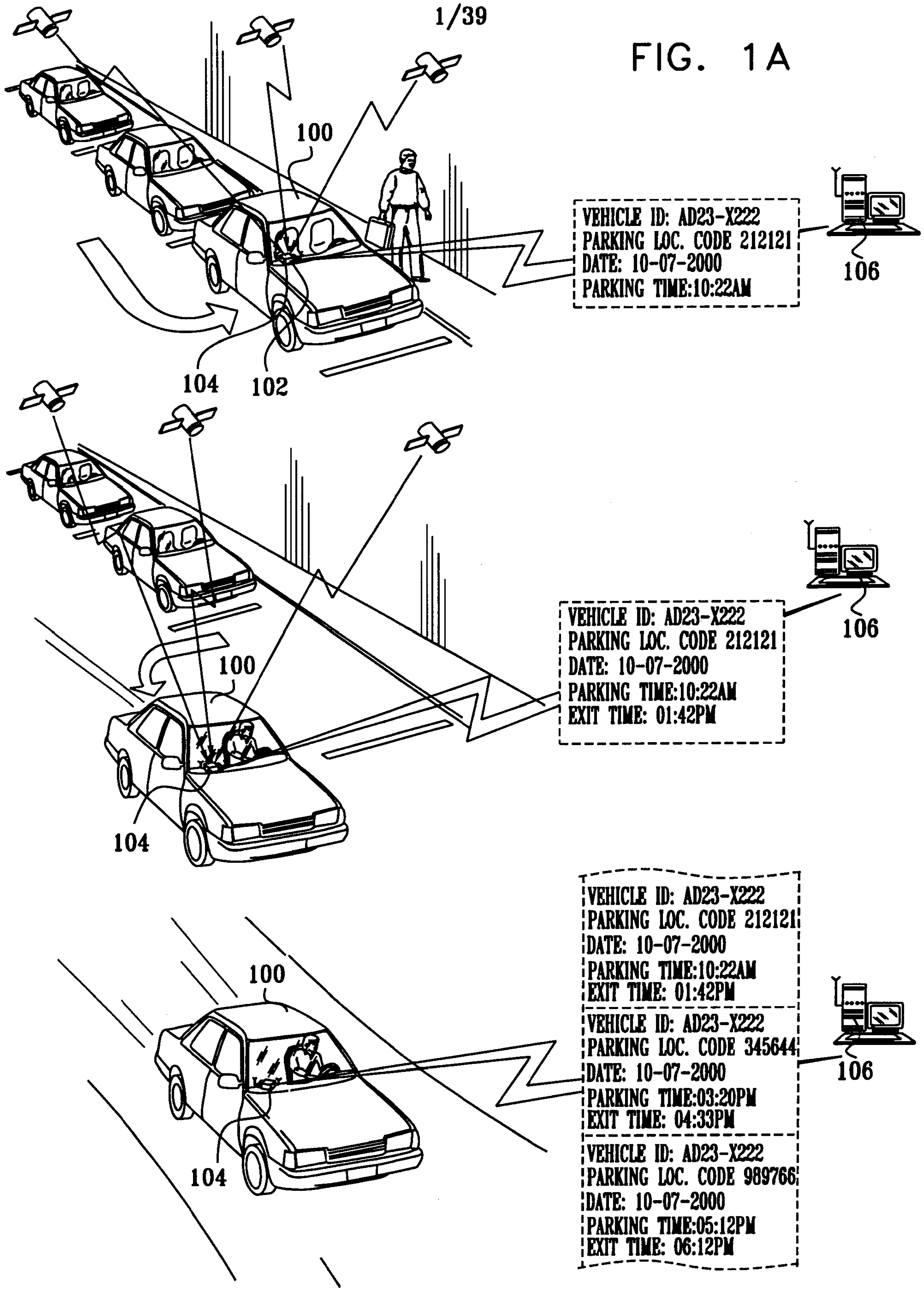
automatically sensing the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated;

communicating an output indicating the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated; and

receiving a communication indicating the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated and providing an insurance billing data output in respect of vehicle insurance which is dependent only on the time during which said vehicle is being operated and the distance traveled by said vehicle while it is being operated.

54. A vehicle-related services method according to claim 53 and wherein said billing data comprises vehicle insurance billing data wherein the only automatically sensed variables which are considered in said billing data are the distance traveled by said vehicle while it is being operated and time of day or night of vehicle operation.

FIG. 1A


100
104
102
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
106
100
104
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 01:42PM
106
100
104
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 01:42PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 345644
DATE: 10-07-2000
PARKING TIME:03:20PM
EXIT TIME: 04:33PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 989766
DATE: 10-07-2000
PARKING TIME:05:12PM
EXIT TIME: 06:12PM
106

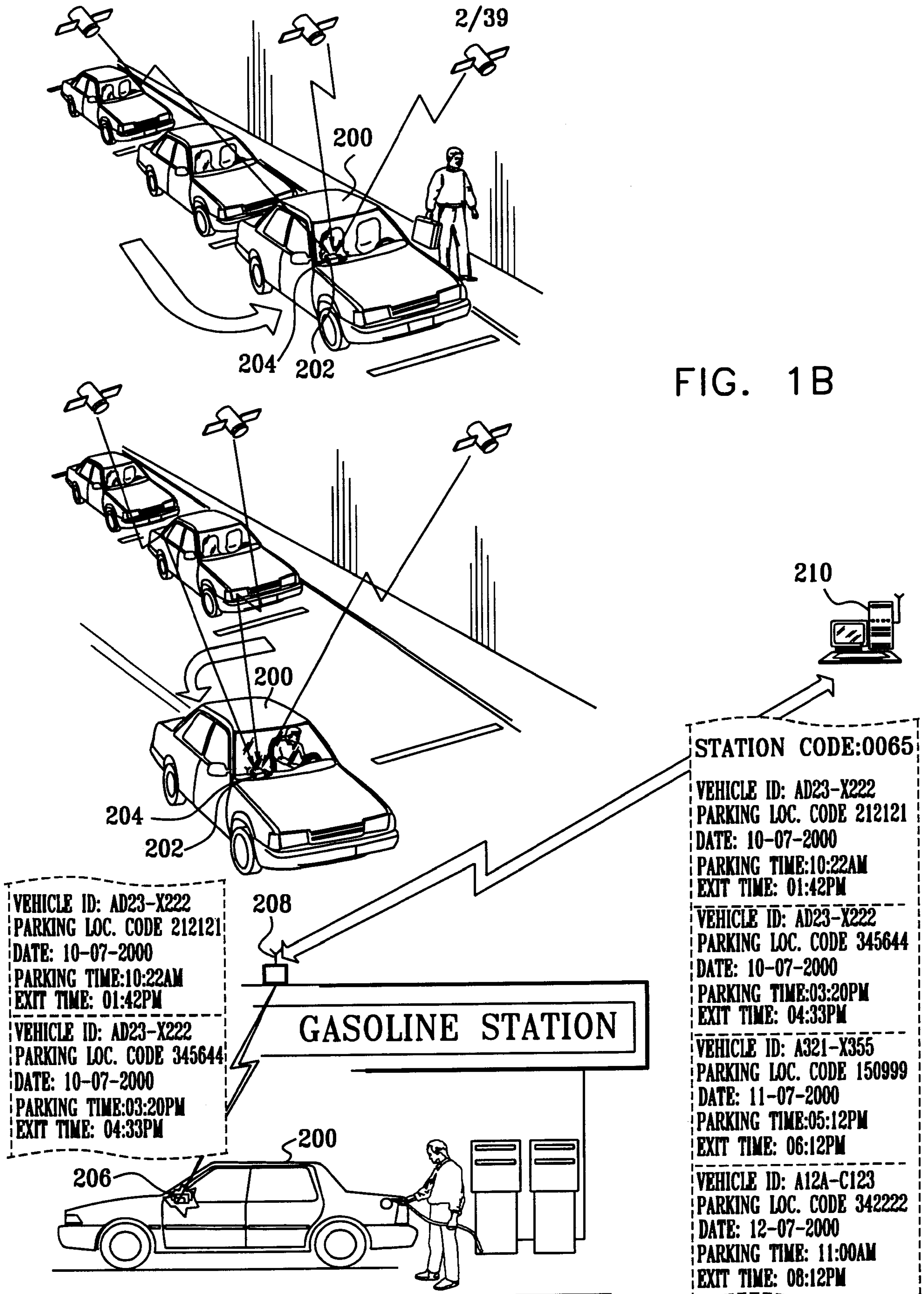

200
204
202
200
204
202
210
208
GASOLINE STATION
200
206
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 01:42PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 345644
DATE: 10-07-2000
PARKING TIME:03:20PM
EXIT TIME: 04:33PM
STATION CODE:0065
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 01:42PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 345644
DATE: 10-07-2000
PARKING TIME:03:20PM
EXIT TIME: 04:33PM
VEHICLE ID: A321-X355
PARKING LOC. CODE 150999
DATE: 11-07-2000
PARKING TIME:05:12PM
EXIT TIME: 06:12PM
VEHICLE ID: A12A-C123
PARKING LOC. CODE 342222
DATE: 12-07-2000
PARKING TIME: 11:00AM
EXIT TIME: 08:12PM

FIG. 1B

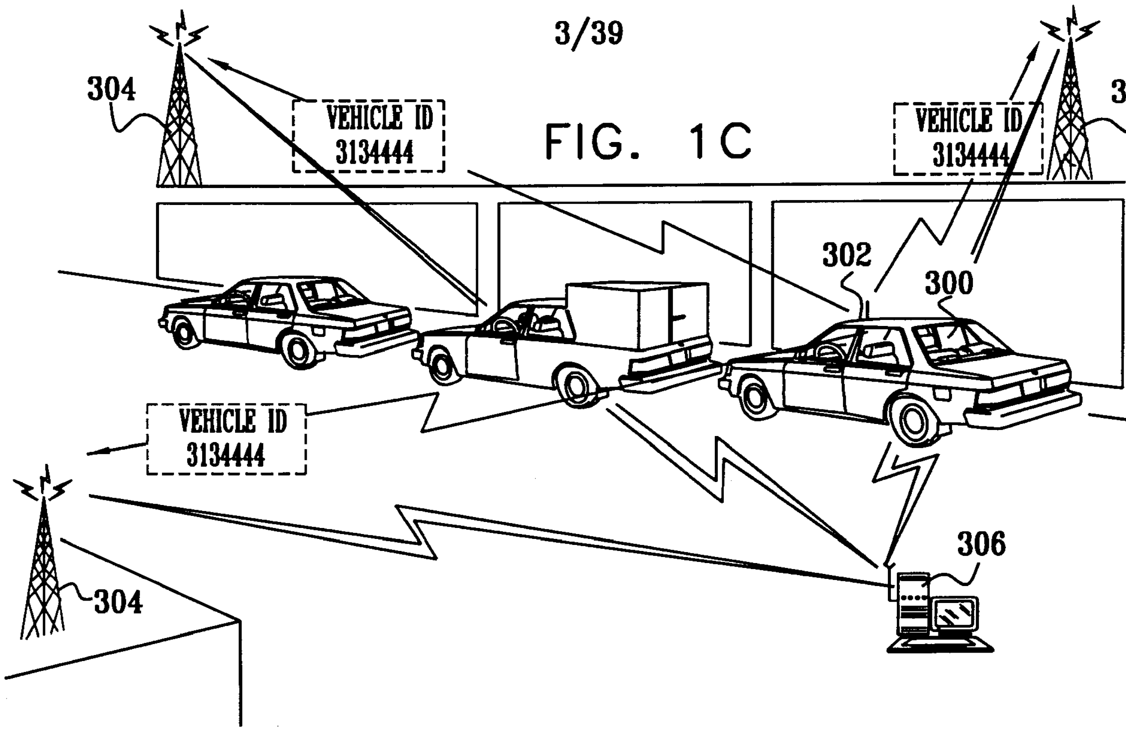
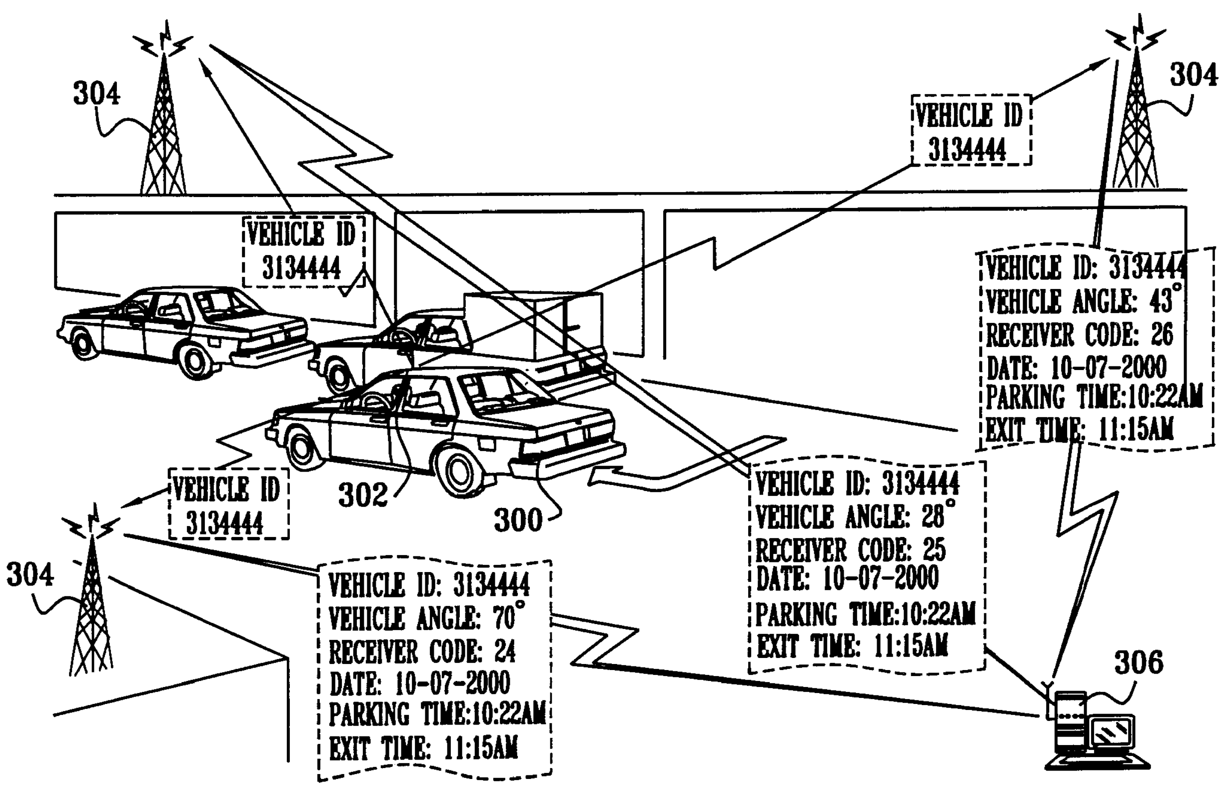

304
VEHICLE ID
3134444
304
VEHICLE ID
3134444
302
300
VEHICLE ID
3134444
306
304

FIG. 1C


304
304
VEHICLE ID
3134444
VEHICLE ID
3134444
VEHICLE ID: 3134444
VEHICLE ANGLE: 43°
RECEIVER CODE: 26
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 11:15AM
VEHICLE ID
3134444
302
300
VEHICLE ID: 3134444
VEHICLE ANGLE: 28°
RECEIVER CODE: 25
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 11:15AM
304
VEHICLE ID: 3134444
VEHICLE ANGLE: 70°
RECEIVER CODE: 24
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 11:15AM
306

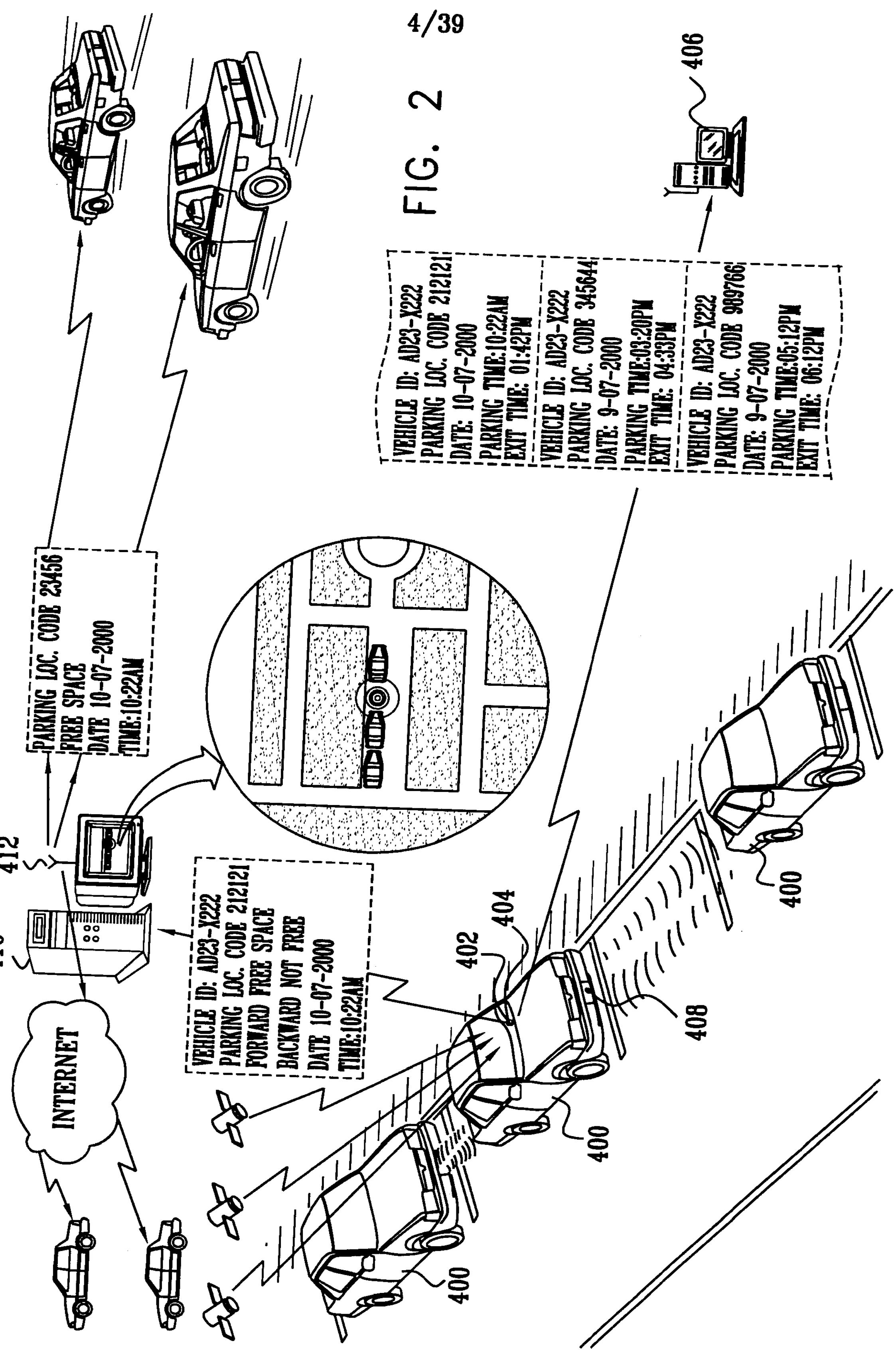

INTERNET
410
412
PARKING LOC. CODE 23456
FREE SPACE
DATE 10-07-2000
TIME:10:22AM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
FORWARD FREE SPACE
BACKWARD NOT FREE
DATE 10-07-2000
TIME:10:22AM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 212121
DATE: 10-07-2000
PARKING TIME:10:22AM
EXIT TIME: 01:42PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 345644
DATE: 9-07-2000
PARKING TIME:03:20PM
EXIT TIME: 04:33PM
VEHICLE ID: AD23-X222
PARKING LOC. CODE 989766
DATE: 9-07-2000
PARKING TIME:05:12PM
EXIT TIME: 06:12PM
406
402
404
408
400
400
400
400

FIG. 2

FIG 3A

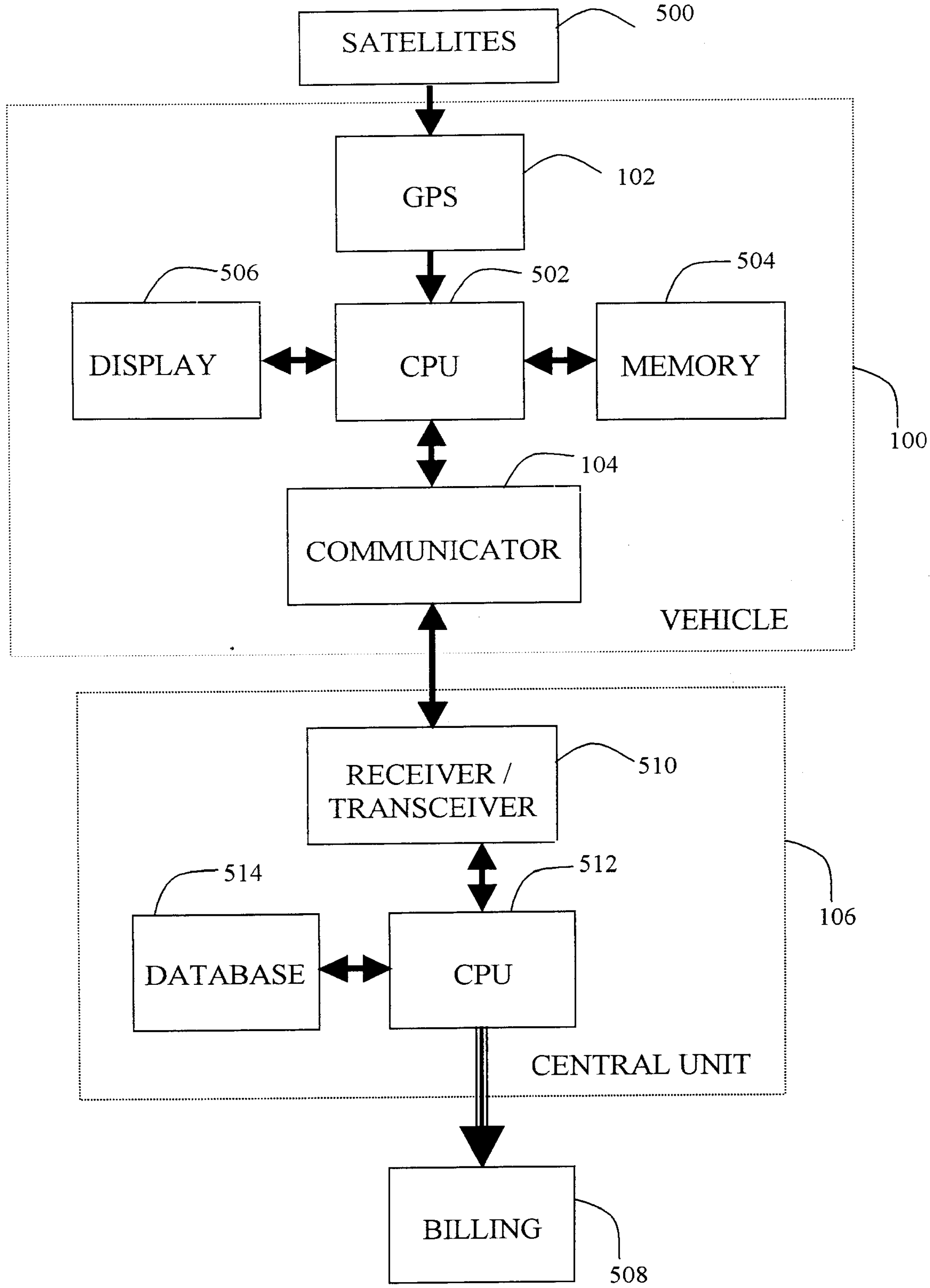
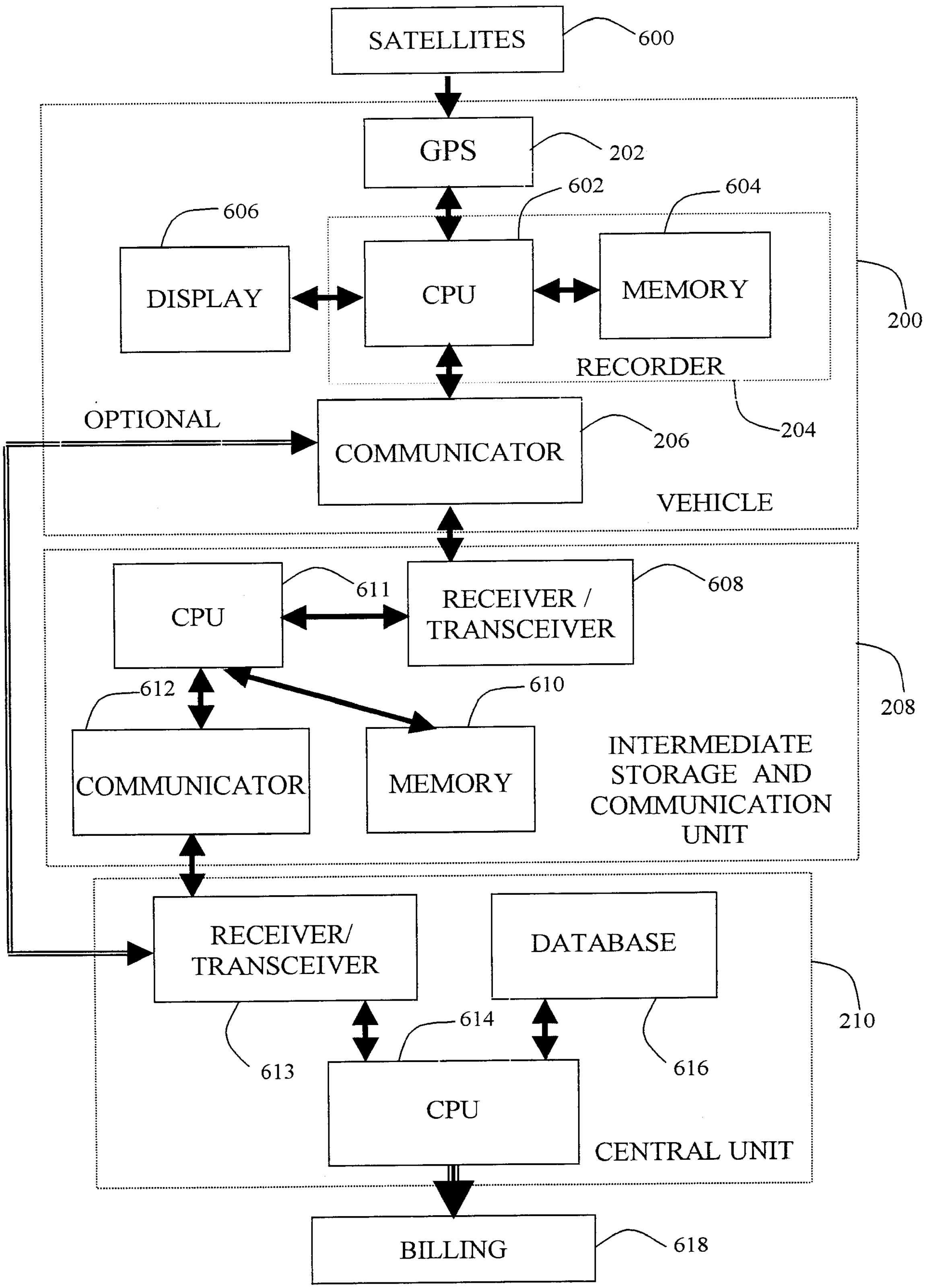

SATELLITES
500
GPS
102
506
502
504
DISPLAY
CPU
MEMORY
100
104
COMMUNICATOR
VEHICLE
RECEIVER /
TRANSCEIVER
510
514
512
106
DATABASE
CPU
CENTRAL UNIT
BILLING
508

FIG 3B


SATELLITES
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GPS
202
602
604
606
DISPLAY
CPU
MEMORY
200
RECORDER
OPTIONAL
COMMUNICATOR
206
204
VEHICLE
CPU
611
RECEIVER / TRANSCEIVER
608
612
610
208
COMMUNICATOR
MEMORY
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
RECEIVER/ TRANSCEIVER
DATABASE
614
210
613
616
CPU
CENTRAL UNIT
BILLING
618

FIG 3C

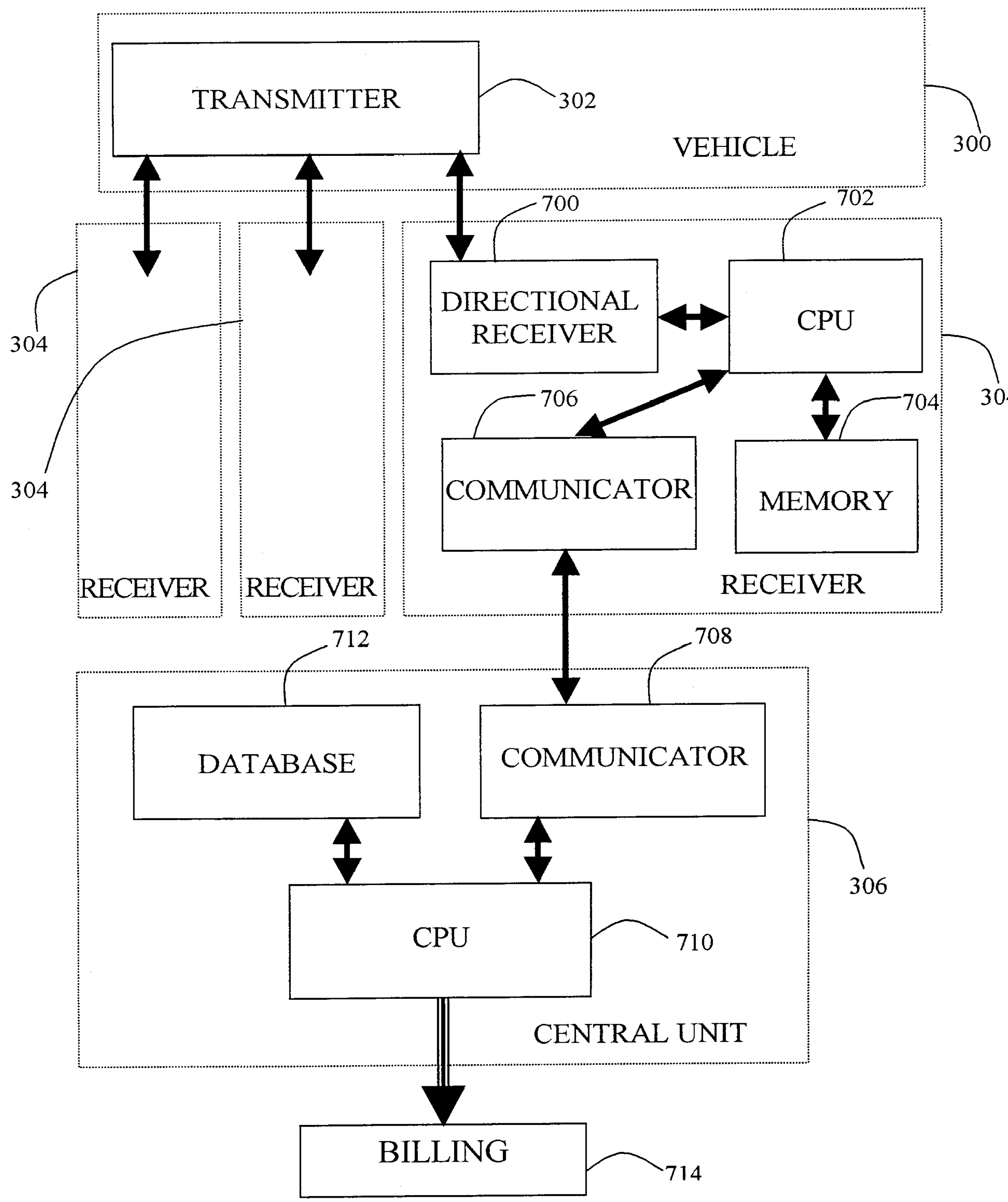

TRANSMITTER
302
VEHICLE
300
700
702
304
DIRECTIONAL RECEIVER
CPU
304
304
706
704
COMMUNICATOR
MEMORY
RECEIVER
RECEIVER
RECEIVER
712
708
DATABASE
COMMUNICATOR
306
CPU
710
CENTRAL UNIT
BILLING
714

FIG 4A

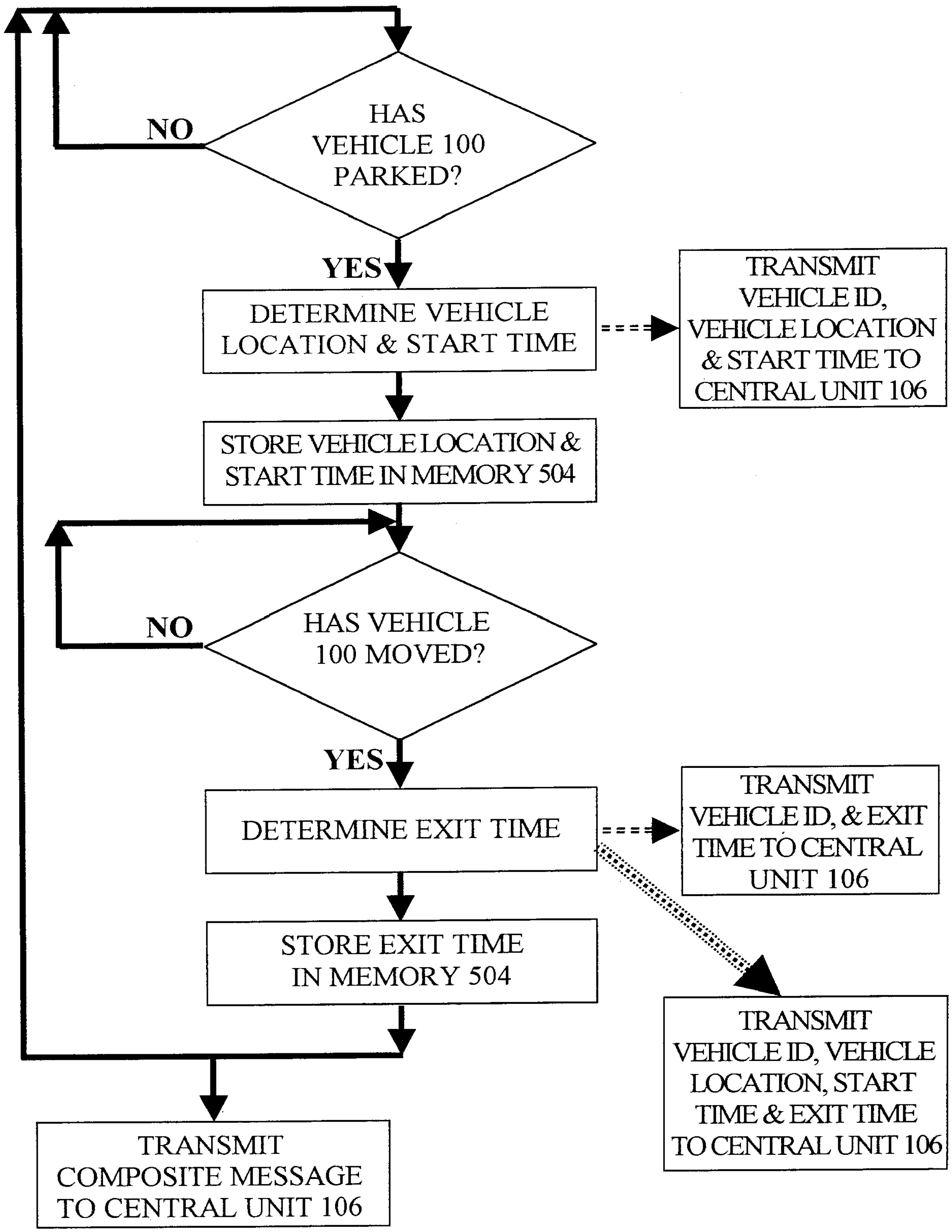

HAS
VEHICLE 100
PARKED?
NO
YES
DETERMINE VEHICLE
LOCATION & START TIME
TRANSMIT
VEHICLE ID,
VEHICLE LOCATION
& START TIME TO
CENTRAL UNIT 106
STORE VEHICLE LOCATION &
START TIME IN MEMORY 504
HAS VEHICLE
100 MOVED?
NO
YES
DETERMINE EXIT TIME
TRANSMIT
VEHICLE ID, & EXIT
TIME TO CENTRAL
UNIT 106
STORE EXIT TIME
IN MEMORY 504
TRANSMIT
VEHICLE ID, VEHICLE
LOCATION, START
TIME & EXIT TIME
TO CENTRAL UNIT 106
TRANSMIT
COMPOSITE MESSAGE
TO CENTRAL UNIT 106

FIG 4B

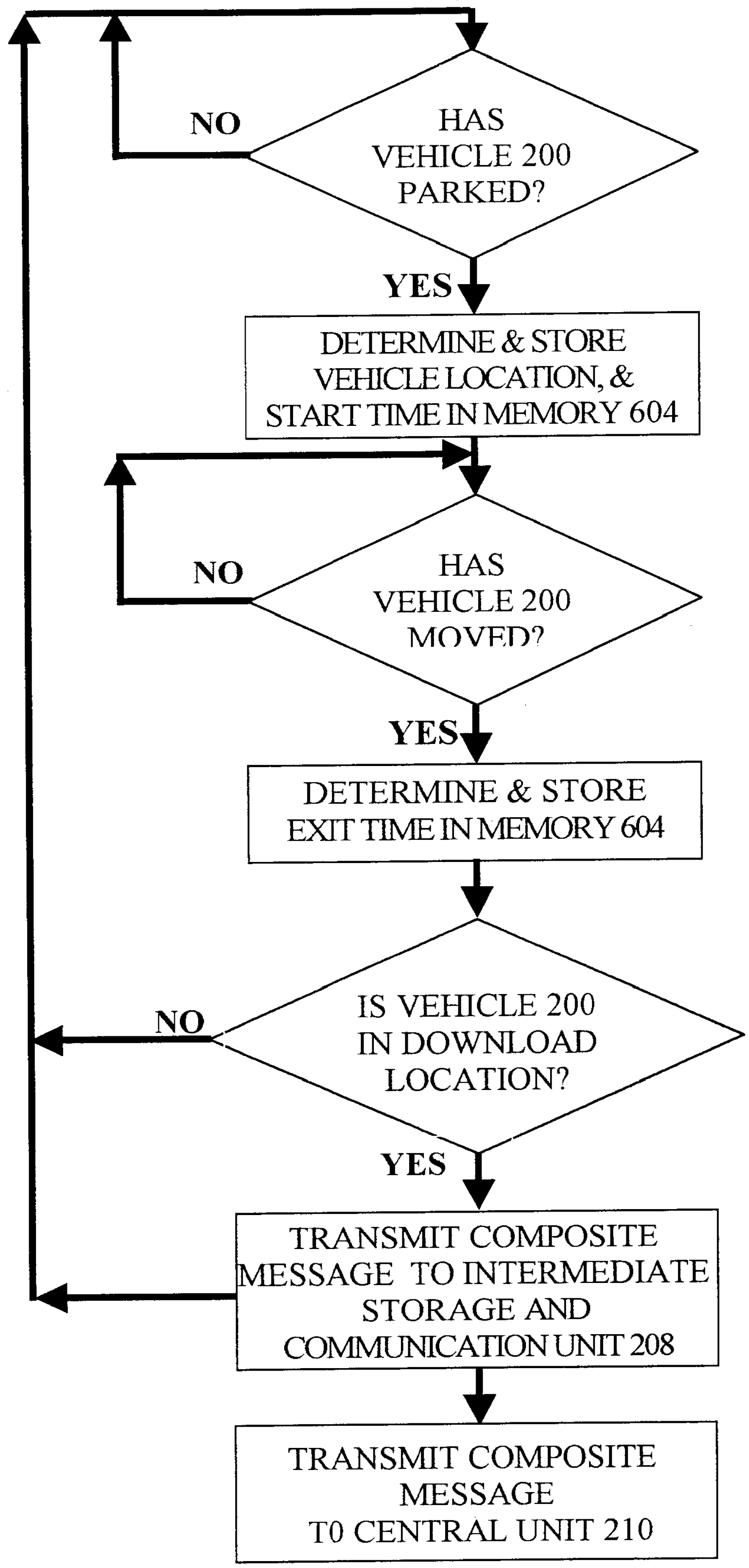

HAS
VEHICLE 200
PARKED?
NO
YES
DETERMINE & STORE
VEHICLE LOCATION, &
START TIME IN MEMORY 604
HAS
VEHICLE 200
MOVED?
NO
YES
DETERMINE & STORE
EXIT TIME IN MEMORY 604
IS VEHICLE 200
IN DOWNLOAD
LOCATION?
NO
YES
TRANSMIT COMPOSITE
MESSAGE TO INTERMEDIATE
STORAGE AND
COMMUNICATION UNIT 208
TRANSMIT COMPOSITE
MESSAGE
T0 CENTRAL UNIT 210

FIG 4C

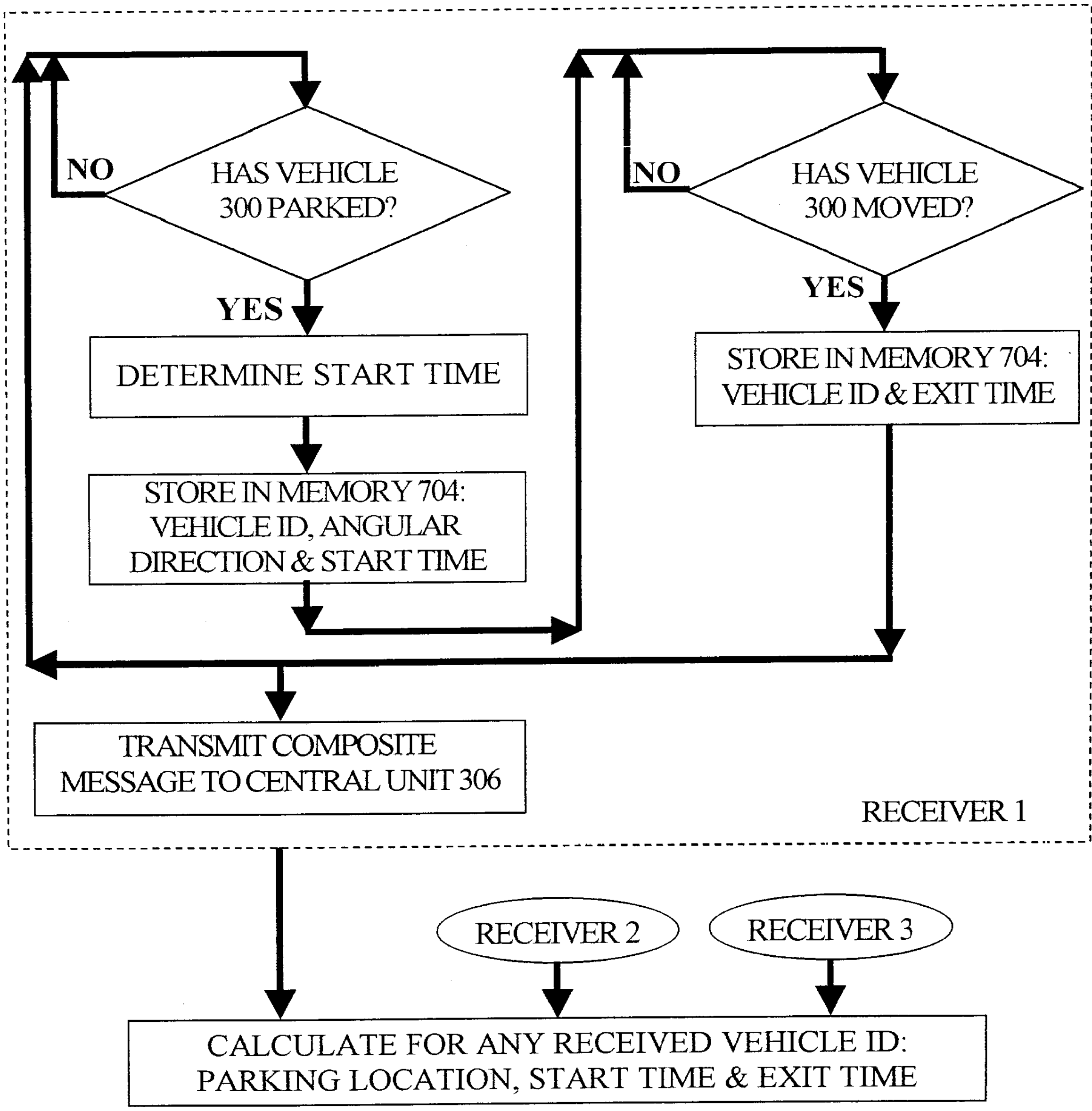

HAS VEHICLE 300 PARKED?
NO
YES
DETERMINE START TIME
STORE IN MEMORY 704: VEHICLE ID, ANGULAR DIRECTION & START TIME
HAS VEHICLE 300 MOVED?
NO
YES
STORE IN MEMORY 704: VEHICLE ID & EXIT TIME
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 306
RECEIVER 1
RECEIVER 2
RECEIVER 3
CALCULATE FOR ANY RECEIVED VEHICLE ID: PARKING LOCATION, START TIME & EXIT TIME

FIG 5

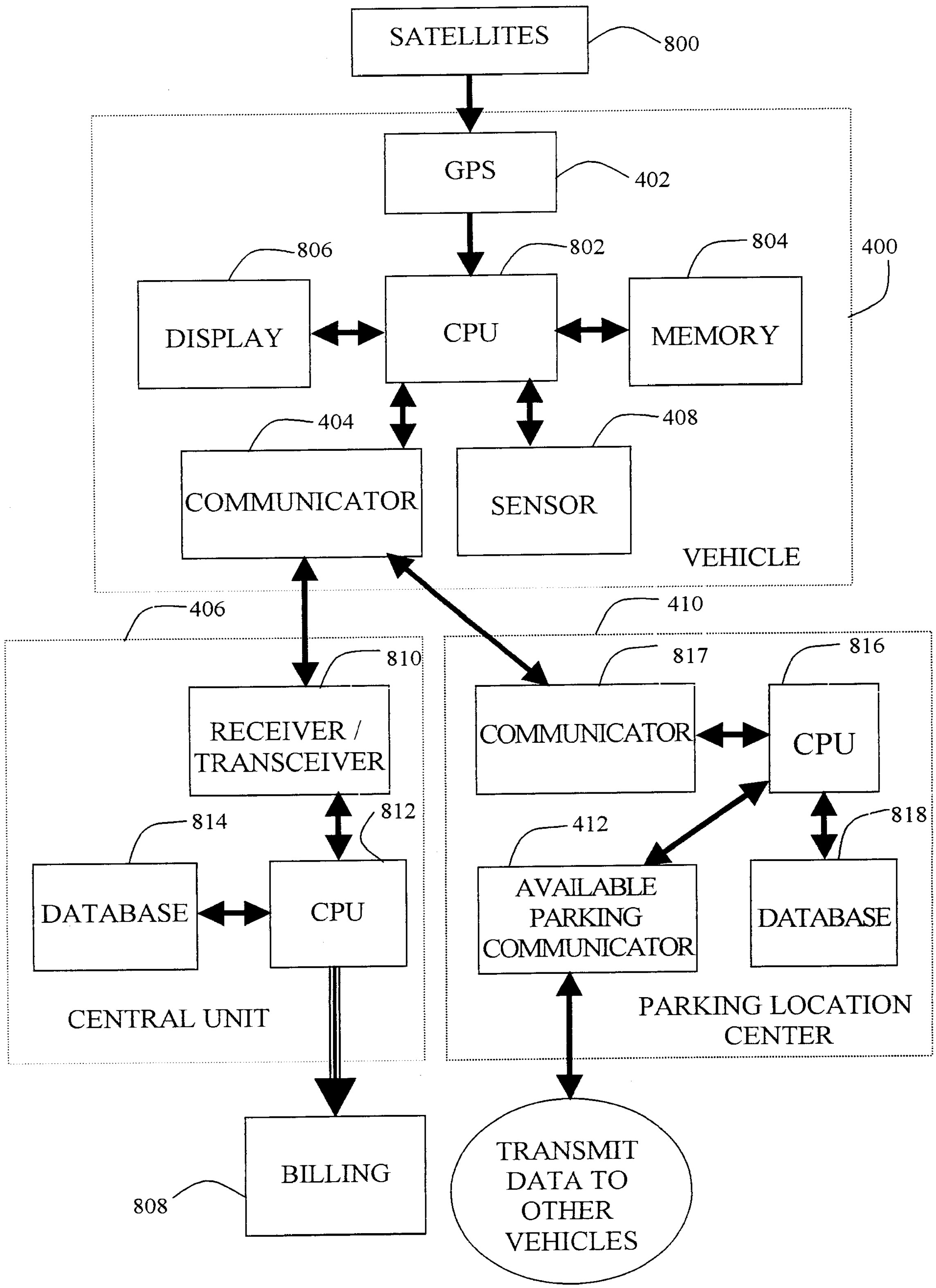
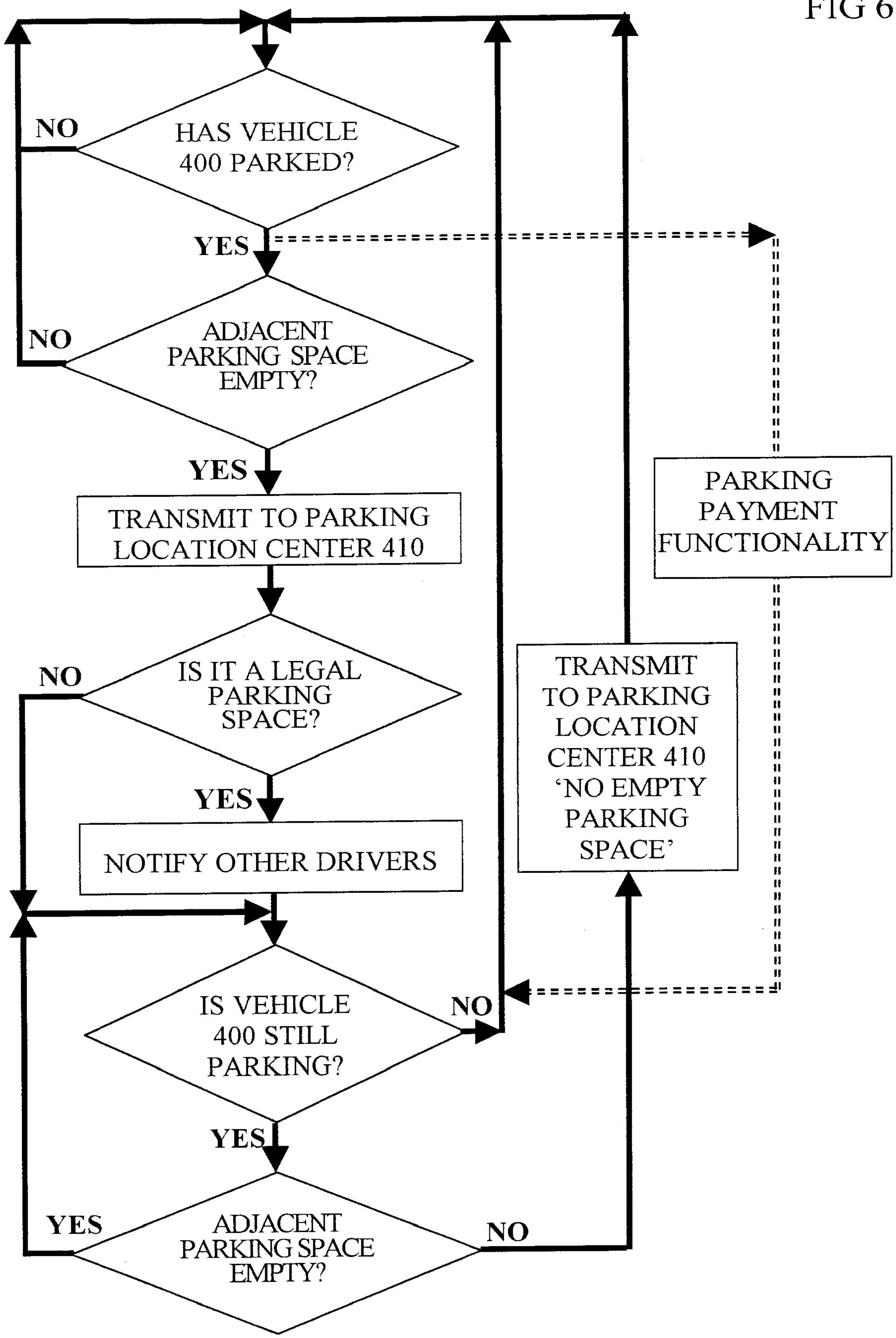

SATELLITES
800
GPS
402
806
802
804
400
DISPLAY
CPU
MEMORY
404
408
COMMUNICATOR
SENSOR
VEHICLE
406
410
810
817
816
RECEIVER / TRANSCEIVER
COMMUNICATOR
CPU
814
812
412
818
DATABASE
CPU
AVAILABLE PARKING COMMUNICATOR
DATABASE
CENTRAL UNIT
PARKING LOCATION CENTER
BILLING
808
TRANSMIT DATA TO OTHER VEHICLES

FIG 6


HAS VEHICLE 400 PARKED?
NO
YES
ADJACENT PARKING SPACE EMPTY?
NO
YES
TRANSMIT TO PARKING LOCATION CENTER 410
IS IT A LEGAL PARKING SPACE?
NO
YES
NOTIFY OTHER DRIVERS
IS VEHICLE 400 STILL PARKING?
NO
YES
ADJACENT PARKING SPACE EMPTY?
YES
NO
TRANSMIT TO PARKING LOCATION CENTER 410 'NO EMPTY PARKING SPACE'
PARKING PAYMENT FUNCTIONALITY

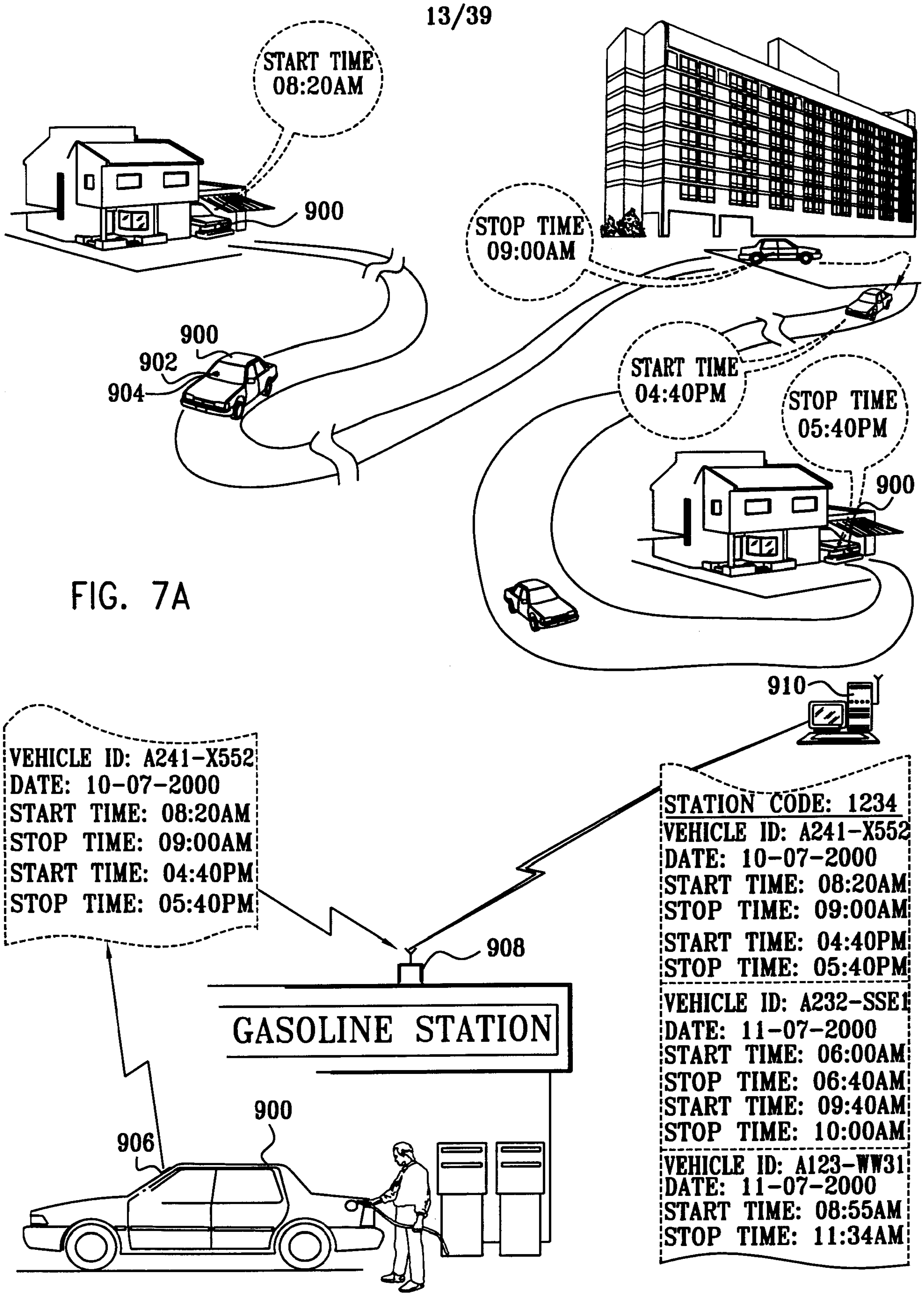

START TIME
08:20AM
900
STOP TIME
09:00AM
900
902
904
START TIME
04:40PM
STOP TIME
05:40PM
900
910
VEHICLE ID: A241-X552
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
START TIME: 04:40PM
STOP TIME: 05:40PM
STATION CODE: 1234
VEHICLE ID: A241-X552
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
START TIME: 04:40PM
STOP TIME: 05:40PM
VEHICLE ID: A232-SSE1
DATE: 11-07-2000
START TIME: 06:00AM
STOP TIME: 06:40AM
START TIME: 09:40AM
STOP TIME: 10:00AM
VEHICLE ID: A123-WW31
DATE: 11-07-2000
START TIME: 08:55AM
STOP TIME: 11:34AM
908
GASOLINE STATION
900
906

FIG. 7A

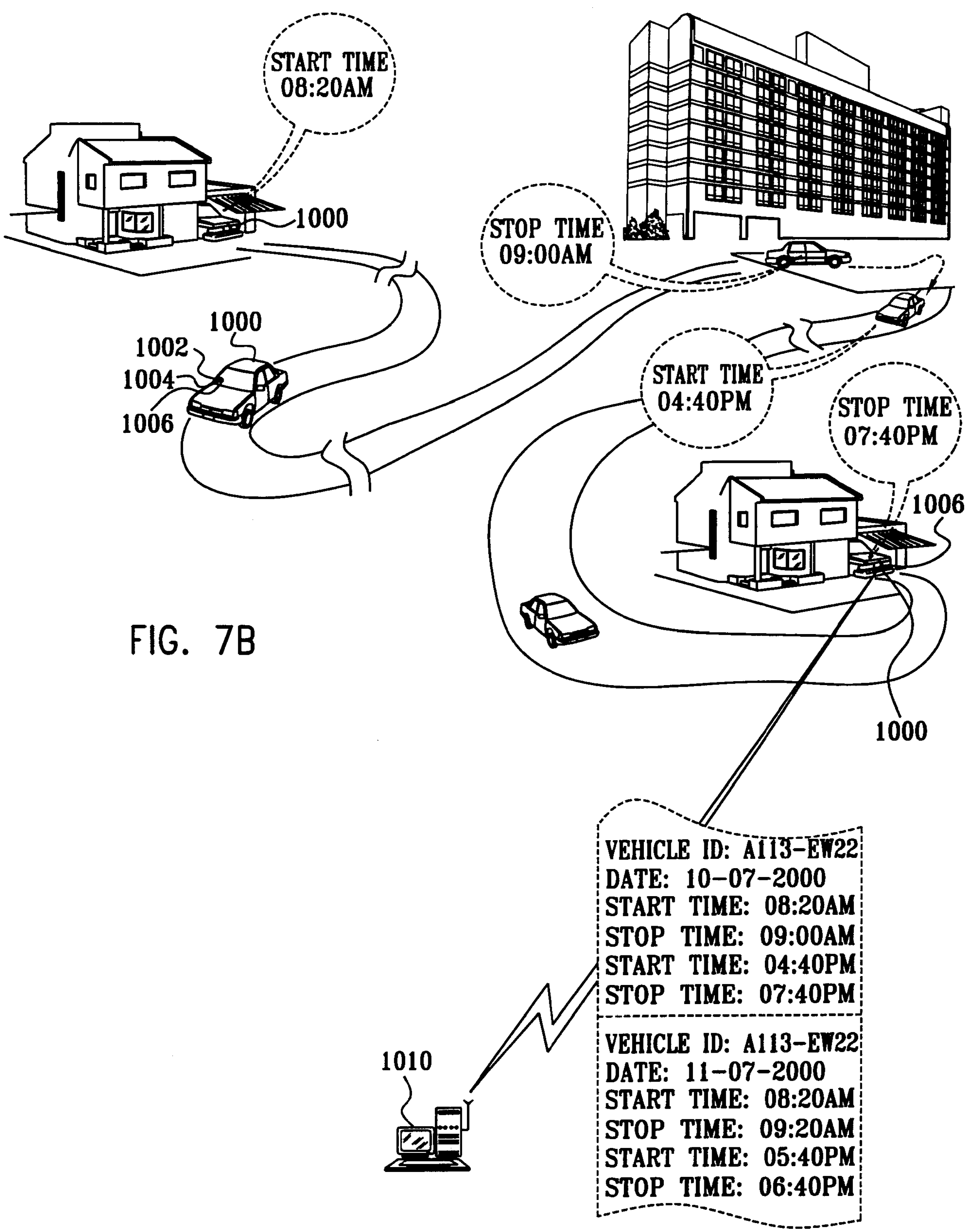
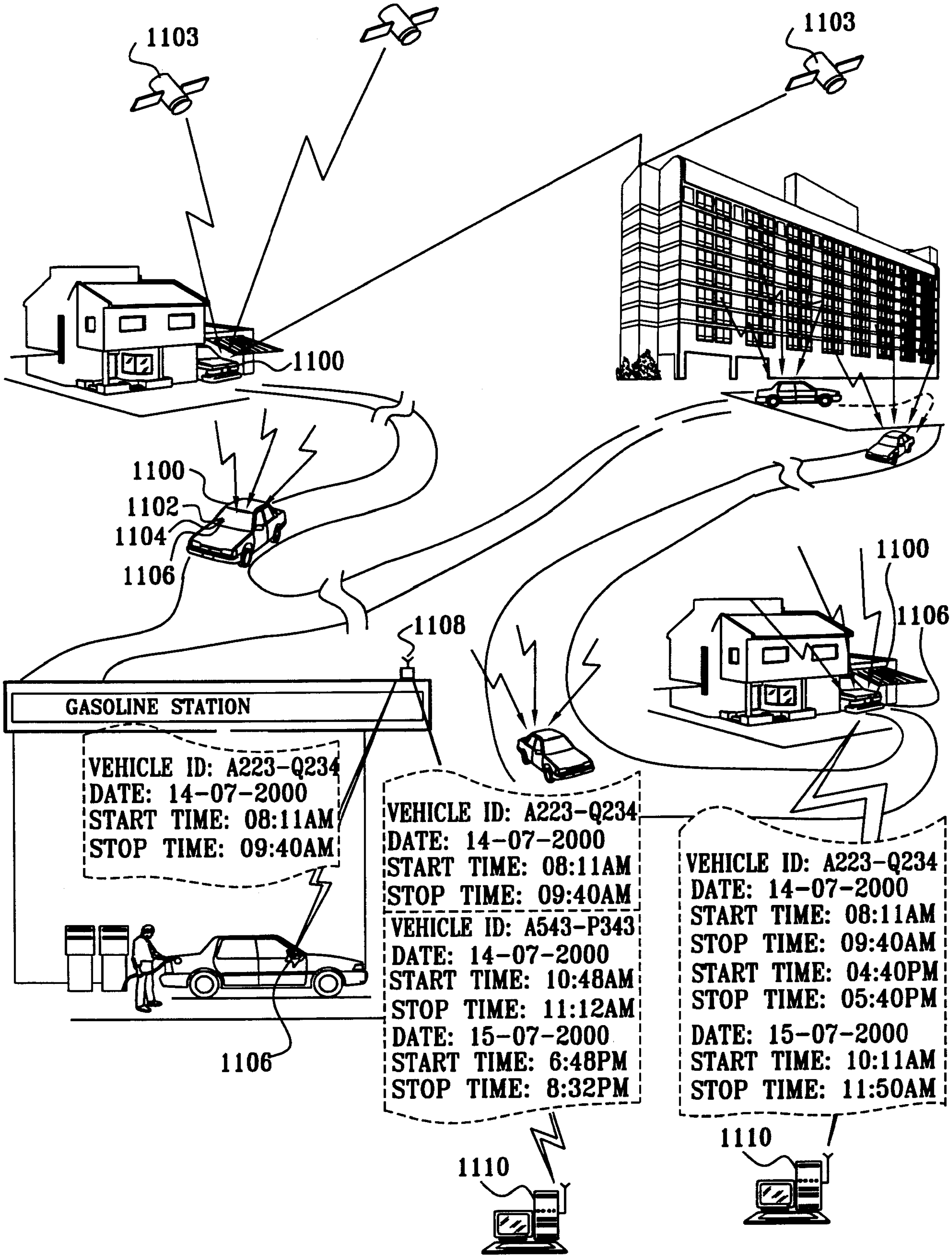

START TIME
08:20AM
1000
STOP TIME
09:00AM
1000
1002
1004
1006
START TIME
04:40PM
STOP TIME
07:40PM
1006
1000
VEHICLE ID: A113-EW22
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
START TIME: 04:40PM
STOP TIME: 07:40PM
VEHICLE ID: A113-EW22
DATE: 11-07-2000
START TIME: 08:20AM
STOP TIME: 09:20AM
START TIME: 05:40PM
STOP TIME: 06:40PM
1010

FIG. 7B

FIG. 7C



1103
1103
1100
1100
1102
1104
1106
1100
1106
1108
GASOLINE STATION
VEHICLE ID: A223-Q234
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
VEHICLE ID: A223-Q234
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
VEHICLE ID: A543-P343
DATE: 14-07-2000
START TIME: 10:48AM
STOP TIME: 11:12AM
DATE: 15-07-2000
START TIME: 6:48PM
STOP TIME: 8:32PM
VEHICLE ID: A223-Q234
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
START TIME: 04:40PM
STOP TIME: 05:40PM
DATE: 15-07-2000
START TIME: 10:11AM
STOP TIME: 11:50AM
1106
1110
1110

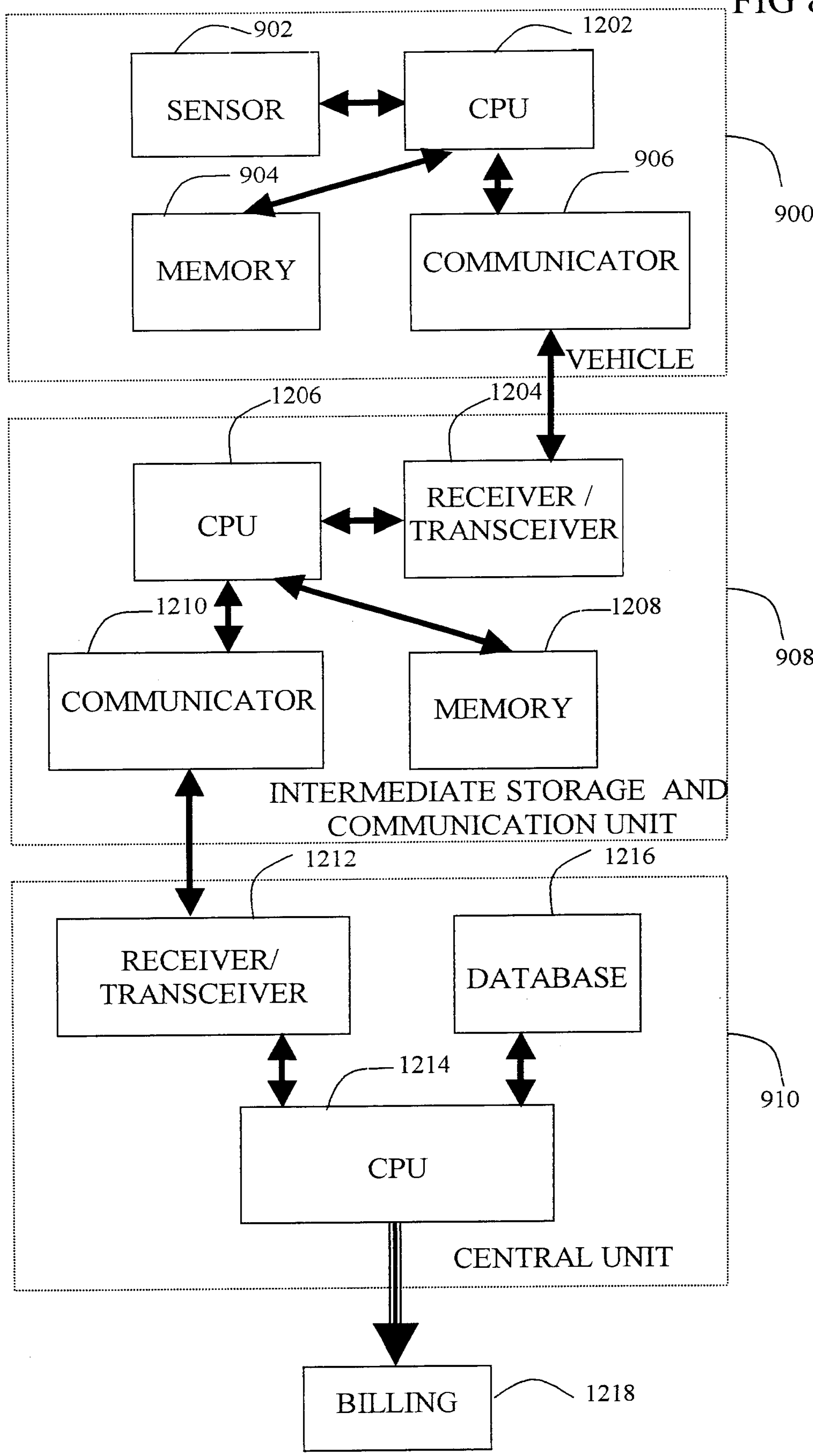

902
SENSOR
1202
CPU
904
MEMORY
906
COMMUNICATOR
900
VEHICLE
1206
1204
CPU
RECEIVER / TRANSCEIVER
1210
1208
COMMUNICATOR
MEMORY
908
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
1212
1216
RECEIVER/ TRANSCEIVER
DATABASE
1214
CPU
910
CENTRAL UNIT
BILLING
1218

FIG 8A

FIG 8B

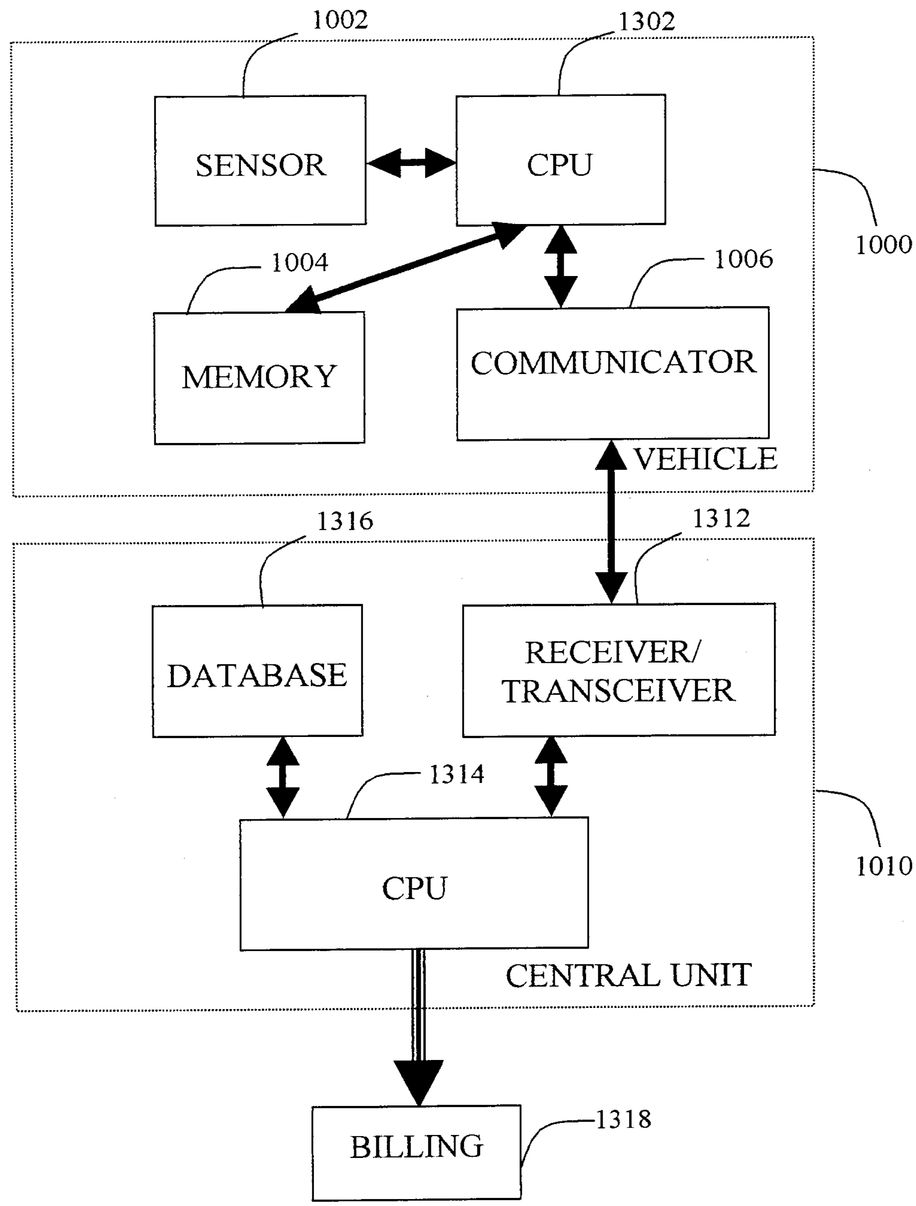

1002
1302
SENSOR
CPU
1000
1004
1006
MEMORY
COMMUNICATOR
VEHICLE
1316
1312
DATABASE
RECEIVER/
TRANSCEIVER
1314
1010
CPU
CENTRAL UNIT
BILLING
1318

FIG 8C

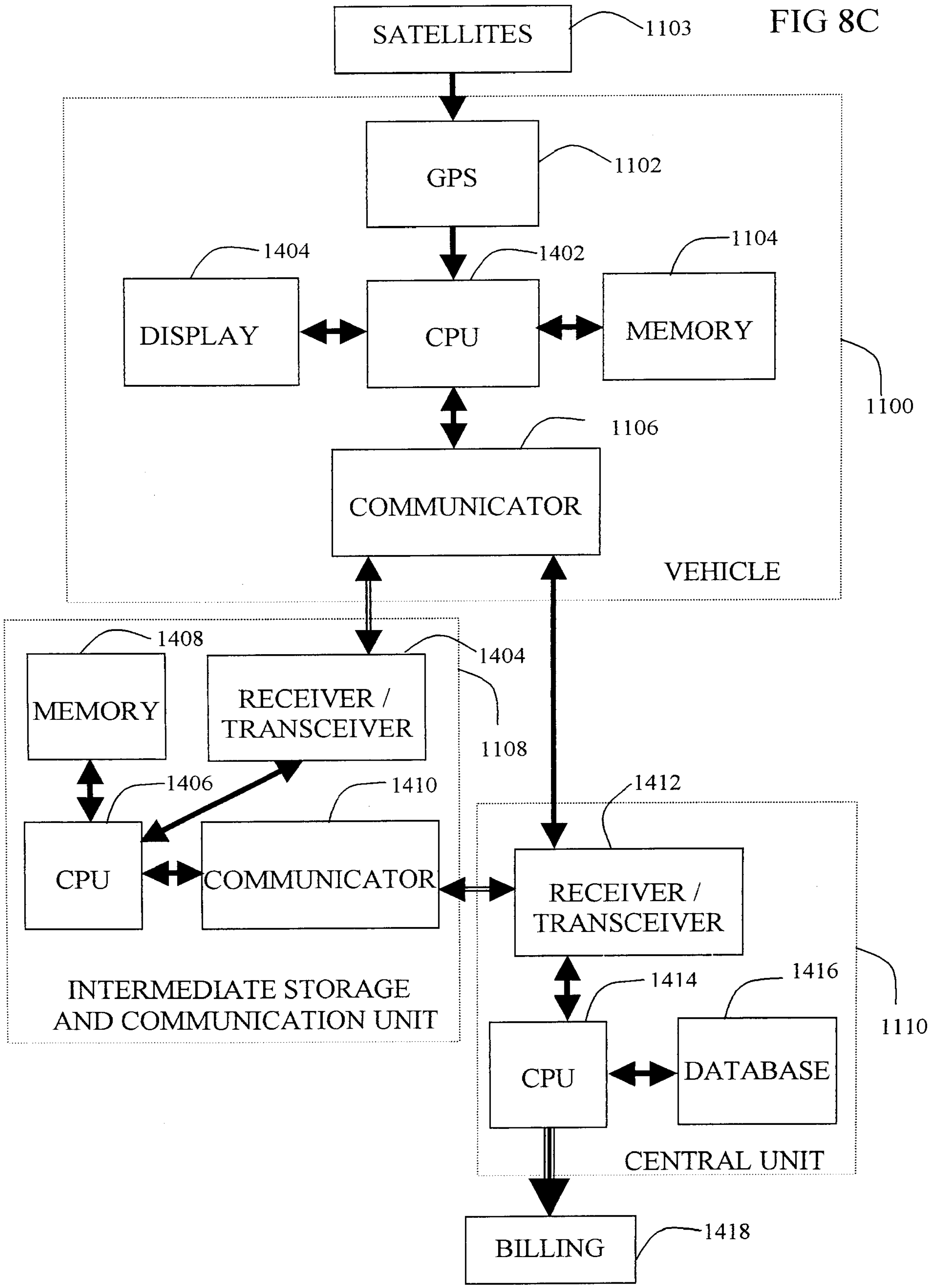

SATELLITES
1103
GPS
1102
1404
1402
1104
DISPLAY
CPU
MEMORY
1100
1106
COMMUNICATOR
VEHICLE
1408
1404
MEMORY
RECEIVER / TRANSCEIVER
1108
1406
1410
1412
CPU
COMMUNICATOR
RECEIVER / TRANSCEIVER
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
1414
1416
1110
CPU
DATABASE
CENTRAL UNIT
BILLING
1418

FIG 9A

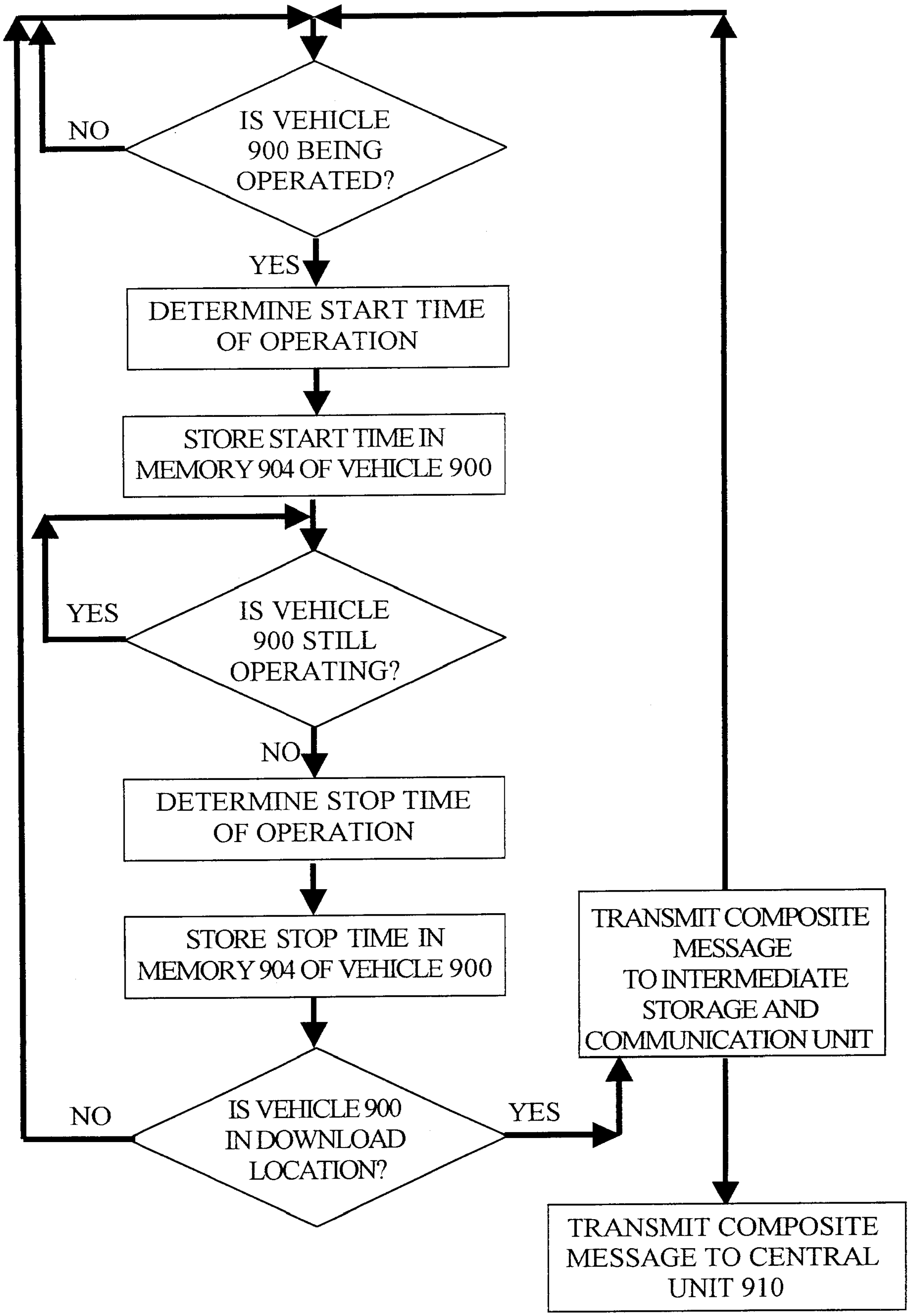

IS VEHICLE 900 BEING OPERATED?
NO
YES
DETERMINE START TIME OF OPERATION
STORE START TIME IN MEMORY 904 OF VEHICLE 900
IS VEHICLE 900 STILL OPERATING?
YES
NO
DETERMINE STOP TIME OF OPERATION
STORE STOP TIME IN MEMORY 904 OF VEHICLE 900
IS VEHICLE 900 IN DOWNLOAD LOCATION?
NO
YES
TRANSMIT COMPOSITE MESSAGE TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 910

FIG 9B

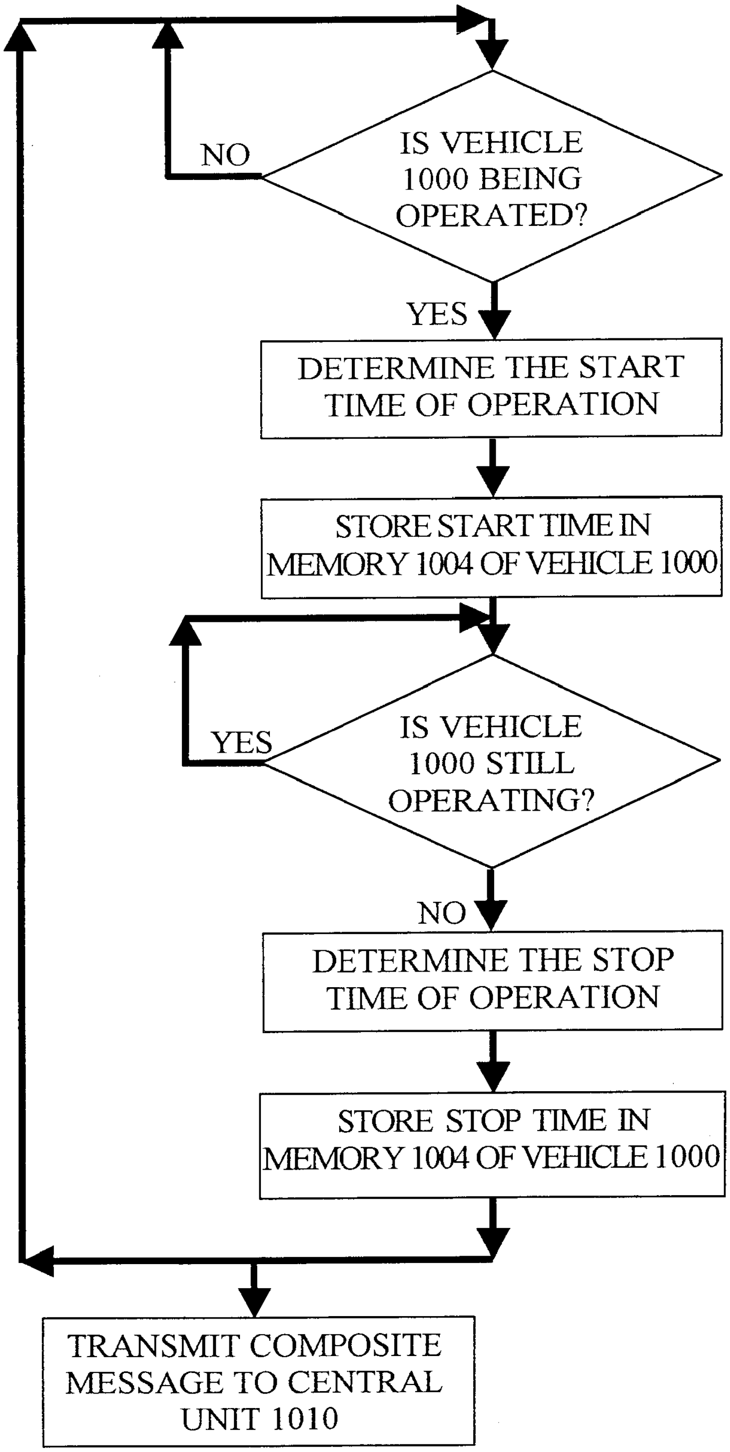
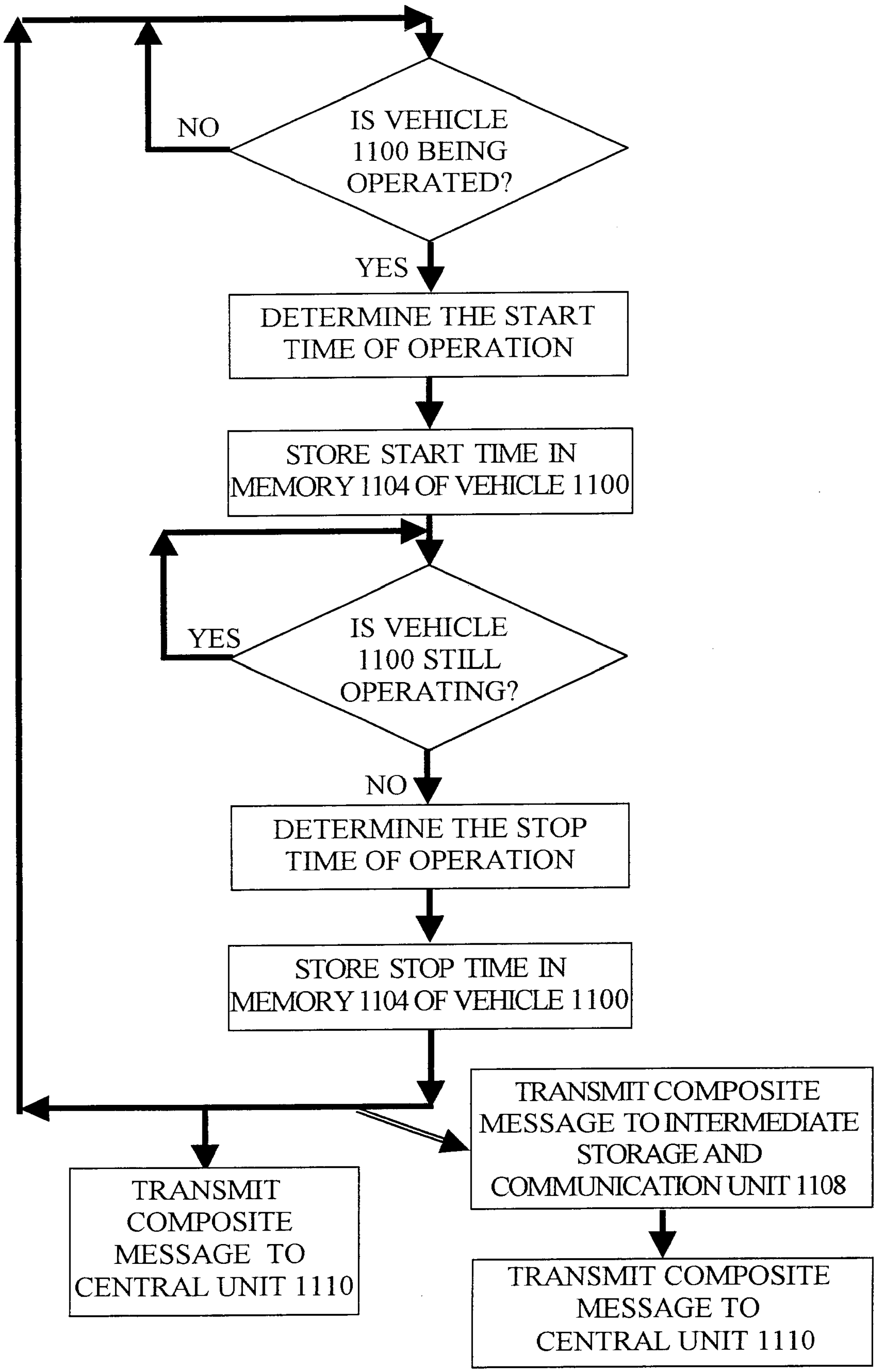

IS VEHICLE 1000 BEING OPERATED?
NO
YES
DETERMINE THE START TIME OF OPERATION
STORE START TIME IN MEMORY 1004 OF VEHICLE 1000
IS VEHICLE 1000 STILL OPERATING?
YES
NO
DETERMINE THE STOP TIME OF OPERATION
STORE STOP TIME IN MEMORY 1004 OF VEHICLE 1000
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 1010

FIG 9C


IS VEHICLE 1100 BEING OPERATED?
NO
YES
DETERMINE THE START TIME OF OPERATION
STORE START TIME IN MEMORY 1104 OF VEHICLE 1100
IS VEHICLE 1100 STILL OPERATING?
YES
NO
DETERMINE THE STOP TIME OF OPERATION
STORE STOP TIME IN MEMORY 1104 OF VEHICLE 1100
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 1110
TRANSMIT COMPOSITE MESSAGE TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT 1108
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 1110

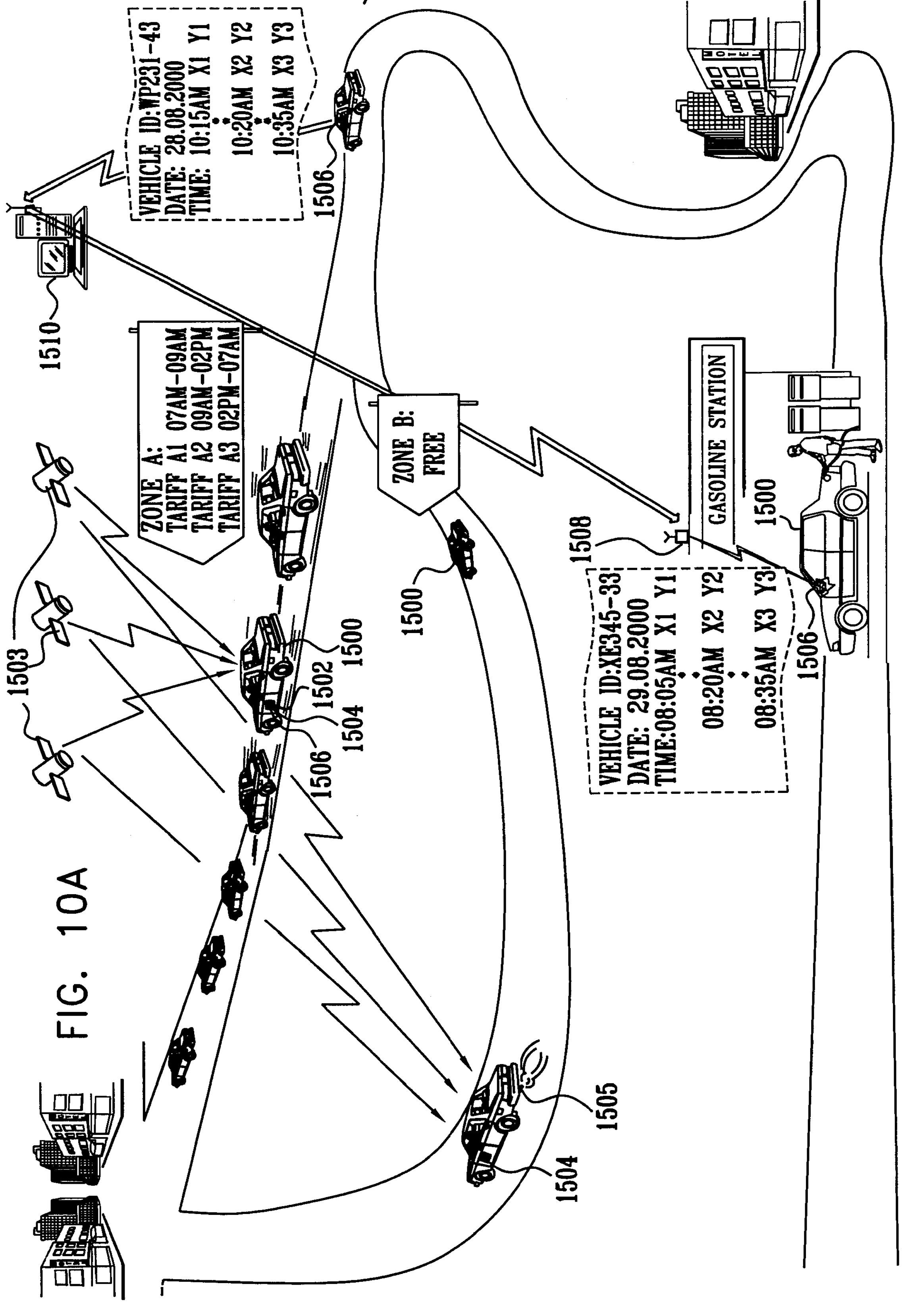

VEHICLE ID:WP231-43
DATE: 28.08.2000
TIME: 10:15AM X1 Y1
10:20AM X2 Y2
10:35AM X3 Y3
1506
1510
ZONE A:
TARIFF A1 07AM-09AM
TARIFF A2 09AM-02PM
TARIFF A3 02PM-07AM
ZONE B:
FREE
GASOLINE STATION
1500
1508
VEHICLE ID:XE345-33
DATE: 29.08.2000
TIME:08:05AM X1 Y1
08:20AM X2 Y2
08:35AM X3 Y3
1506
1500
1503
1503
1502
1500
1504
1506
1505
1504

FIG. 10A

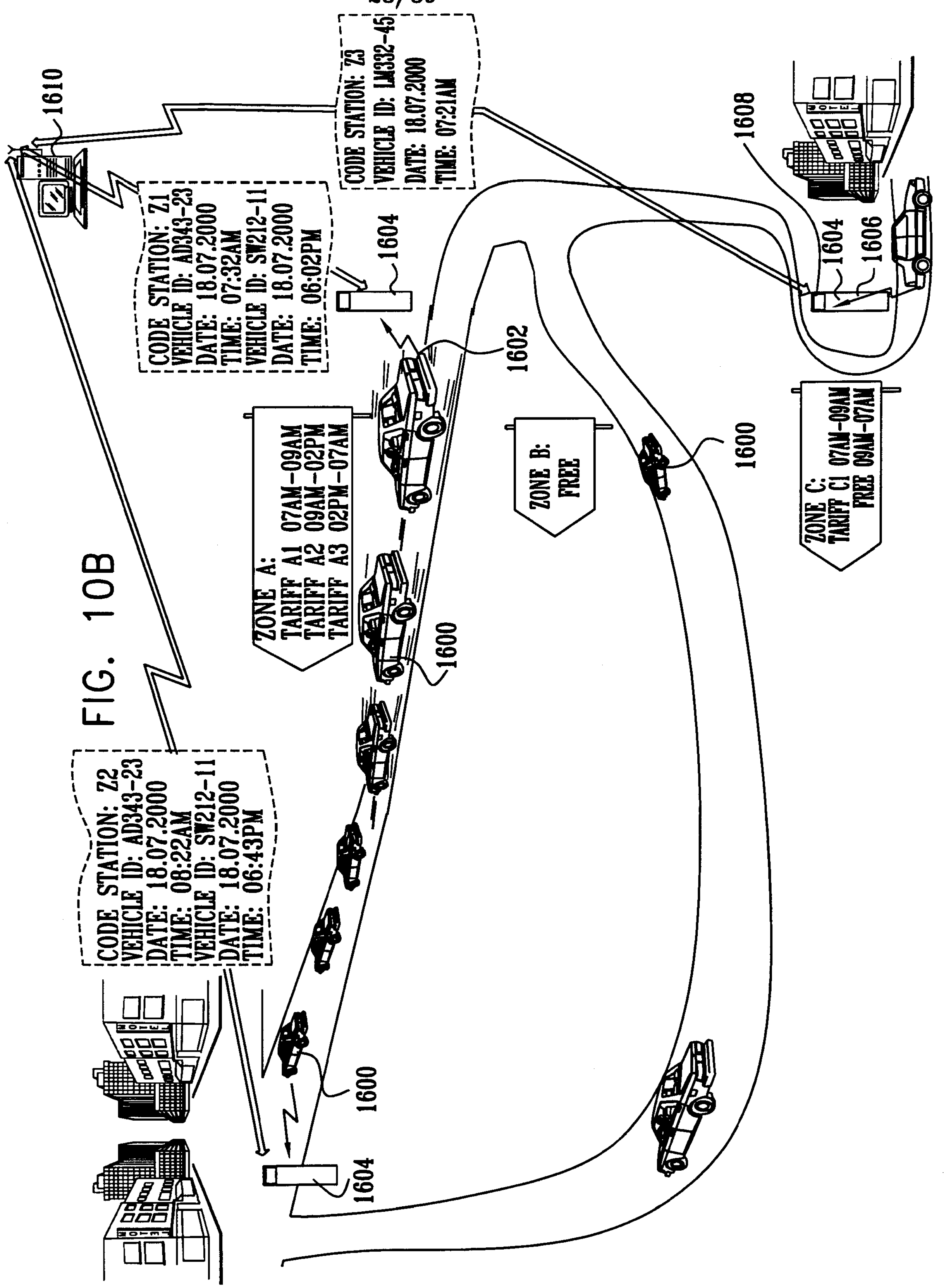

CODE STATION: Z3
VEHICLE ID: LM332-45
DATE: 18.07.2000
TIME: 07:21AM
1610
CODE STATION: Z1
VEHICLE ID: AD343-23
DATE: 18.07.2000
TIME: 07:32AM
VEHICLE ID: SW212-11
DATE: 18.07.2000
TIME: 06:02PM
1604
1608
1604
1606
1602
ZONE A:
TARIFF A1 07AM-09AM
TARIFF A2 09AM-02PM
TARIFF A3 02PM-07AM
ZONE B:
FREE
1600
ZONE C:
TARIFF C1 07AM-09AM
FREE 09AM-07AM
1600
CODE STATION: Z2
VEHICLE ID: AD343-23
DATE: 18.07.2000
TIME: 08:22AM
VEHICLE ID: SW212-11
DATE: 18.07.2000
TIME: 06:43PM
1600
1604

FIG. 10B

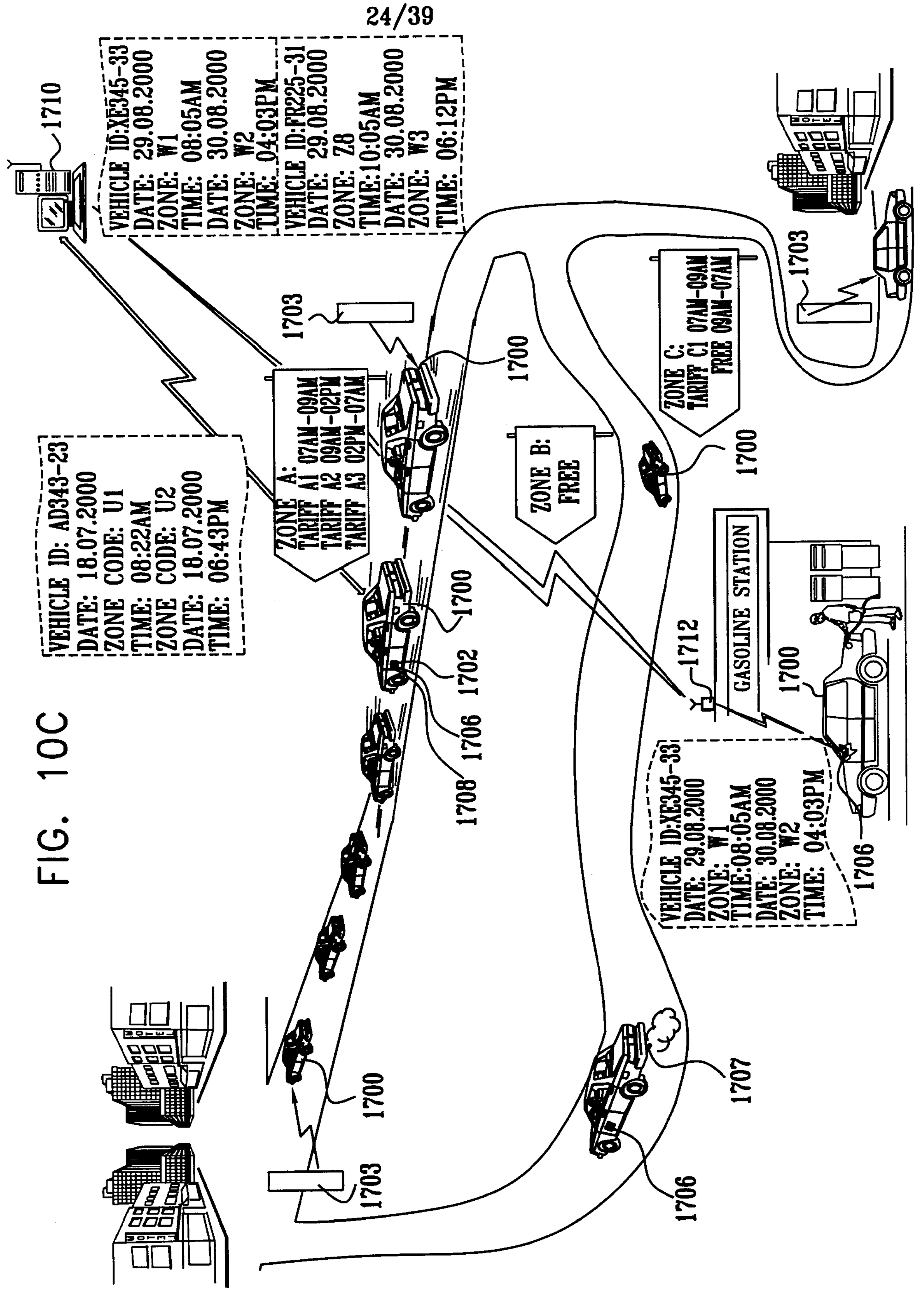

1710
VEHICLE ID:XE345-33
DATE: 29.08.2000
ZONE: W1
TIME: 08:05AM
DATE: 30.08.2000
ZONE: W2
TIME: 04:03PM
VEHICLE ID:FR225-31
DATE: 29.08.2000
ZONE: Z8
TIME:10:05AM
DATE: 30.08.2000
ZONE: W3
TIME: 06:12PM
VEHICLE ID: AD343-23
DATE: 18.07.2000
ZONE CODE: U1
TIME: 08:22AM
ZONE CODE: U2
DATE: 18.07.2000
TIME: 06:43PM
ZONE A:
TARIFF A1 07AM-09AM
TARIFF A2 09AM-02PM
TARIFF A3 02PM-07AM
ZONE B:
FREE
ZONE C:
TARIFF C1 07AM-09AM
FREE 09AM-07AM
GASOLINE STATION
VEHICLE ID:XE345-33
DATE: 29.08.2000
ZONE: W1
TIME:08:05AM
DATE: 30.08.2000
ZONE: W2
TIME: 04:03PM
1700
1702
1703
1706
1707
1708
1712

FIG. 10C

FIG 11A

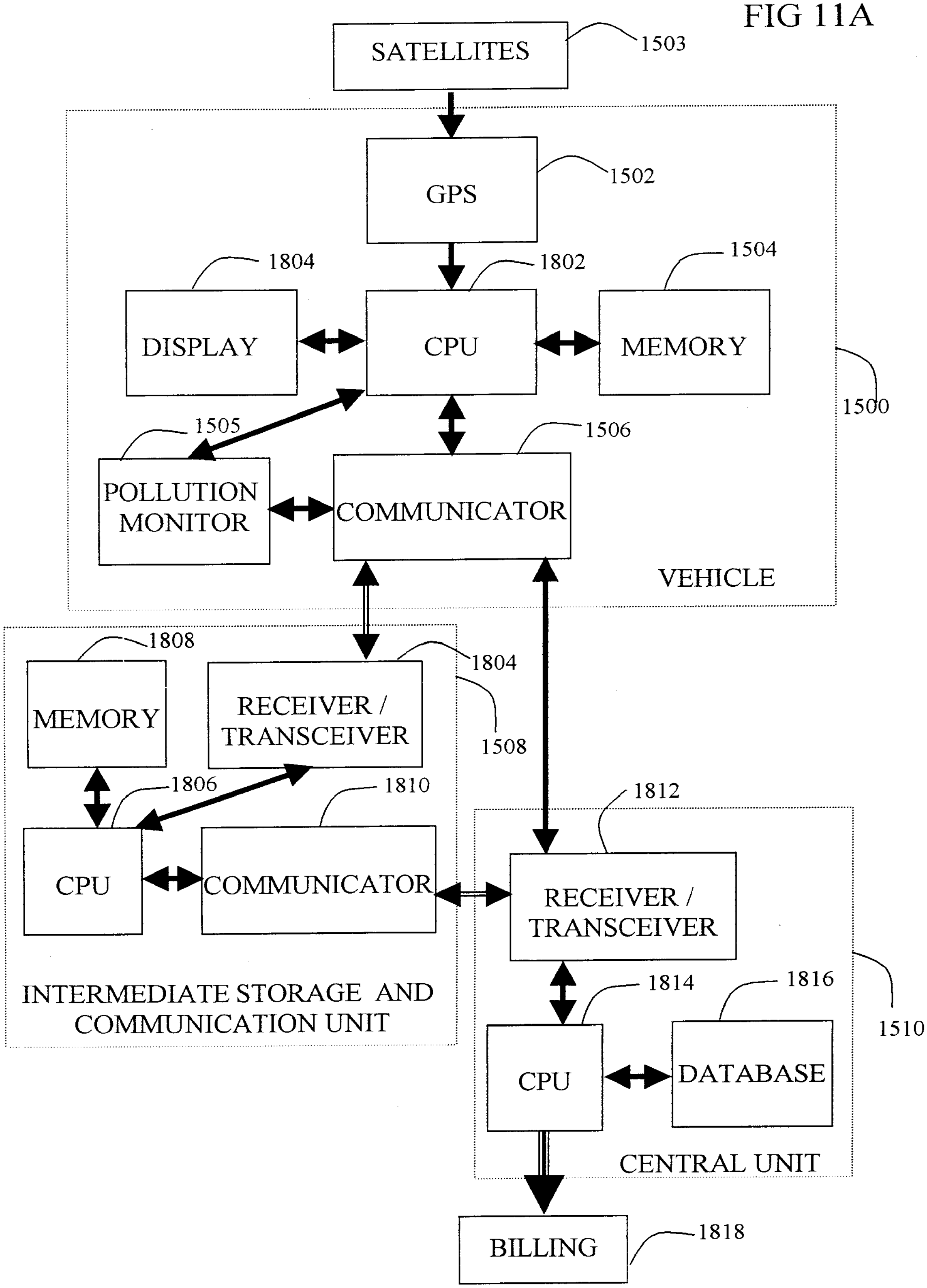
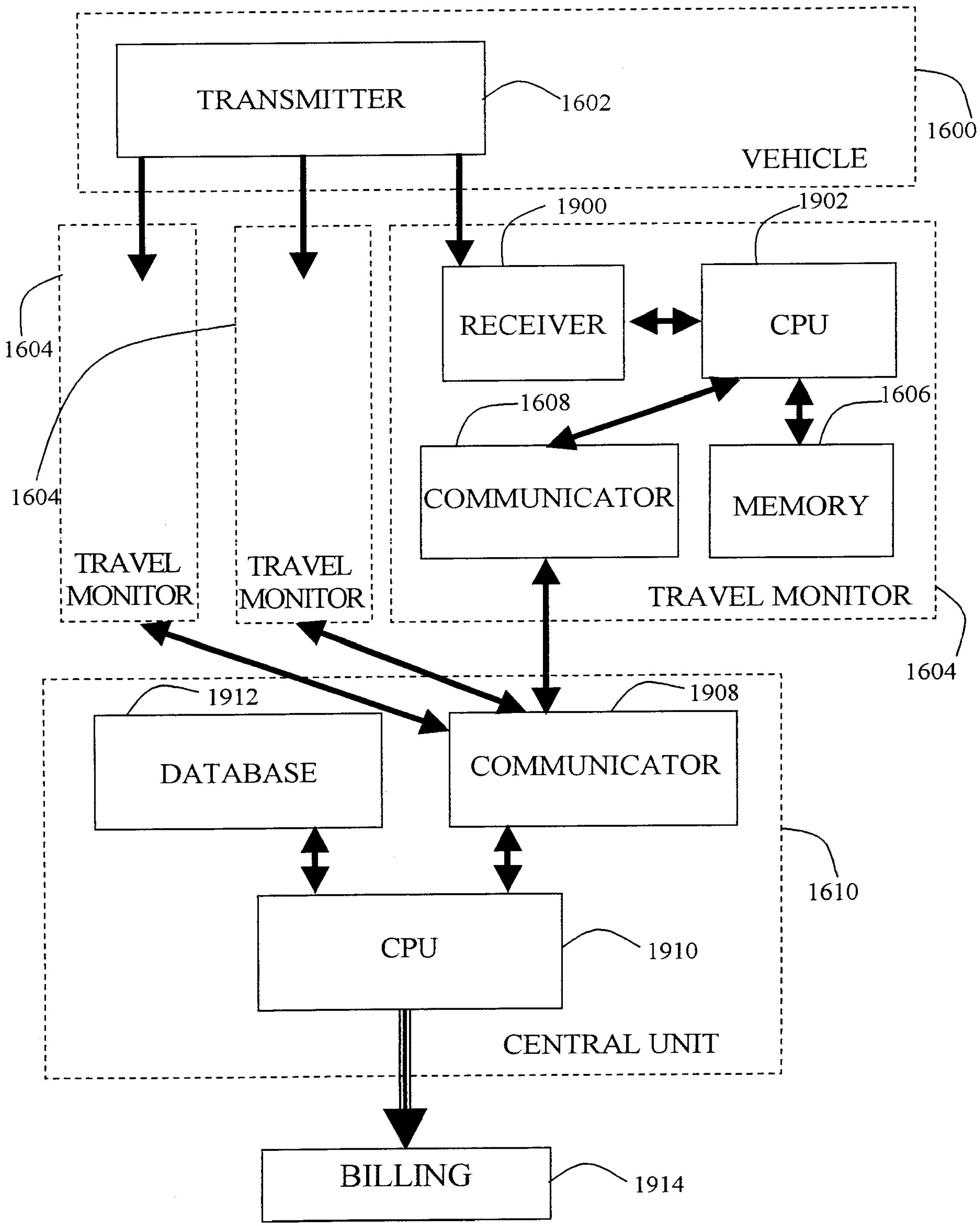

SATELLITES
1503
GPS
1502
1804
1802
1504
DISPLAY
CPU
MEMORY
1500
1505
1506
POLLUTION MONITOR
COMMUNICATOR
VEHICLE
1808
1804
MEMORY
RECEIVER / TRANSCEIVER
1508
1806
1810
1812
CPU
COMMUNICATOR
RECEIVER / TRANSCEIVER
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
1814
1816
1510
CPU
DATABASE
CENTRAL UNIT
BILLING
1818

FIG 11B



TRANSMITTER
1602
1600
VEHICLE
1900
1902
1604
RECEIVER
CPU
1608
1606
1604
COMMUNICATOR
MEMORY
TRAVEL MONITOR
TRAVEL MONITOR
TRAVEL MONITOR
1604
1912
1908
DATABASE
COMMUNICATOR
1610
CPU
1910
CENTRAL UNIT
BILLING
1914

FIG 11C

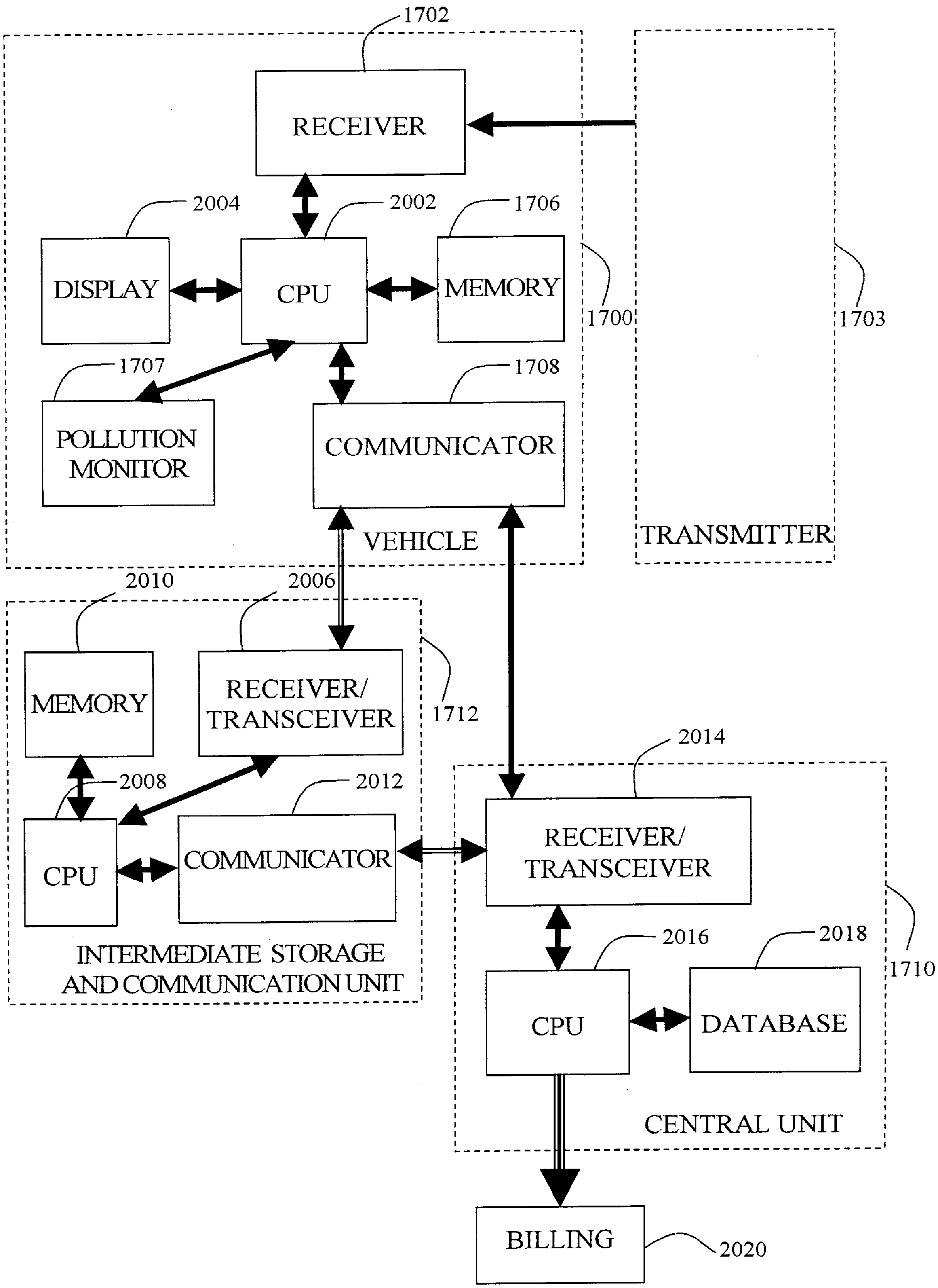

1702
RECEIVER
2004
2002
1706
DISPLAY
CPU
MEMORY
1700
1703
1707
1708
POLLUTION MONITOR
COMMUNICATOR
VEHICLE
TRANSMITTER
2010
2006
MEMORY
RECEIVER/ TRANSCEIVER
1712
2014
2008
2012
CPU
COMMUNICATOR
RECEIVER/ TRANSCEIVER
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
2016
2018
1710
CPU
DATABASE
CENTRAL UNIT
BILLING
2020

FIG 12A

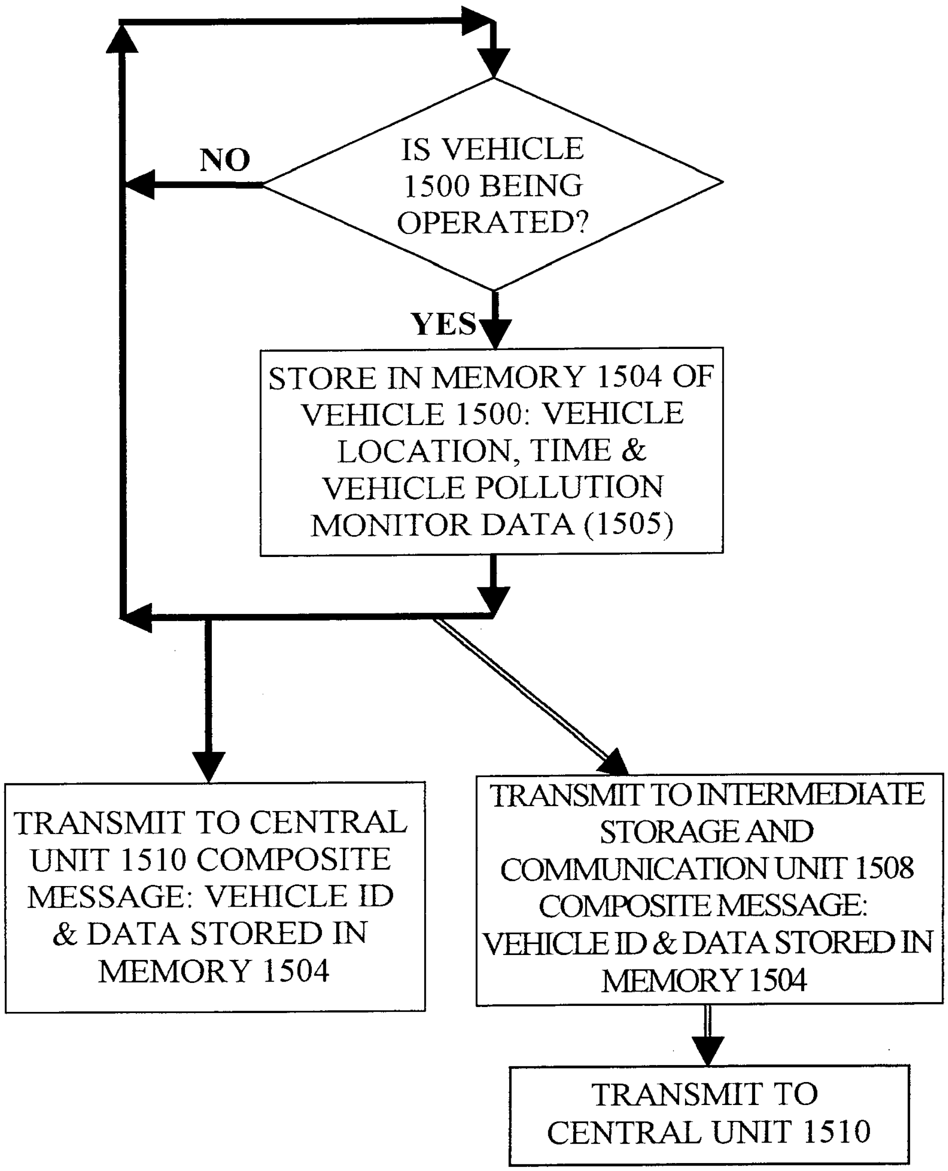

IS VEHICLE 1500 BEING OPERATED?
NO
YES
STORE IN MEMORY 1504 OF VEHICLE 1500: VEHICLE LOCATION, TIME & VEHICLE POLLUTION MONITOR DATA (1505)
TRANSMIT TO CENTRAL UNIT 1510 COMPOSITE MESSAGE: VEHICLE ID & DATA STORED IN MEMORY 1504
TRANSMIT TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT 1508 COMPOSITE MESSAGE: VEHICLE ID & DATA STORED IN MEMORY 1504
TRANSMIT TO CENTRAL UNIT 1510

FIG 12B

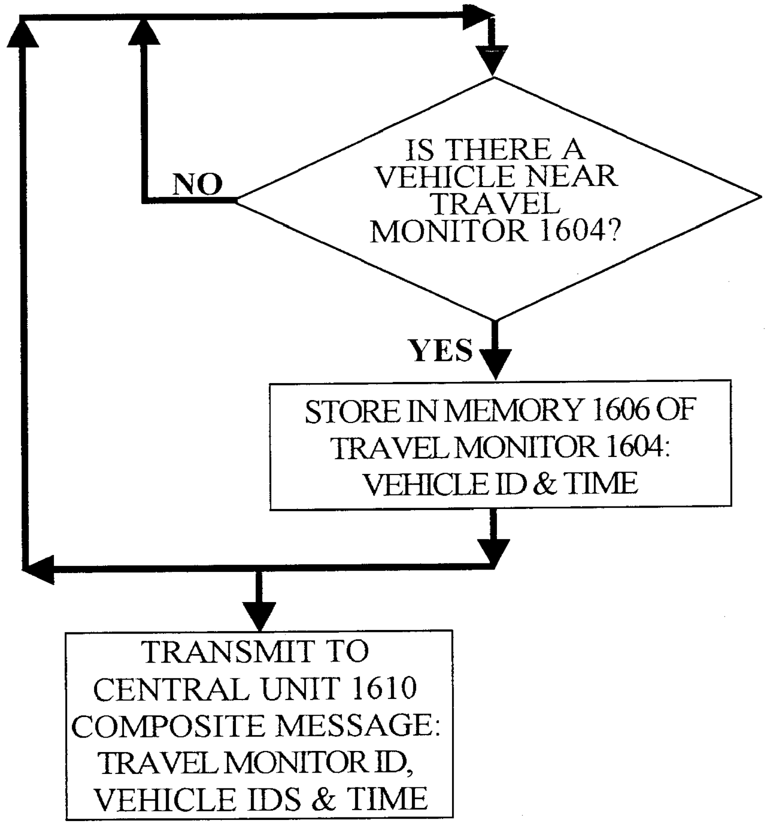
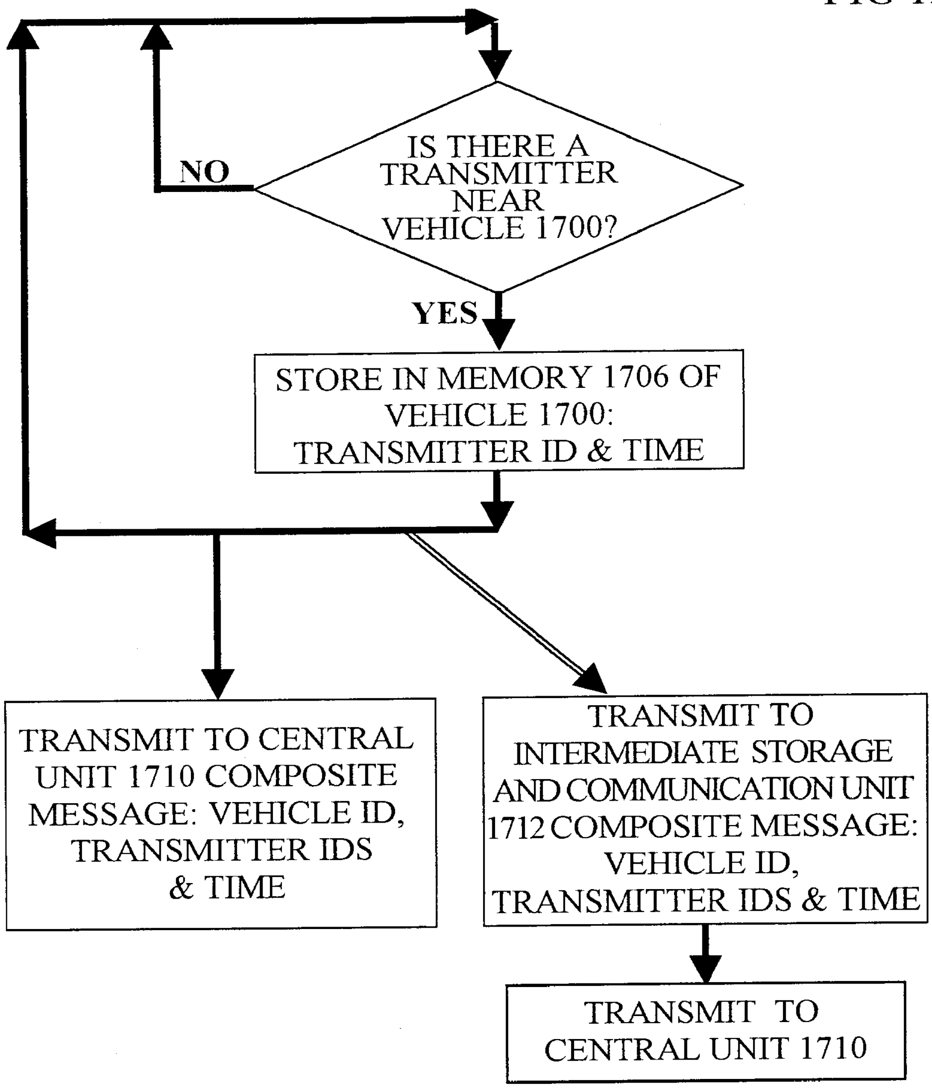

IS THERE A VEHICLE NEAR TRAVEL MONITOR 1604?
NO
YES
STORE IN MEMORY 1606 OF TRAVEL MONITOR 1604: VEHICLE ID & TIME
TRANSMIT TO CENTRAL UNIT 1610 COMPOSITE MESSAGE: TRAVEL MONITOR ID, VEHICLE IDS & TIME

FIG 12C


IS THERE A TRANSMITTER NEAR VEHICLE 1700?
NO
YES
STORE IN MEMORY 1706 OF VEHICLE 1700: TRANSMITTER ID & TIME
TRANSMIT TO CENTRAL UNIT 1710 COMPOSITE MESSAGE: VEHICLE ID, TRANSMITTER IDS & TIME
TRANSMIT TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT 1712 COMPOSITE MESSAGE: VEHICLE ID, TRANSMITTER IDS & TIME
TRANSMIT TO CENTRAL UNIT 1710

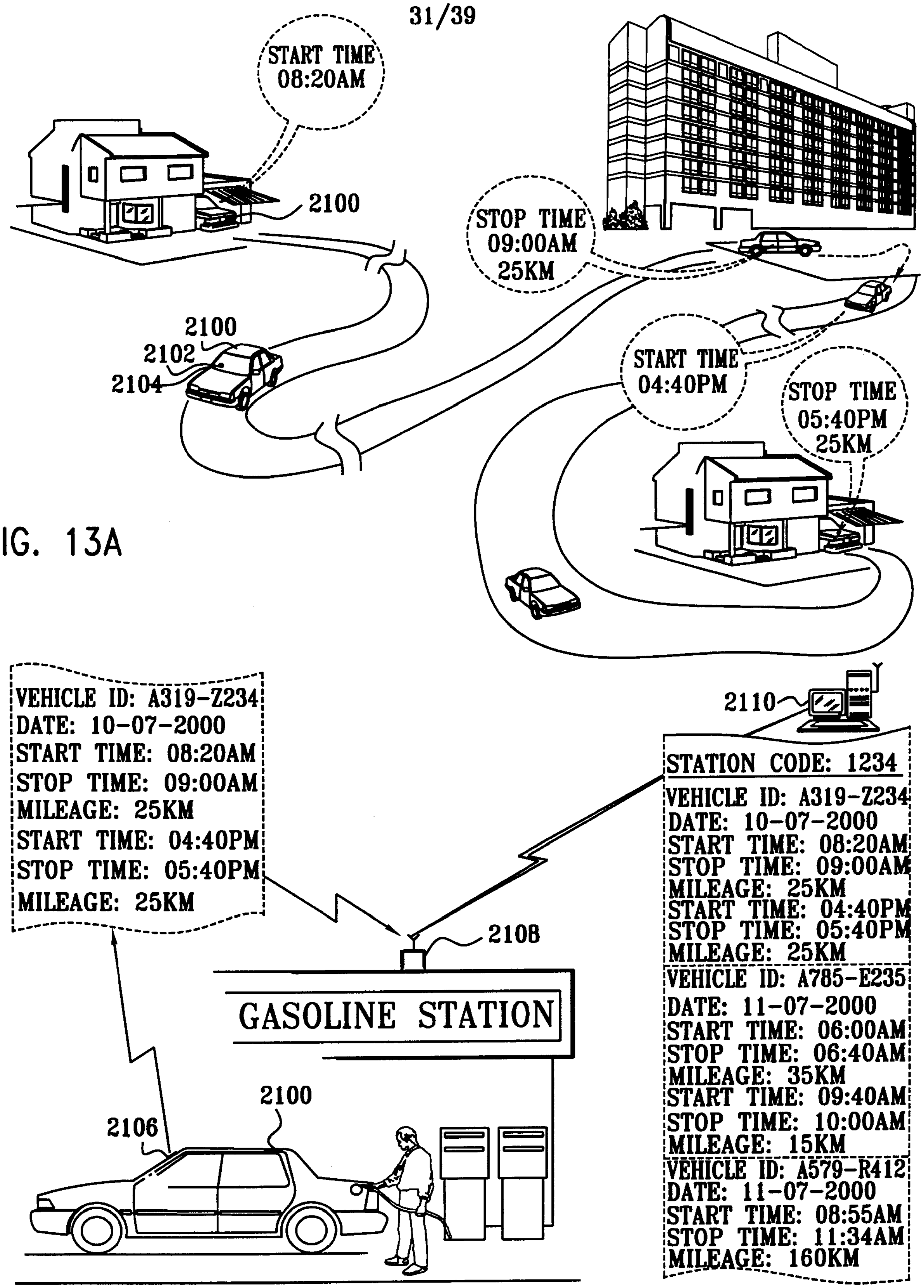

START TIME
08:20AM
2100
STOP TIME
09:00AM
25KM
2100
2102
2104
START TIME
04:40PM
STOP TIME
05:40PM
25KM
VEHICLE ID: A319-Z234
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
MILEAGE: 25KM
START TIME: 04:40PM
STOP TIME: 05:40PM
MILEAGE: 25KM
2110
STATION CODE: 1234
VEHICLE ID: A319-Z234
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
MILEAGE: 25KM
START TIME: 04:40PM
STOP TIME: 05:40PM
MILEAGE: 25KM
VEHICLE ID: A785-E235
DATE: 11-07-2000
START TIME: 06:00AM
STOP TIME: 06:40AM
MILEAGE: 35KM
START TIME: 09:40AM
STOP TIME: 10:00AM
MILEAGE: 15KM
VEHICLE ID: A579-R412
DATE: 11-07-2000
START TIME: 08:55AM
STOP TIME: 11:34AM
MILEAGE: 160KM
2108
GASOLINE STATION
2100
2106

FIG. 13A

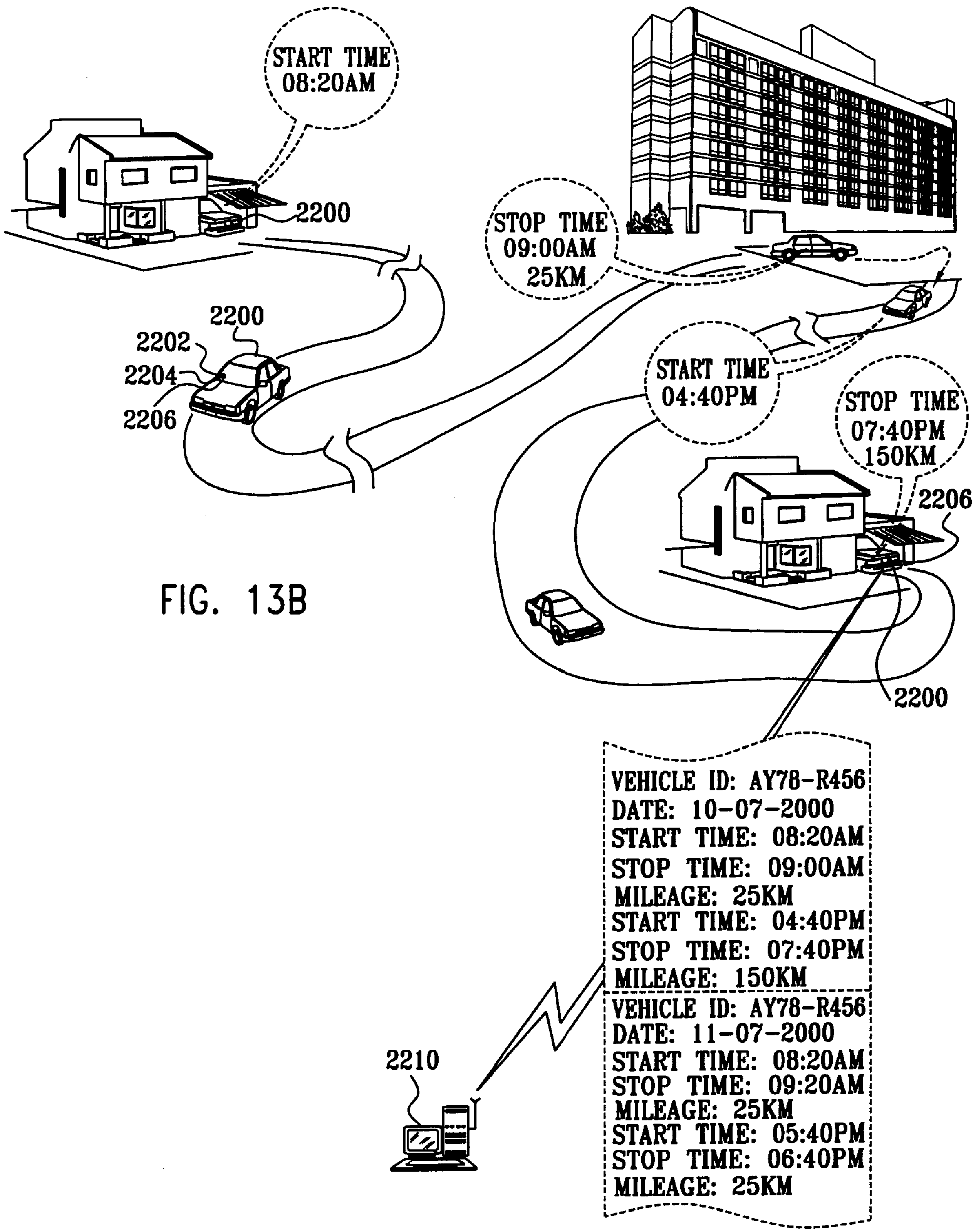

START TIME
08:20AM
2200
STOP TIME
09:00AM
25KM
2200
2202
2204
2206
START TIME
04:40PM
STOP TIME
07:40PM
150KM
2206
2200
VEHICLE ID: AY78-R456
DATE: 10-07-2000
START TIME: 08:20AM
STOP TIME: 09:00AM
MILEAGE: 25KM
START TIME: 04:40PM
STOP TIME: 07:40PM
MILEAGE: 150KM
VEHICLE ID: AY78-R456
DATE: 11-07-2000
START TIME: 08:20AM
STOP TIME: 09:20AM
MILEAGE: 25KM
START TIME: 05:40PM
STOP TIME: 06:40PM
MILEAGE: 25KM
2210

FIG. 13B

FIG. 13C

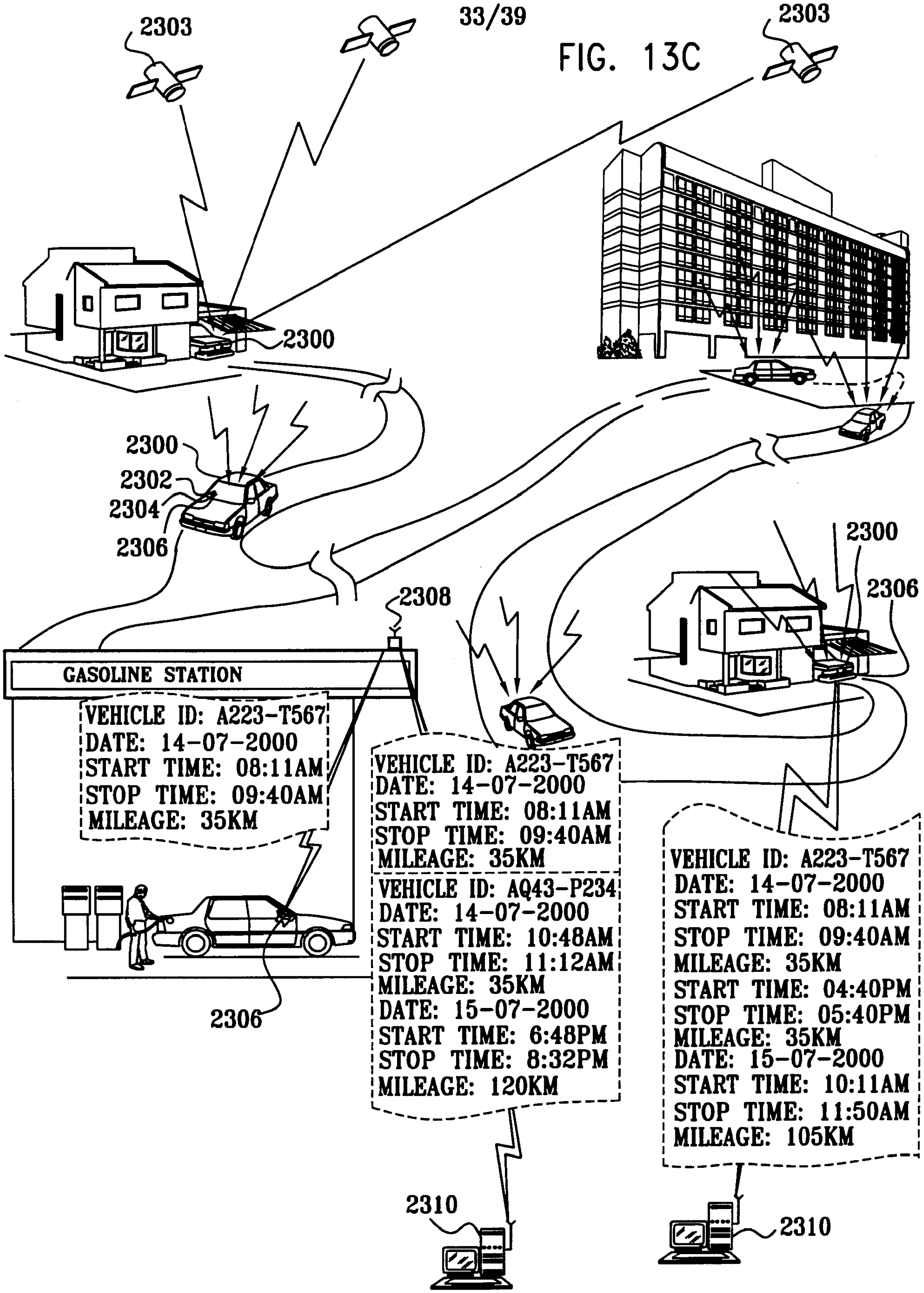

2303
2303
2300
2300
2302
2304
2306
2300
2306
2308
GASOLINE STATION
VEHICLE ID: A223-T567
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
MILEAGE: 35KM
VEHICLE ID: A223-T567
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
MILEAGE: 35KM
VEHICLE ID: AQ43-P234
DATE: 14-07-2000
START TIME: 10:48AM
STOP TIME: 11:12AM
MILEAGE: 35KM
DATE: 15-07-2000
START TIME: 6:48PM
STOP TIME: 8:32PM
MILEAGE: 120KM
VEHICLE ID: A223-T567
DATE: 14-07-2000
START TIME: 08:11AM
STOP TIME: 09:40AM
MILEAGE: 35KM
START TIME: 04:40PM
STOP TIME: 05:40PM
MILEAGE: 35KM
DATE: 15-07-2000
START TIME: 10:11AM
STOP TIME: 11:50AM
MILEAGE: 105KM
2306
2310
2310

FIG 14A

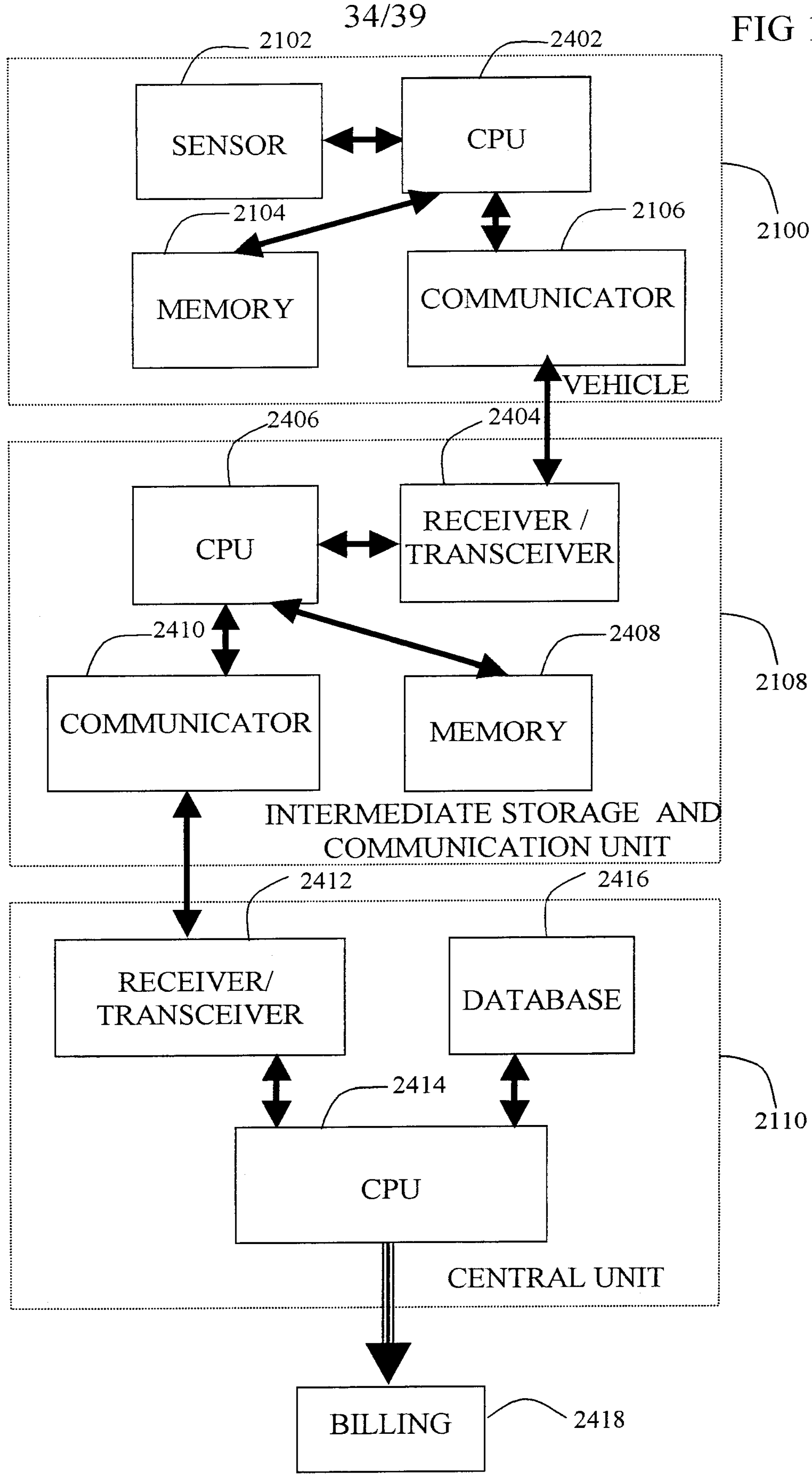

2102
2402
SENSOR
CPU
2104
2106
MEMORY
COMMUNICATOR
VEHICLE
2100
2406
2404
CPU
RECEIVER / TRANSCEIVER
2410
2408
COMMUNICATOR
MEMORY
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
2108
2412
2416
RECEIVER/ TRANSCEIVER
DATABASE
2414
CPU
CENTRAL UNIT
2110
BILLING
2418

FIG 14B

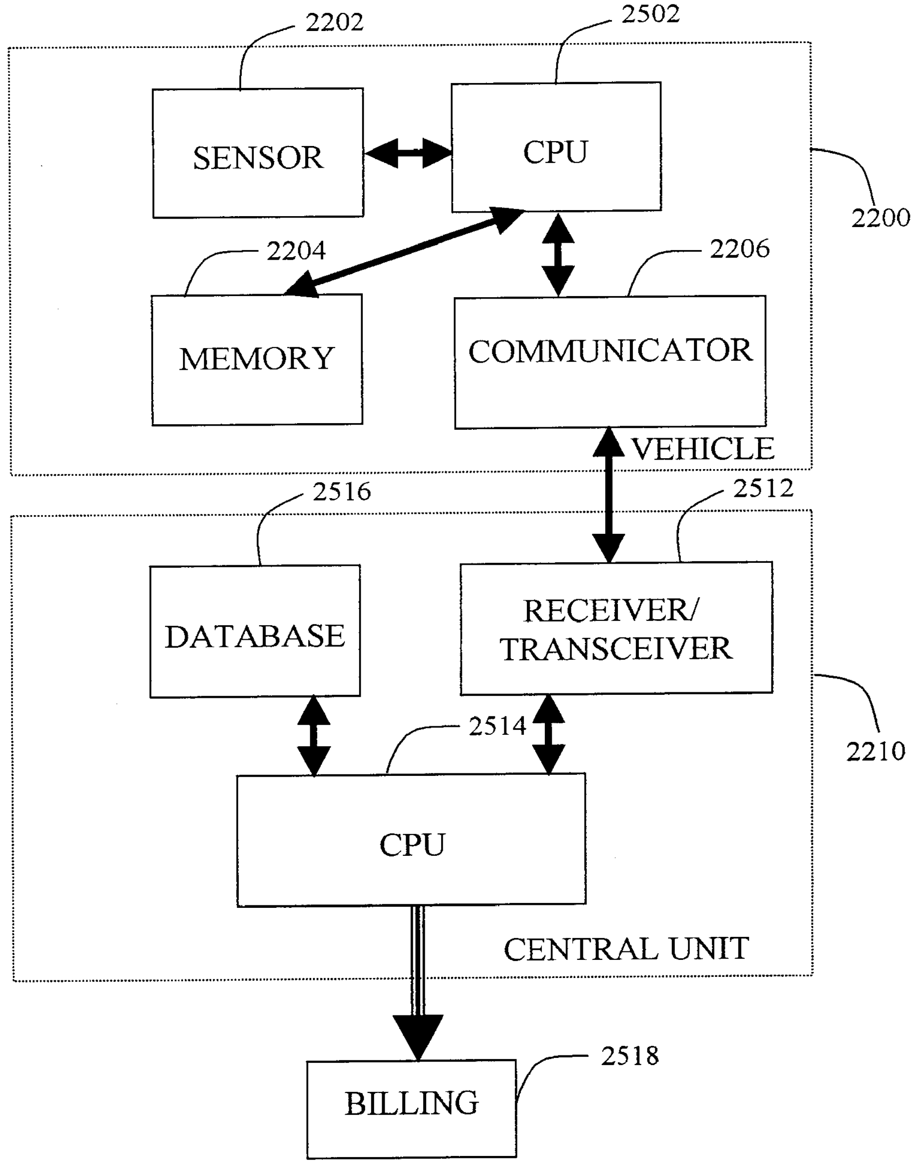

2202
2502
SENSOR
CPU
2200
2204
2206
MEMORY
COMMUNICATOR
VEHICLE
2516
2512
DATABASE
RECEIVER/
TRANSCEIVER
2210
2514
CPU
CENTRAL UNIT
2518
BILLING

FIG 14C

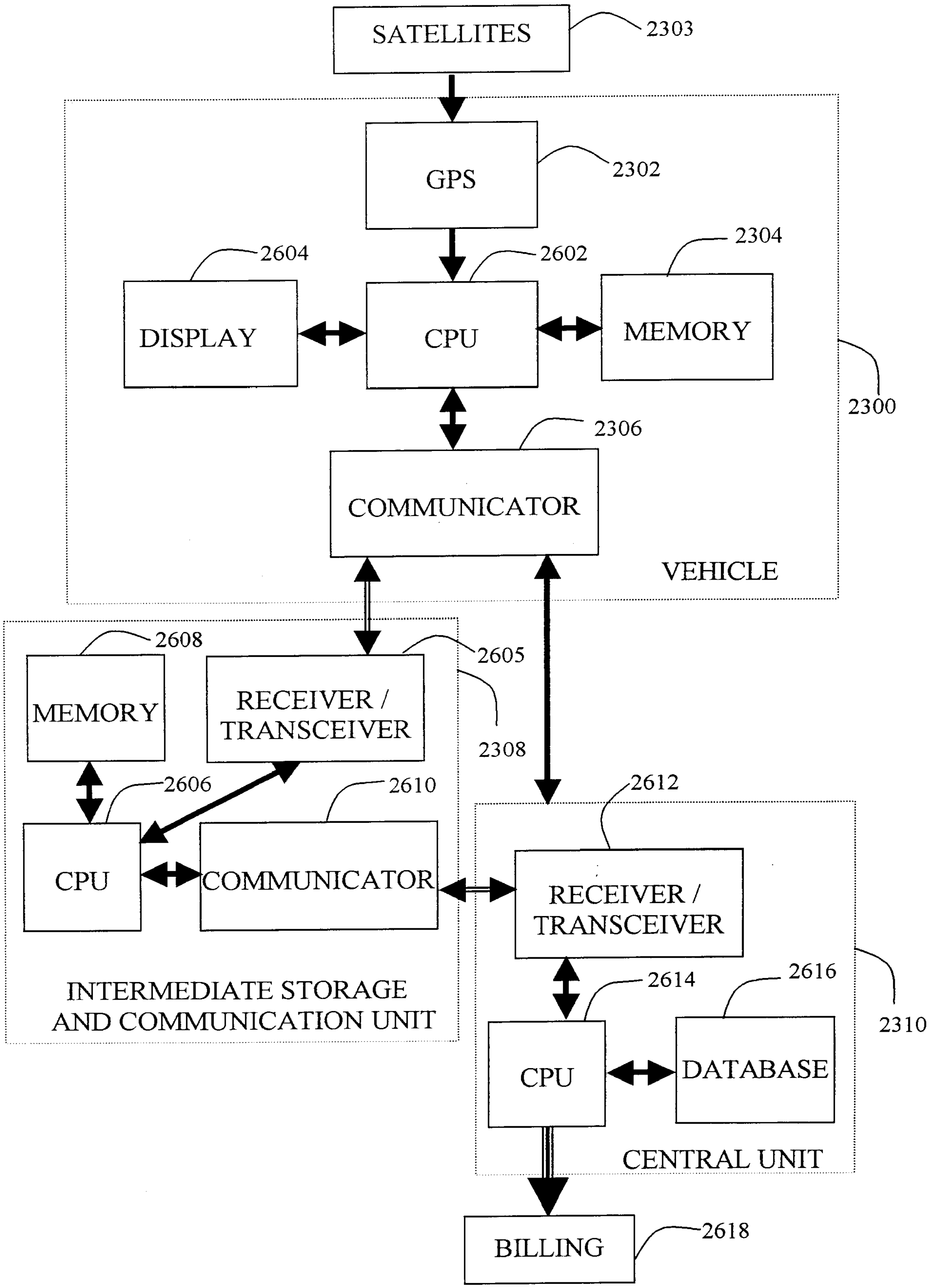

SATELLITES
2303
GPS
2302
2604
2602
2304
DISPLAY
CPU
MEMORY
2300
2306
COMMUNICATOR
VEHICLE
2608
2605
MEMORY
RECEIVER / TRANSCEIVER
2308
2606
2610
2612
CPU
COMMUNICATOR
RECEIVER / TRANSCEIVER
2614
2616
2310
INTERMEDIATE STORAGE AND COMMUNICATION UNIT
CPU
DATABASE
CENTRAL UNIT
BILLING
2618

FIG 15A

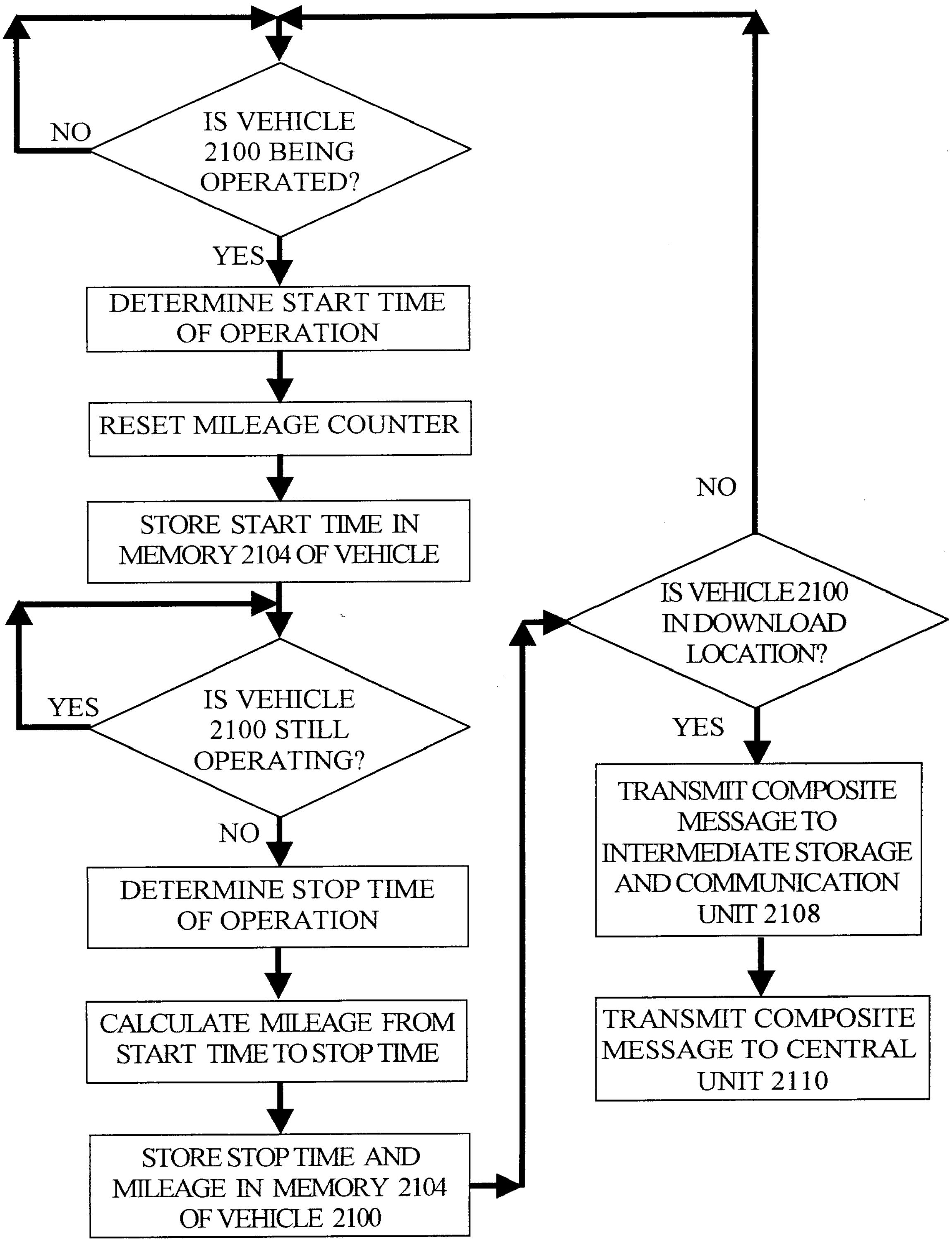

IS VEHICLE 2100 BEING OPERATED?
NO
YES
DETERMINE START TIME OF OPERATION
RESET MILEAGE COUNTER
STORE START TIME IN MEMORY 2104 OF VEHICLE
IS VEHICLE 2100 STILL OPERATING?
YES
NO
DETERMINE STOP TIME OF OPERATION
CALCULATE MILEAGE FROM START TIME TO STOP TIME
STORE STOP TIME AND MILEAGE IN MEMORY 2104 OF VEHICLE 2100
IS VEHICLE 2100 IN DOWNLOAD LOCATION?
NO
YES
TRANSMIT COMPOSITE MESSAGE TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT 2108
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 2110

FIG 15B

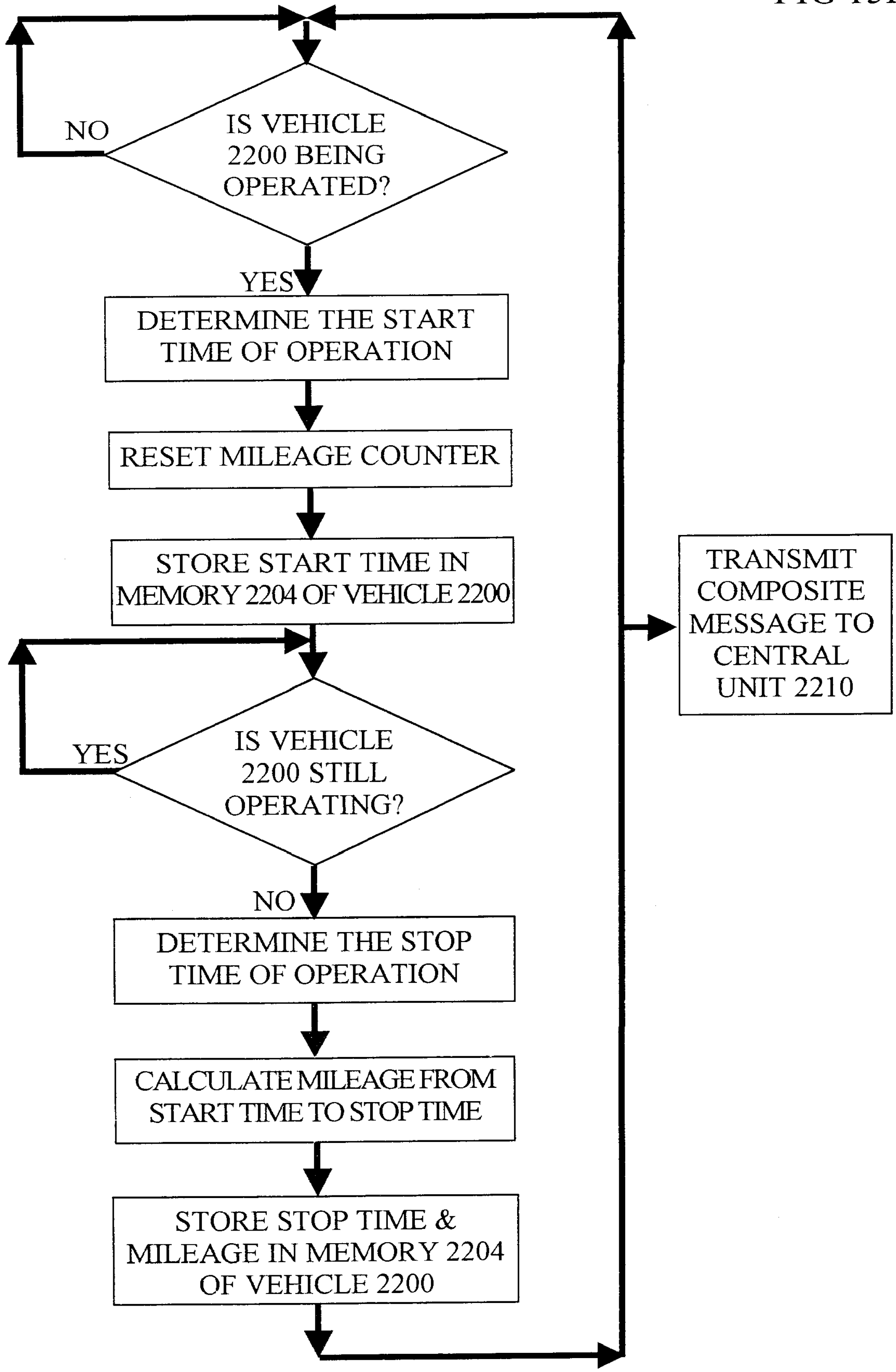
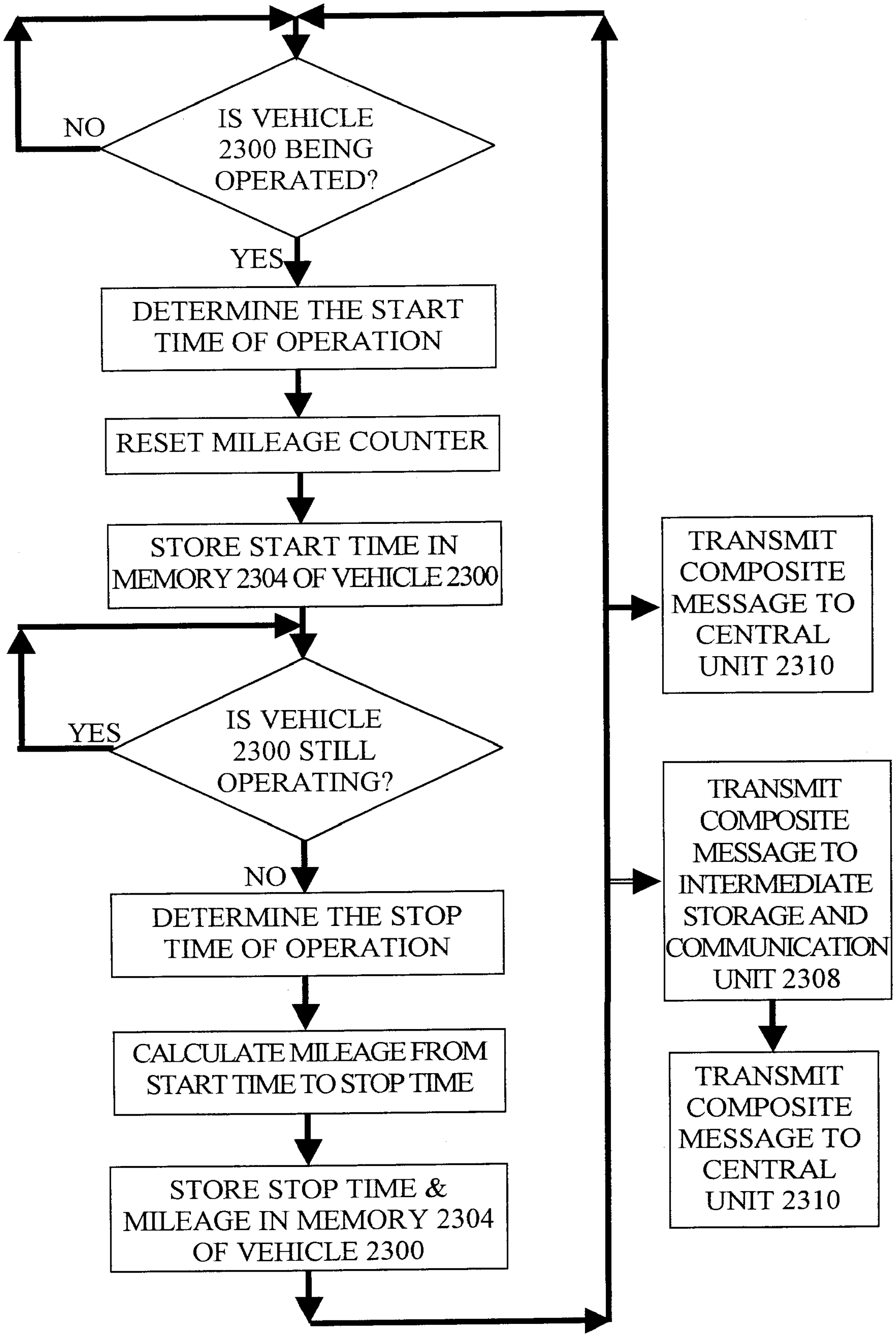

IS VEHICLE 2200 BEING OPERATED?
NO
YES
DETERMINE THE START TIME OF OPERATION
RESET MILEAGE COUNTER
STORE START TIME IN MEMORY 2204 OF VEHICLE 2200
IS VEHICLE 2200 STILL OPERATING?
YES
NO
DETERMINE THE STOP TIME OF OPERATION
CALCULATE MILEAGE FROM START TIME TO STOP TIME
STORE STOP TIME & MILEAGE IN MEMORY 2204 OF VEHICLE 2200
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 2210

FIG 15C


IS VEHICLE 2300 BEING OPERATED?
NO
YES
DETERMINE THE START TIME OF OPERATION
RESET MILEAGE COUNTER
STORE START TIME IN MEMORY 2304 OF VEHICLE 2300
IS VEHICLE 2300 STILL OPERATING?
YES
NO
DETERMINE THE STOP TIME OF OPERATION
CALCULATE MILEAGE FROM START TIME TO STOP TIME
STORE STOP TIME & MILEAGE IN MEMORY 2304 OF VEHICLE 2300
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 2310
TRANSMIT COMPOSITE MESSAGE TO INTERMEDIATE STORAGE AND COMMUNICATION UNIT 2308
TRANSMIT COMPOSITE MESSAGE TO CENTRAL UNIT 2310

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 May 2002 (23.05.2002)

PCT

(10) International Publication Number
WO 02/41119 A2

(51) International Patent Classification[7]: G06F

(21) International Application Number: PCT/US01/49935

(22) International Filing Date: 23 October 2001 (23.10.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/244,408 30 October 2000 (30.10.2000) US

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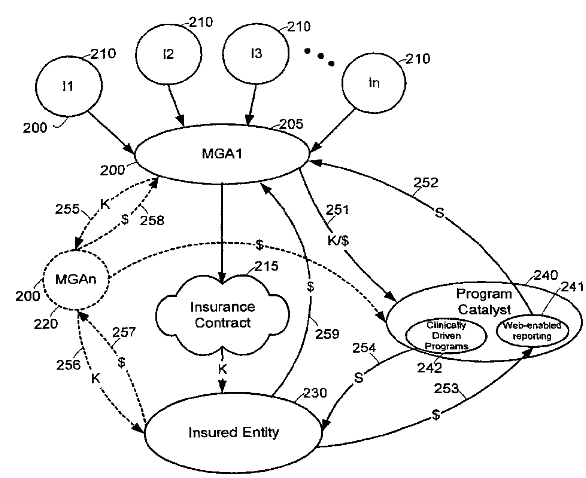
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A SYSTEM AND METHOD FOR IMPROVING THE OPERATIONS OF A BUSINESS ENTITY AND MONITORING AND REPORTING THE RESULTS THEREOF



(57) Abstract: The present invention is a method and system for providing reduced insurance premiums to an insured entity and a reduced risk of loss to an insuring entity. A program containing certain program requirements for the insured entity is created, and procedures are designed for the insured entity to meet these predetermined program requirements. The proximity in meeting these program requirements are monitored and then communicated to an interested third party, such as the insurer. Thus, the present invention by monitoring the insured entity, and communicating information relating to the insured entity to the insuring entity, allows the insuring entity to reduce the insurance costs to the insured entity if such monitoring results in favorable information for the insurer.

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A SYSTEM AND METHOD FOR IMPROVING THE OPERATION OF A BUSINESS ENTITY AND MONITORING AND REPORTING THE RESULTS THEREOF

TECHNICAL FIELD

This invention relates to the field of insurance contracting and, more particularly to the field of providing a business model that effectively allows the provision of reduced insurance premiums and reduced risk of loss.

BACKGROUND OF THE INVENTION

The insurance industry is religiously governed by the law of averages. To be profitable, insurance companies must sell policies at premiums that will exceed the cost necessary to cover expected claims and operating expenses. Identifying the operating expenses for the insurance company is basic business management. However, identifying the expected claims that will arise from an insurance company's client base is a complex task. The typical insurance company has a team of actuarial scientist that pour through statistics, cost curves, trends, risk assessments, and a pocket protector full of other variables in an effort to accurately identify the risk of loss associated with particular client profiles or genres. Too many ill conceived projections can drag an insurance company into bankruptcy.

Thus, the insurance company is met with at least two competing interests or goals. On one hand, it needs to guaranty the reception of premiums adequate to keep the company profitable. On the other hand, the insurance company needs to offer price competitive programs that will attract a large number of clients. If the premiums for the insurance programs are set too low, the insurance company runs the risk of becoming cash poor. If the premiums for the insurance programs are set too high, the insurance company may not be able to attract enough clients to make the program worth while. The optimum scenario is to provide competitively priced programs to low risk clients. Therefore, there is a need in the art for a technique to help reduce the premiums of an insurance program while at the same time, reducing the risk attributed to insuring a particular entity.

The health care provider industry heavily relies on the insurance industry. Of particular interest is the long-term health care industry, such as nursing homes, elderly homes or the like. During the 1998 to 2000 time-frame, these long-term health care providers experienced insurance premium increases as high as 350% per year. One reason that these escalating premiums can be attributed to is the high-risk nature of the business. The number one claim levied against long-term health care providers are fall claims. In addition, wound care claims, such as bed sores, result in multimillion dollar judgments against the health care provider. These judgments are ultimately paid by the insurance companies.

The insurance risk of long-term health care providers dramatically increased with the implementation of the new Medicare system. When initially implemented, the rates offered by the Medicare system were drastically insufficient to meet the cost of the services provided. As a result, it was necessary for many long-term health care providers to reduce their nursing staff and to cut corners in obtaining proper medical equipment and supplies.

Although corrective reimbursement changes have been made, this industry is still plagued with a high turnover rate of clinical and support personnel. The high turnover rate directly has an effect on the number of incidents that occur in such a long-term health care provider establishment.

High-risk entities, such as long-term health care providers are stuck in a "catch 22" situation. The providers cannot afford to provide the level of service necessary to reduce their insurability risks. Because of the high risk, the insurance premiums for such entities continue to escalate which results in increasing the insurability risk of the entity. Thus, there is a need in the art for a technique to help reduce the insurability risk of a long-term health care provider and to reduce the insurance premiums charged to the same.

Similar to the long-term health care industry, many other industries are also plagued by escalating insurance premiums do to their high-risk status. Thus there is a need in the art for a general technique that can help reduce the insurability risk of an entity and to provide affordable and profitable insurance programs to the entities.

SUMMARY OF THE INVENTION

The present invention satisfies the above needs by providing a method and a system that operate to (a) reduce the insurability risk of an insured entity, (b) reduce the insurance premiums for insurance programs, (c) increase the profitability of the insuring entities by decreasing the probability of incident claims being levied against the insured entity, and (d) reduce the overall risk factors in the health care industry, or other industry, being serviced by another entity to improve operations.

The present invention formulates a program for the insured entity that contains various program requirements. Procedures designed for the insured entity to meet the program requirements are implemented and monitored to identify the proximity of the insured entity meeting the program requirements. Once the present invention calculates the proximity of the insured entity meeting these program requirements, the proximity is calculated to an interested third party, such as the insurer. Thus, the present invention by monitoring the insured entity, and communicating information relating to the insured entity to the insuring entity, allows the insuring entity to reduce the insurance costs to the insured entity if such monitoring results in favorable information for the insurer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a functional block diagram illustrating an exemplary embodiment of the business model of the present invention.

Fig. 2 is a functional block diagram illustrating an exemplary embodiment of the business model of the present invention.

Fig. 3 is a flow diagram illustrating the steps and procedures that are involved in the exemplary implementation of the present invention illustrated in Fig. 1

Fig. 4 is a functional block diagram illustrating one specific application of the present invention.

DETAILED DESCRIPTION

Referring now to the figures in which like numerals refer to like elements throughout the several views, various embodiments and aspects of the present invention are described. The present invention provides a system and method and business model for providing reduced-cost and cost-effective insurance programs, and has been described in relation to particular embodiments which are intended in all respects to be illustrative rather than restrictive. Those skilled in the art will understand that the principles of the present invention may be applied to, and embodied in, various program modules for execution on differing types of computers and/or equipment, operating in differing types of networks, regardless of the application. Although the business model of the present invention has been described as being integrated within an insuring entity, it should be understood that the business model of the present invention can actually exist independent of an insuring entity. In addition, the present invention has been described as being interactive with a user; however, those skilled in the art will appreciate that the user interface may also be substituted with a computer or machine interface.

Fig. 1 is a functional block diagram illustrating an exemplary structure of the business model of the present invention. The business model includes three entity classes: strategic partners 100, program catalysts 140 , and program clients 130. The strategic partners include one or more entities that cooperatively, or independently, provide contractual programs 115 to program clients 140. Examples of such programs include, but are not limited to, life, health, product liability or other insurance programs, warranty programs, malpractice liability and maintenance programs. As illustrated in Fig. 1, the strategic partners 100 include multiple strategic partners 110, a priority strategic partner 105 and distribution 120.

The program clients 130 may include a variety of entities and the present invention is not limited to any particular entity or class of entities. However, examples of program clients 130 are provided within the specification and each such provision is to be intended for illustrative purposes only and is not intended to be restrictive or to limit the scope of the present invention. A few examples of program clients 130 include a health care provider, an individual person, a building owner, a vehicle owner, individual entity/corporation or the like.

The program catalyst 140 operates to assist the program clients 130 in meeting the obligations and requirements of the program. The obligations and requirements of the program may be set by the program catalyst 140 based on its experience and expertise, the strategic partners 100, and even in some cases, the program clients.

The business model of the present invention allow the strategic partners 100, operating independently or in conjunction with a program catalyst 140, to create programs to be offered to the program clients 130. One a program 115 is in place, the program catalyst 140 works with the program client 130 to ensure that certain obligations, requirements, performance standards, or the like are being met. The program catalyst 140 then utilizes a web-enabled, proprietary software reporting system to provide instantaneous feedback to the strategic partners 100 and/or the program clients 130 regarding the performance of the program 115. However, it should be understood that the Program catalyst is not required to utilize the reporting system but rather, this activity simply comprises one inventive aspect.

Fig. 2 is a functional block diagram illustrating an exemplary embodiment of the business model of the present invention. In this embodiment, the operation of the business model of the present invention is illustrated in the provision of an insurance program offered to a long-term health care provider is illustrated. The strategic partners in this embodiment include entities that provide or are affiliated with the insurance industry "insuring entities" 200. The program clients in this embodiment include insured entities 230.

The insuring entities 200 include insurance providers 210, authorizing or initiating brokers (MGA1) 205 and managing general agents ("MGAs") 220. The insured entities 230 may include a variety of entities and the present invention is not limited to any particular entity or class of entities; however, for this example, the insured entity 230 is a long-term health care provider, such as a nursing home. The program catalyst 240 operates to assist the insured entity 230 in meeting the obligations and requirements of the insurance program offered by the insuring entities 200.

Insuring entities 200 typically provide multiple insurance programs from which a potential insured entity 230 can select. Under the business model of the present invention, at least one of these insurance programs is offered at a reduced premium, and in exchange for the reduced premium, the services of the program catalyst 240 are employed. The program catalyst 240 works closely with the insured entity 230 and provides a program management and risk management function. The program catalyst 230 also works closely with the insuring entities 200 to provide program feedback intended to assist the insuring entities 200 in the administration of the insurance program. Thus, the program catalyst may include the provision of clinically driven programs 242 in one embodiment and web-enabled reporting 241 in another embodiment, or yet in even another embodiment, both.

Fig. 3 is a flow diagram illustrating the steps and procedures that are involved in the exemplary implementation of the present invention illustrated in Fig. 1. Initially an insurance program is formulated 310. The result of this process is a insurance contract or program 215 that can be subscribed to our purchased by a potential program customer - the insured entity 230. Several techniques including various participants may be employed in this process and the present invention is not limited to any particular technique. In one embodiment, several insurance providers are pooled together to underwrite the insurance program. This technique advantageously allows the risk associated with the insurance to be diluted by spreading any losses to all of the pooled insurers. Those skilled in the art and knowledgeable about the insurance industry will realize that this is simply one technique that can be used to create the insurance program. In other embodiments, a single insurer may offer the program.

Once the insurance program is formulated 310, the insuring entities 200 and one or more potential insured entities 230, enter into insurance relationships 320. This procedure may be conducted in a variety of manners and the present invention is not limited to any particular manner. Rather, the present invention is only dependent upon ultimately establishing an insurance relationship between the insured entity 230 and an insuring entity 200. In the embodiment illustrated in Fig. 2, the insurance program can be sold to a potential insured entity 230 either directly 250 or through a managing general agent ("MGA") 220 255 256. In the first instance, the insured entity 230 pays insurance premiums to the insuring entity 205 259. In the second instance, the insured entity 230 pays insurance premiums to the MGA 220 258 and the MGA 220 provides payment to the authorizing or initiating brokers 205 258.

An additional step that must be performed is the creation of a relationship between the insuring entity 200 and the program catalyst 240 330. The program catalyst can take on a variety of forms and the present invention is not limited to one particular form nor to the examples provided herein. In one embodiment, the program catalyst 240 is a service company that provides services to the insured entity 200 on behalf of the insuring entity 230. As an example, if the insured entity 230 is a long-term health care provider, the program catalyst may provide risk management/assessment services to help reduce the number of incidents within the facilities of the insured entity 230.

In the preferred embodiment, directed toward the health care industry, an exemplary program catalyst 240 can utilize the latest technologies and techniques to reduce the risk of accidents occurring in the health care arena. These efforts can be directed towards fall prevention, wound care, documentation guidelines, nutritional issues, security issues, pharmacy/drug programs, sexual harassment programs, or the like. Advantageously, the program catalyst 240 of the preferred embodiment of the present invention utilizes licensed clinicians and nurse managers to provide the risk management/assessment services.

The relationship between the insuring entity 200 and the program catalyst 240 may take the form of a services contract under which the program catalyst 240 is paid for services rendered. Alternatively, the business model of the present invention also anticipates that the program catalyst 240 may enter into an agreement with the insured entity 230 for the provision of the services. In yet another alternate embodiment, the program catalyst 240 and the insuring entity 200 may be the same entity. In yet another embodiment, the program catalyst 240 may be an integral part of the insured entity 230. In yet another embodiment, the program catalyst 240 may enter into an agreement with the priority strategic partner - the MGA1 205.

Regardless of which of the above-described embodiments are utilized, at step 340 the program catalyst 240 provides services to the insured entity 230 and then provides a reporting service to the insuring entity 200 and/or the insured entity 230. In the preferred embodiment, a web-based and/or a web-enabled software solution is utilized by the program catalyst 240 in providing these services. Periodically (i.e., once per week, month, etc.), a member of the program catalyst 240 team (i.e., a nurse manager) will utilize the software solution to address the key factors of the risk management program. Based on the input from the program catalyst 240 team member, scoring data for relevant issues are generated. This scoring data identifies a relevant issue in the applicable industry and attaches a performance score to indicate the insured entity's conformance or adherence to operational requirements associated with this issue. In one embodiment, a value of 1 is assigned for poor performance and a 5 is assigned for excellent or above standard performance. These scores are a compilation of many factors, scored/measured on any particular subject matter within the program. Advantageously, the web-based software solution enables the program catalyst 240 to generate and deliver to pertinent parties in a timely and expedient manner.

Finally the insuring entity 200 can utilize the provided reports to modify, enhance or cancel insurance programs 350. Based on the reported performances of the insured entities 230, weak points and strong points can be identified. For the weak points, countermeasures can be employed, either directly or through the program catalyst to further reduce the amount of risk. The program catalyst 140 also provides access to the web-enabled software solution so that it serves as key and primary communication tool between the program catalyst 240 and the insuring entities 200. In addition, the program catalyst 240 can also provide training services to the insured entity 230. The training services instruct the insured entity regarding procedures and operations to help them attain a high scores.

Although the business model of the present invention has been described as being integrated within an insuring entity, it should be understood that the business model of the present invention can actually exist independent of an insuring entity. As an independent business model, the present invention provides an entity that provides special and skilled services to particular entity. The provision of these special and skilled services from an independent party are focused on the attainment of certain goals and objectives for the particular entity that are either established by the particular entity or some other third party. The entity providing the special and skilled services also employs the use of a web-enabled software solution that provides feedback pertaining to progress made toward reaching the goals and objectives. This feedback is provided through the web-enables software as a score system. The score system identifies the particular issues pertaining to the attainment of the goals and then provides a score to indicate the progress made in attaining the goal.

Fig. 4 is a functional block diagram illustrating one specific application of the present invention. In this embodiment, the risk management provider 440 teams up with one or more insurance carriers 400 to create a new insurance product 470. This new insurance product 470 provides multiple benefits such as reduced premiums, reduced risk of claims through providing adherence assurances, and increased standard in providing services by the insured. The new insurance product 470 is then distributed through authorized brokers distribution 420, or some other distribution channel, to entities in the health care industry 430, such as nursing homes, hospitals, future insured/customers. In providing the feedback, the risk management provider 440 will provide a program directed towards meeting a particular standard. The standard will be the score for compliance measurement that will be a mandate with the new insurance product 470. These scores are communicated to the insurance carriers 100 at intervals of their request (i.e., monthly). The scores are also sent to the insured client/ health care facility.

Under this application, the program catalyst 140 provides skilled clinical delivery of holistic risk management programs, coupled with the use of a proprietary, web-enabled software solution to provide scores/measurements of the performance under the programs. Advantageously, this application of the present invention assists in providing a higher level of care to patients. In addition, this application of the present invention provides cost and performance benefits to health care facilities and insurance companies/carriers. Thus, the business model of the present invention can be utilized to provide holistic clinically-driven risk management programs that facilitates bring two major industries together creating great opportunities, and equally important, to raise the standard of care within the health care industry.

Under this application of the present invention, it is readily observed that the program catalyst or the risk management provider 340 can easily modify its program to best suit the needs of the partners that rely on the business model. For instance, the risk management/assessment program may be customized to meet the specific requirements of various insurance policies, or to adjust the program to best suit the environment within which the health care provider is located. For example, the program may be adjusted to accommodate large amounts of inclement weather, multiple floors with steps, or particular characteristics of the patients and staff.

Alternate embodiments will become apparent to those skilled in the art to which the present invention pertains without departing from its spirit and scope. Accordingly, the scope of the present invention is described by the appended claims and supported by the foregoing description.

CLAIMS

What is claimed is:

1. A method for providing improved performance of a target entity, the method comprising the steps of:

formulating a program containing program requirements;

implementing procedures designed for the target entity to meet the program requirements;

monitoring the results of the procedures to identify the proximity of the target entity meeting the program requirements;

identifying the proximity of the target entity meeting the program requirements;

communicating the proximity to an interested third party.

2. The method of Claim 1, wherein the formulating a program containing program requirements step comprises a target entity purchasing the insurance program.

3. The method of Claim 1, wherein formulating a program containing program requirements comprises a single insurer offering the program.

4. The method of Claim 1, wherein the formulating a program containing program requirements step comprises several insurance providers underwriting the insurance program.

5. The method of Claim 1, wherein monitoring the results of the procedures to identify the proximity of the target entity meeting the program requirements further comprises providing feedback to the target entity regarding satisfaction of the program requirements.

6. The method of Claim 1, wherein communicate the proximity to an interested third party further comprises the steps of:

attributing a score to the monitored results; and

providing the score to the interested third party.

7. The method of Claim 6, wherein attributing a score to the monitored results further comprises attributing a numerical score indicating the conformance of the target entity to the program requirements.

8. The method of Claim 7, wherein communicate the proximity to an interested third party further comprises the step of providing the score to the target entity.

9. A method for providing reduced insurance premiums for an insured entity from an insuring entity, the method comprising the steps of:

formulating an insurance program containing predetermined program requirements;

implementing procedures designed for the insured entity to meet the program requirements;

monitoring the results of the procedures to identify the proximity of the insured entity meeting the program requirements;

identify the proximity of the insured entity meeting the program requirements;

attributing a score to the monitored results; and

providing the score to the insuring entity.

10. The method of Claim 9, wherein the formulating an insurance program step comprises an insured entity purchasing the insurance program.

11. The method of Claim 9, wherein the formulating an insurance program step comprises a single insurer offering the program.

12. The method of Claim 9, wherein the formulating an insurance program step comprises several insurance providers underwriting the insurance program.

13. The method of Claim 9, further comprising the step of providing the monitored results to the insured entity.

14. The method of Claim 9, wherein providing the monitored results to an insuring entity further comprises providing the monitored results by utilizing a web enabled software solution.

15. The method of Claim 14 wherein providing the monitored results by utilizing a web enabled software solution further comprises providing services to the insured entity and providing reports to the insured entity and the insuring entity.

16. The method of Claim 9, wherein attributing a score to the monitored results comprises attributing a numerical score indicated the conformance of the insured entity to the program requirements.

17. A method for creating an insurance product for an insured entity while minimizing insurance risks and reducing premium costs, said method comprising the steps of:

creating a new insurance product;

distributing the new insurance product to the insured entity though a distribution channel;

providing a program designed for the insured entity to meet program requirements;

determining the proximity of the insured entity to the program requirements; and

communicating the proximity to a third party.

18. The method of Claim 17, wherein creating a new insurance product comprises creating an insurance product comprising reduced premiums, reduced risk of claims by adherence assurances, and an increased standard in provided services.

19. The method of Claim 17, wherein distributing the new insurance product to the insured entity though a distribution channel comprises distributing the new insurance product through authorized brokers.

20. A system for providing reduced insurance premiums for an insured entity from an insuring entity, the system comprising:

a system server connected to a telecommunications network;

an independent program catalyst, residing on said system server, and operative to:

formulate an insurance program containing predetermined program requirements for the insured entity to be insured by the insuring entity;

implement procedures designed to enable the insured entity to meet the program requirements;

monitoring the results of the procedures to identify the proximity of the insured entity meeting the program requirements; and

attribute a score to the monitored results;

a web-enable software solution for communicating between the insuring entity, the insured entity, and the program catalyst.

21. The system of Claim 20, wherein said score comprises an indication of the insured entity's conformance with said program requirements.

22. The system of Claim 20, wherein the program catalyst is further operative to provide feedback to the insuring entity regarding said monitored results and said score.

23. The system of Claim 20, wherein the program catalyst provides feedback to the insuring entity by utilizing the web-enable software.

24. A system for providing improved performances for a target entity, the system comprising the components of:

an independent program catalyst that is operative to:

identify program requirements:

implement procedures directed towards assisting the target entity in meeting the program requirements;

monitoring the results of the target entity to identify the proximity to meeting the program requirements;

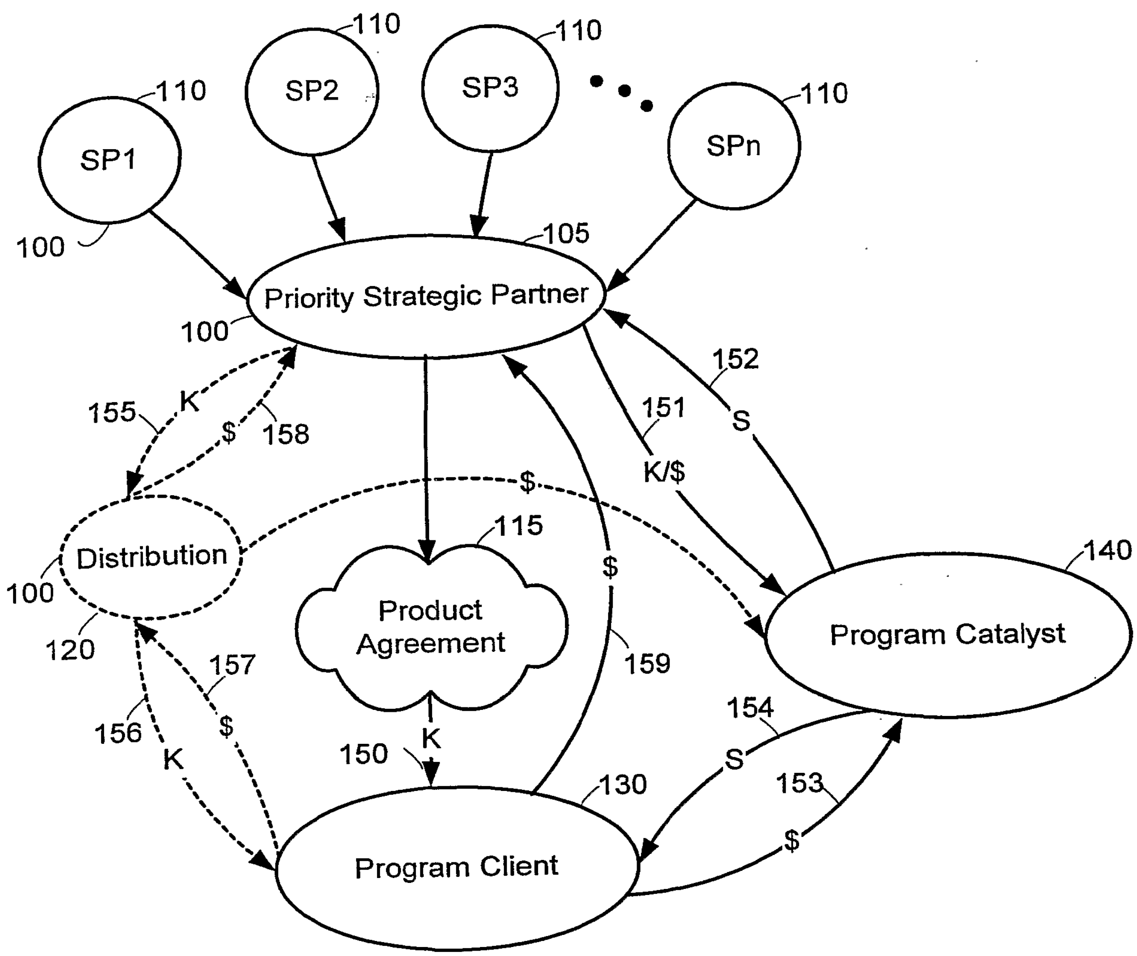
attributing a score to the monitored results; and

a web-enable software solution for providing the monitoring results and the scores to the target entity, the independent program catalyst and an interested third party.

25. The system of Claim 24, wherein said score comprises an indication of the insured entity's conformance with said program requirements.

26. The system of Claim 24, wherein the program catalyst is further operative to provide feedback to the insuring entity regarding said monitored results and said score.

27. The system of Claim 24, wherein the program catalyst provides feedback to the insuring entity by utilizing the web-enable software.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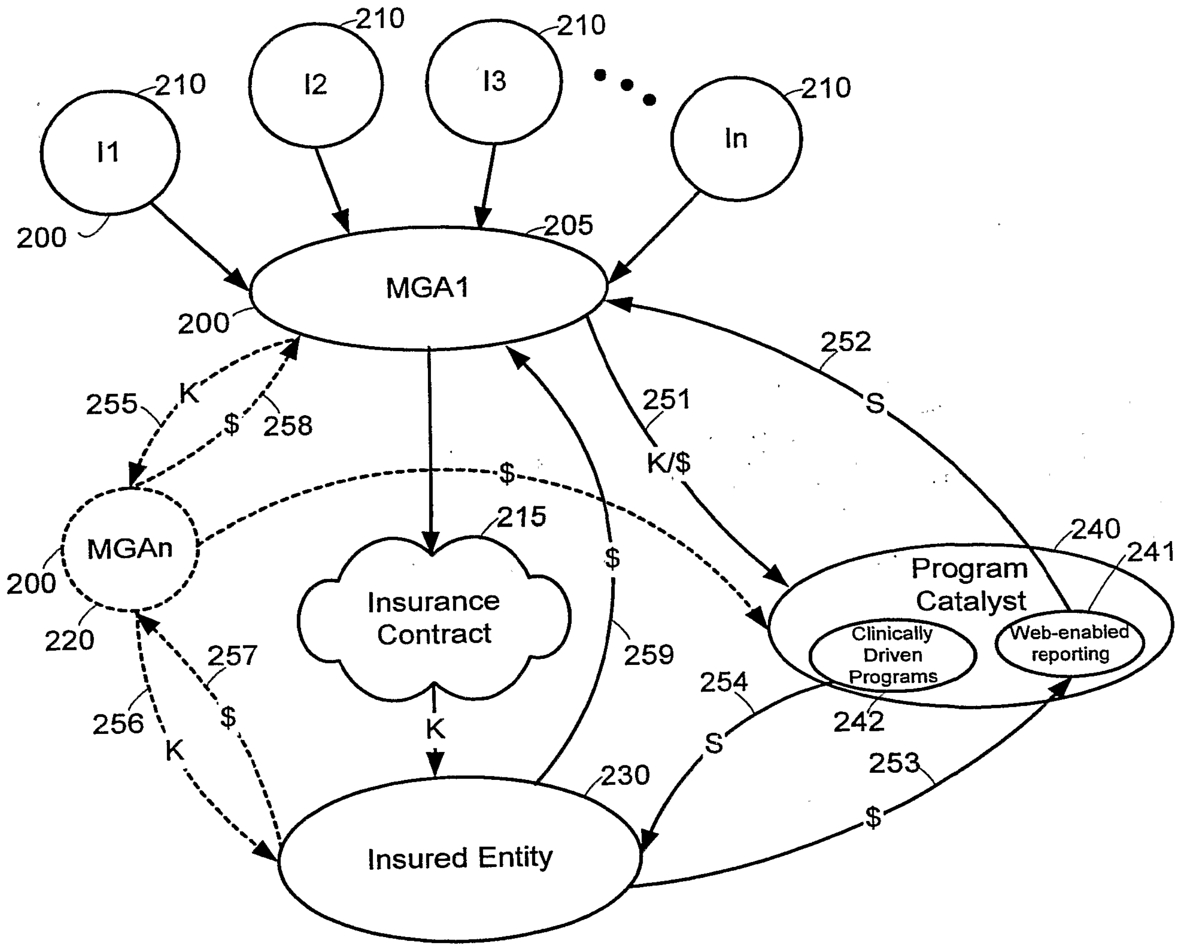
Program Client

Fig. 1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Contract
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Program
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Clinically
Driven
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reporting
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Insured Entity

Fig. 2

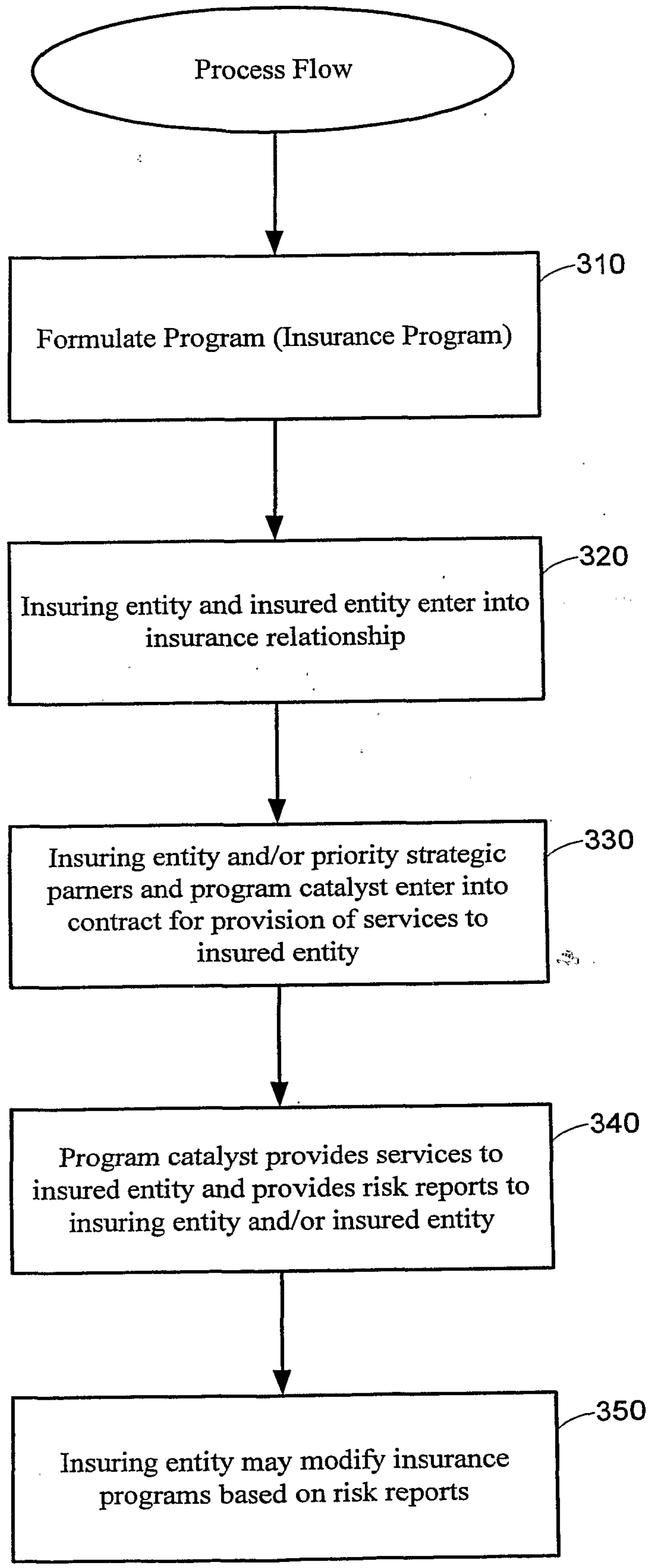
Process Flow
310
Formulate Program (Insurance Program)
320
Insuring entity and insured entity enter into insurance relationship
330
Insuring entity and/or priority strategic parners and program catalyst enter into contract for provision of services to insured entity
340
Program catalyst provides services to insured entity and provides risk reports to insuring entity and/or insured entity
350
Insuring entity may modify insurance programs based on risk reports

Fig. 3

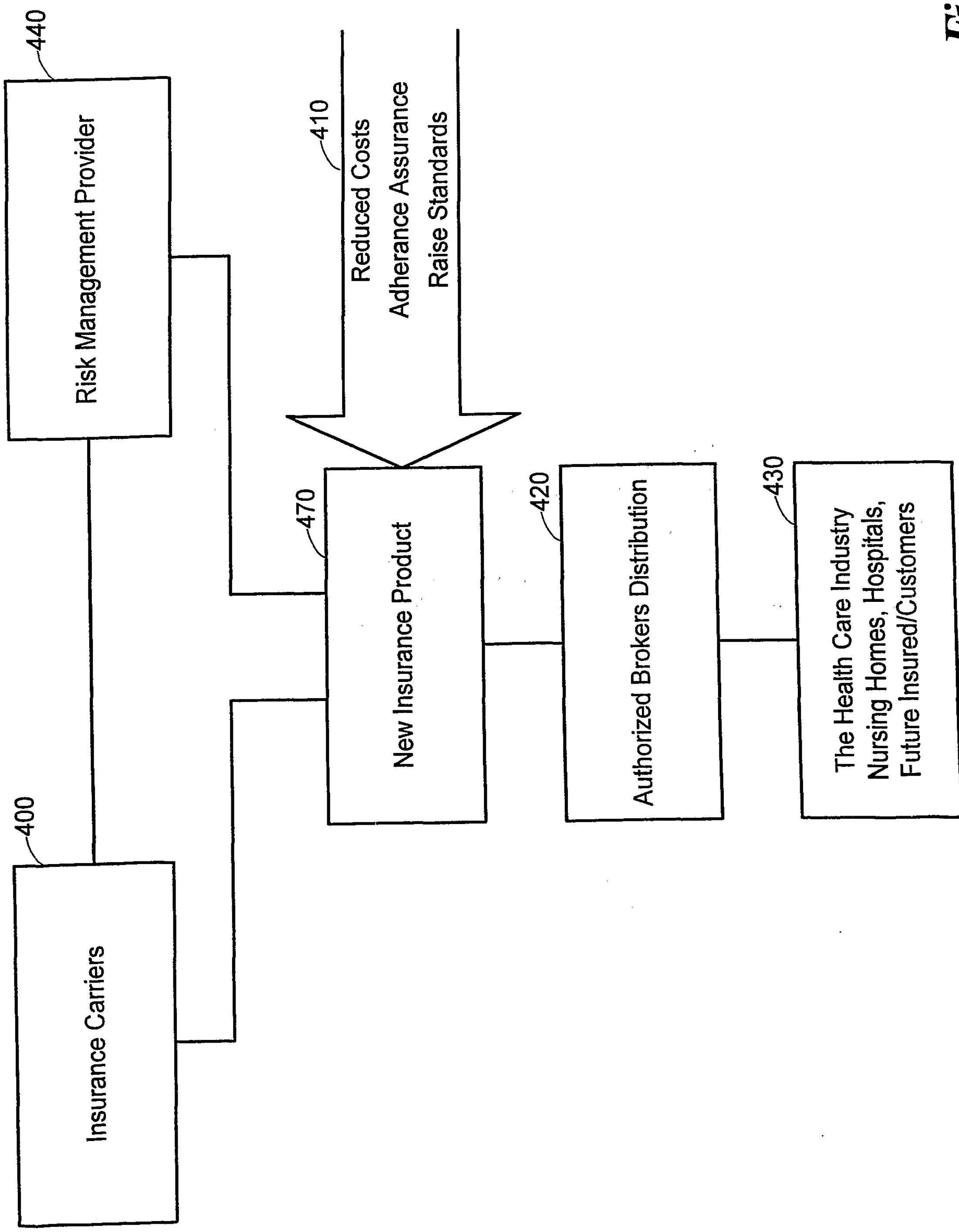
Risk Management Provider
440
410
Reduced Costs
Adherance Assurance
Raise Standards
470
New Insurance Product
420
Authorized Brokers Distribution
430
The Health Care Industry
Nursing Homes, Hospitals,
Future Insured/Customers
400
Insurance Carriers

Fig. 4

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 September 2003 (04.09.2003)

PCT

(10) International Publication Number
WO 03/073339 A1

(51) International Patent Classification[7]: G06F 17/60, G08G 1/123, G07C 5/00

(21) International Application Number: PCT/IE03/00028

(22) International Filing Date: 26 February 2003 (26.02.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

S020149	26 February 2002 (26.02.2002)	IE
S020259	9 April 2002 (09.04.2002)	IE
S020786	1 October 2002 (01.10.2002)	IE

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(81) **Designated States** *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI,

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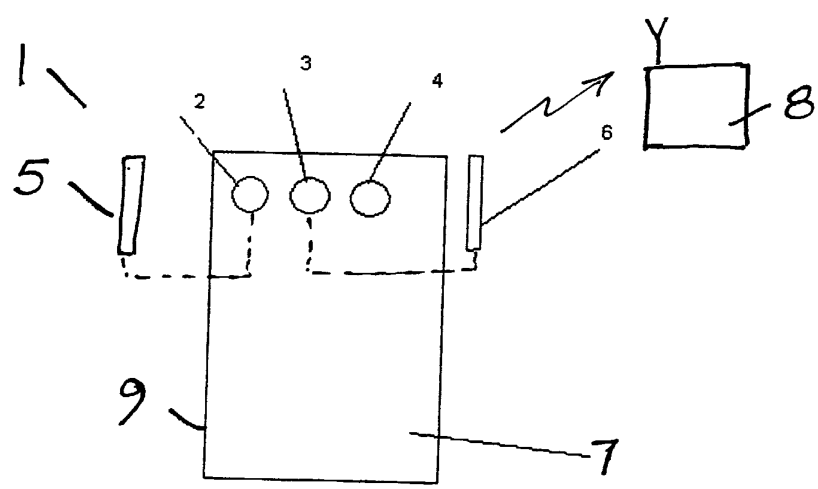
(54) **Title:** VEHICLE MONITORING SYSTEM



(57) **Abstract:** A vehicle monitoring system (1) has a vehicle mounted electronic device (7) and an associated remote monitoring station (8) which are interconnected by a communications link. The device (7) is connected to a GPS system which provides speed and location data for the vehicle which is independent of driver control. Additional data relevant to safe operation of the vehicle can also be collected. Some of the data is stored at intervals in the device (7) for later transmission to the remote monitoring station (8). The length of the intervals between data storage operations depends on the measured speed of the vehicle and the rate of change of speed of the vehicle. The data collected can be used to generate a report profile of the manner in which the driver drives the vehicle in order to calculate a suitable insurance premium for that driver.

WO 03/073339 A1

SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

"Vehicle monitoring system"

Introduction

The present invention relates to a system and method for profiling operation of a vehicle over a period of time for insuring the vehicle comprising an electronic device located within the vehicle and communication means for communicating data to a profile database stored at a remote monitoring station.

Modern communication means enables vehicles to be connected to a central database. This database and its related applications enables separation of the vehicle control environment into two dimensions:

1. Inner Control
2. Outer Control

The inner control is managed by the vehicle manufacturer and is under heavy control by the various safety authorities. All the car control necessary are well supported today, for example – steering , braking, seatbelts, to name but a few, form part of the inner control of a vehicle and are not part of this invention. On the other hand, the outer control is a method, which enables vehicle users or owners to benefit by improving the safety of their vehicle. An example of outer control is a tachograph used by truck drivers, which records the amount of time the vehicle is mobile. However, the technology employed for a tachograph is very basic and does not provide a large amount of information relating to measurable parameters of the vehicle.

A problem with vehicles and associated parties is that it is widely recognised that certain groups of people, particularly young drivers, are a risk to themselves and other vehicles on roads. At present there is no way to monitor these drivers and inhibit them from driving dangerously, for example at high acceleration from 0-60 miles per hour, not adhering to speed limits in the area that they are driving in and carrying more weight than the vehicle is designed to carry. It is desirable to provide a system and method which profiles operators of vehicles for calculating insurance for the vehicle and driver.

Statistics show that speeding is one of the prominent causes of fatalities and injuries on roads. Further, because certain groups of people can be categorised when driving vehicles insurance rates are much higher, for example for a young male single driver irrespective of how responsible the driver is on the road. A problem for these young drivers is that there is no effective solution or device developed to date to effectively monitor operation of vehicles and provide an accurate calculation of the insurance of the vehicle based on driver profiles.

Various solutions have been proposed to estimate the insurance of vehicles depending on driver performance. One such example is disclosed in US Patent No. 6, 064, 970 to McMillan et al. This US patent discloses a method of determining a cost of vehicle insurance based upon monitoring, recording and communicating data representative of operator and vehicle driving characteristics by monitoring a plurality of raw data elements representative of the operating state of the vehicles in response to the action of the operator. However a problem with the system described in this US patent is that it is bulky, expensive and difficult to install in the vehicle. It requires a computer to essentially communicate with three onboard vehicle devices for acquisition of information. The system disclosed in this US patent also suffers from the problem that the processing requirements for the hardware is computationally intensive.

US Patent Publication No. US 2002/0173881 Lash et al. discloses a system for monitoring the speed of a vehicle in relation to a posted speed limit using a global positioning system (GPS) receiver, used to receive conventional positioning data from a GPS satellite network to measure the location and speed of the vehicle. However this US publication is only directed towards informing the driver what speed they are doing in a particular speed limit and to inform the driver visually or audibly that they are exceeding the speed limit. Further, the GPS map is stored on the device in the vehicle which requires a large memory and is difficult to update.

Other examples of wireless intelligent vehicle speed controller monitoring systems are disclosed by US Patent No. US 6,246,948 Thakker. However this US patent does not disclose monitoring means for calculating insurance purposes and profiling drivers of vehicles. US Patent No. 6,141,611 Mackey et al., discloses a mobile vehicle accident data system incorporating a camera in the vehicle which records and stores data of images of a vehicle as it is moving. This data can be used in the event of an accident. However the system disclosed by this US patent is bulky and expensive and difficult to install.

It is an object of the present invention to provide a solution to the above-mentioned problems by providing a system and method to profile drivers of vehicles and to effectively calculate an insurance premium for the vehicle in response to the manner in which the driver drives the vehicle. The invention is further directed towards reducing the number of accidents on roads today and providing essential information at the time of an accident.

<u>Statements of Invention</u>

According to the invention there is provided a method of profiling operation of a vehicle over a period of time for insuring the vehicle comprising an electronic device located within the vehicle and communication means for communicating data from the electronic device to a profile database stored at a remote monitoring station comprising the steps of:

monitoring a plurality of parameters representative of an operating state of the vehicle, said parameters including the location of the vehicle and the corresponding speed of the vehicle at said location, said measured speed and location data being determined using a GPS receiver independent of vehicle operator control, said parameters being measured at selected time intervals,

storing the measured parameter data for the vehicle at each time interval in the electronic device;

establishing a communication link between the electronic device and the remote monitoring station;

transmitting the stored measured parameter data for each time interval to the remote monitoring station;

generating a report profile of the vehicle operation from the transmitted data; and

calculating from the report profile an insurance premium for insuring the vehicle.

An important advantage of the invention is that as the data is recorded via GPS the data is completely independent of the vehicle itself which prevents any unauthorised tampering with the data or sensors for collecting the data. It will be appreciated that the determined location and speed of the vehicle can be compared to an electronic map with different speed limit locations to determine whether the vehicle is speeding in a particular location, and this can be either done in real time or recorded for later review.

Various other embodiments of the invention are as described in the claims of this patent specification.

In another embodiment the system includes a modular electronic device comprising an ectronic circuit, a GPS (Global Positioning System) receiver, a computer means and a RF (Radio Frequency) communication means.

Preferably, an RF (Radio Frequency) communication means transmits stored data to a central monitoring station, via GPRS, SMS or GSM. If the chosen communication method is GPRS then the unit would be in constant communication with a central monitoring station allowing real time data analysis. This also means that a message or text can be sent to the driver of the vehicle in real time. Such information can be in an audio or text format to a display unit connected to the device in the vehicle.

In another embodiment there is provided a modular electronic device for a vehicle, including:

an electronic circuit operatively connected to a GPS receiver;

means for sensing and storing data relating to the vehicles position and speed via the GPS receiver;

means for measuring and storing data relating to the weight of the vehicle;

communication means, for transmission of the stored data to an associated computer at a remote central monitoring station;

said computer having means for analysing the location of the vehicle and the maximum weight and speed allowed for the vehicle at said location from a predetermined electronic map stored by the computer.

In another embodiment there is provided a modular electronic device for a goods vehicle for carrying a liquid cargo comprising:

an electronic circuit operatively connected to a GPS receiver;

means for sensing and storing data relating to the vehicle's position and speed via the GPS receiver;
means for measuring and storing data relating to the amount of liquid cargo that the vehicle is carrying;

communication means for transmission of stored data to an associated computer at a remote central monitoring station;

said computer having means for analysing the location of the vehicle, and the amount of liquid cargo and the vehicle speed allowed at said location from a predetermined electronic map stored by the computer.

Further, means may be provided such that the temperature of the liquid can be measured and stored for analysis. For example, it is possible to monitor the liquid during transit as well as determining whether the vehicle has exceeded the speed limit at a particular location.

In a further embodiment of the present invention there is provided a modular electronic device for vehicles comprising;

an electronic circuit operatively connected to a GPS receiver.

means for determining and storing data relating to the time the vehicle has spent on the road via the GPS receiver;

means for determining and storing data relating to the time the vehicle has spent parked and the location via the GPS receiver;

means for determining and storing data relating to the distance travelled by the vehicle;

communication means for transmission of the stored data to an associated computer at a central monitoring station;

said computer having means for analysis of the position of the vehicle and the amount of driving time recorded.

In another embodiment the system may include a camera means or other image sensor means such as a CCD element for mounting on the vehicle and means for storing images generated by the camera means. Said images could be stored locally on the vehicle for later retrieval or could be transmitted immediately or at timed intervals to a remote central monitoring station. It will be appreciated that various communication methods may be employed for example USB, Ethernet, RF Local Communication, Blue Tooth. Individual images may be recorded, for example a picture is taken every second or every few seconds. The images could be stored in the internal memory of the vehicle mounted device. If a sudden acceleration or deceleration of the vehicle occurs a sequence of pictures relating to the event may be transmitted to the computer in the remote central monitoring station, via cellular technology for example, or are stored in the vehicle mounted device to be downloaded at a later time.

In another arrangement continuous visual images can be generated by a video camera and recorded over a period. The recordal could for example overwrite previously stored video images over a period of time until a sudden acceleration or deceleration of the vehicle occurs. This event would store the video images relating to the event and then stop recording before erasing or overwriting these images. For example should the vehicle be involved in a collision the recorded images could be read directly via RS232 communication port, Blue Tooth, IR or other methods for later investigation. The number of CCD elements, or C-MOS technology can be varied according to the application and the system cost.

In a further embodiment means may be provided for sensing health parameters of the driver and for recording and/or onward transmission of any recorded data. For example, ECG, blood sugar level, hypertension and other data relating to the driver may be recorded.

Detailed Description of the Invention

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic view of a vehicle monitoring system according to the invention;

Fig. 2 is a schematic of an electronic device of the monitoring system;

Fig. 3 illustrates a mother board of the electronic device with associated GPS and cellular modem connection;

Fig. 4 is a schematic of the mother board of the device;

Fig. 5 is a collection of tables illustrating a sample vehicle operation profile report;

Fig. 6 is a view similar to Fig. 2 showing another electronic device for the vehicle monitoring system.

Referring initially to Fig.1 there is illustrated a vehicle monitoring system according to the invention indicated generally by the reference numeral 1. The system 1 includes a vehicle mounted electronic device 7 and an associated remote monitoring station 8 which are interconnected by a communications link. The device 7 has a sealed casing 9 which is waterproof. A first connector 2 is provided for connection with a GPS antenna 5. A second connector 3 is provided for connection to a communication antenna 6. A terminal 4 is provided for connection with a power supply (not shown) which may conveniently be the power supply for the vehicle on which the device 1 is mounted or possibly a separate battery.

Referring now to Fig. 2 there is provided a schematic of the electronic circuit of the device 1 indicated generally by the reference numeral 10. An optional display panel 11, which if used can be visually seen by the vehicle driver is connected to a system controller board 12. An optional sensor board 13, which measures various operational parameters of the vehicle if used is connected to the system controller board 12. The system controller board 12 comprises means for storing selected measured parameters associated with operation of the vehicle. The system controller board 12 is connected to a cellular communication board 14 and a GPS board 15, the operation of which will become readily apparent.

Figs. 3 and 4 show in more detail portions of the electronic device. Fig. 3 is a drawing illustrating the GSM modem 14, the GPS receiver 15 and the motherboard 12. It shows the motherboard 12 communicating with the GPS receiver 15 and the GSM modem 14. The motherboard 12 communicates with the two boards 14, 15 via serial communication. The motherboard 12 communicates with the GPS every 1.024 seconds and using it's onboard logic will decide to write a record or not.

Fig. 4 is a drawing of the motherboard 12. It shows the connector to the GPS receiver 15 and the GMS modem 14. It shows the application connector 17 which can be used to connect to external devices in the vehicle so that it is possible to optionally record if the brake was pressed for example. The microcontroller is where the processing takes place. The programming connector is used to update the software in the unit. The Non Volatile memory is where the data is stored. This can be up to 16mb. The RS232 connector allows us to connect a PC or laptop directly to the unit for direct communication.

Fig. 5 shows various tables illustrating vehicle operation in a sample report profile generated by the system during operation of the system.

Referring to Fig. 6 there is shown another electronic device indicated generally by the reference numeral 30. This is largely similar to the device 1 shown in Fig. 2 and like pats are assigned the same reference numerals. In the device 30 of Fig. 6 there is also shown a camera 16 connected to the system controller board 12. This camera 16 is optional, and when used it is mounted on the vehicle and is operable to generate visual images in the manner described previously. Said visual images may be stored in the device 1 for later retrieval or may be transmitted to a remote central monitoring station. Individual images may be recorded, for example a picture is taken every second or every few seconds. The images could be stored in the internal memory of the vehicle mounted device. These could be continuously overwritten during normal operation of the vehicle. If however sudden braking of the vehicle occurs a sequence of pictures relating to the event is stored in the vehicle mounted device 1 to be downloaded at a later time or transmitted to the remote monitoring station.

In operation, the system controller board 12 collects data continuously from the GPS receiver board 15 associated with a GPS system and stores selected data. Upon a predefined event or time the collected data is transmitted to a remote or secure database, in the remote monitoring station 8 for example, by the cellular communication board 14. Data relating to the location of the vehicle and the speed at which the vehicle is travelling at that location is generated continuously by means of the GPS receiver 15, being updated approximately every second. The system controller board 12 receives the information from the GPS receiver 15 and stores selected information at spaced time intervals which preferably depend on the speed of the vehicle and/or acceleration or deceleration of the vehicle. Thus for example if the vehicle is stationary then the location data may be only collected every minute whereas if the speed is in the order of 60 miles per hour then the speed and location data may be polled every twenty seconds.

The GPS receiver 15 is polled by the system controller board 12 roughly every second. The system controller board 12 selects data for storage. This is done in response to the measured speed of the vehicle and also in response to the determined acceleration or deceleration of the vehicle during harsh braking for example. If the vehicle is stationary or only moving slowly there will be relatively long intervals between each sequential set of data values stored, for example the interval might be in the order of sixty seconds. As vehicle speed increases the interval is reduced – for example if vehicle speed is in the order of twenty to thirty miles per hour the interval might be thirty seconds, for a vehicle speed of thirty to forty miles per hour the interval might be twenty five seconds, for a speed of forty to sixty miles per hour the interval might be twenty seconds and so on with the interval reducing as the vehicle speed increases. When harsh braking is detected, which may indicate the possibility of an accident for example, all the data received from the GPS receiver 15 may be collected and stored in the device 7 for later retrieval.

A communication link may be established between the electronic device 1 and the remote monitoring station 8 in a number of ways. In a first embodiment the communication is via a standard dialup connection. The monitoring station 8 stores in a table within a database all the identifiers of the electronic devices 1 that it is responsible for polling. The identifier is simply the GSM phone number assigned to a SIM card contained in each electronic device 1 to identify each vehicle. A server at the monitoring station 8 dials all the electronic devices 1 in rotation. If the data is successfully received by the server from an electronic device 1 then it stores the data in a database and changes the field “contact” within the database to the next due date. It then instructs the local electronic device 1 in the vehicle to erase the data. If is was unsuccessful it will go into a retry queue which is gone through when the server gets through all the other units. If it cannot contact the electronic device 1 in the vehicle at all then it will write this to an error log which will be checked by the operator.

In a second method the communication between the electronic device 1 and the remote monitoring station 8 is via an SMS system (Short Message Service). The server at the remote monitoring station 8 sends a request by SMS to the electronic device 1 in the vehicle. The electronic device 1 in the vehicle then sends its current stored GPS record back to the server at the remote monitoring station 8. The server at the remote monitoring station 8 can also request the last six GPS records. The electronic device 1 in the vehicle transmits this information back to the server at the remote monitoring station 8 in a compressed SMS message.

In a third communication method the electronic device 1 communicates with the remote monitoring station 8 via a GPRS system. This operates in a fashion substantially similar to that described for the dialup method described previously. However instead of a phone number the remote monitoring station 8 stores a designated internet address of each vehicle mounted electronic device 1 in a database. Using this method it is possible for the remote monitoring station 8 to contact hundreds of vehicle mounted electronic devices 1 at the same time. The only limit on the amount of electronic devices 1 would be the bandwidth available to the server.

When the data has been uploaded to the remote monitoring station 8 each speed and associated location measurement is compared with a datum GPS map which has a designated maximum speed for each location on the map. Various comparison tables can then be prepared as shown in Fig. 5 to compare the actual driving speed of the vehicle with the maximum permitted speed at any given location where a measurement was taken. Typical data comparisons are illustrated in the tables shown in Fig. 5. This enables a report profile of the vehicle operation to be prepared from the transmitted data. From these report profiles an insurance premium for insuring the vehicle can then be calculated.

As can be seen in the various tables in Fig. 5 various different comparisons can be made. For example table 1 gives a general driving profile on the basis of percentage time spent driving within or above the maximum speeds for given locations. Table 2 compares the speeds actually driven with the related maximum speed allowed at the measured locations. Table 3 gives a log of when the vehicle is in motion. Table 4 gives a similar log indicating when and where the vehicle was parked. Table 5 records incidences where the vehicle was suddenly accelerated and table 6 shows when harsh braking of the vehicle was carried out. Table 7 shows areas in which the vehicle was driven and the percentage time spent in each area. Table 8 gives a graph of the speed profile of the vehicle over a given period. Table 9 shows a table of data collected. Table 10 gives a map with a route travelled by the vehicle indicated on the map.

Further data such as personal and medical data from the passengers or the driver of the vehicle can also be collected, stored and transmitted. Additional parameters such as direction of the vehicle, location, weight of the vehicle and other parameters can also be collected and stored. The information can be transmitted to the remote monitoring station 8 by the communication board 14 using standard RF communication or one of the previously mentioned communication methods.

The device 7 stores at predetermined intervals the vehicle's current location, speed, heading and other various different data as required. This additional data can be functions such as whether or not the vehicle lights are on, whether or not seatbelts are being worn, and can integrate with current systems in the vehicle such as the temperature in the compartment of a freezer unit or the amount of liquid being carried in a tanker. It could possibly even record the weight of a load or how many people are in the vehicle. These are just some of the possibilities for the type of data that can be recorded. The remote monitoring station 8 once a day contacts the vehicle mounted device 7. The monitoring station 8 then requests any information from the device 7 that has not been sent to the monitoring station 8 previously. This data is then analysed by the monitoring station software and a report is generated. The report is based on selected criteria depending on end user requirements. Typically for example the report may give information about speed limit infringements, area of main use, distance travelled, time vehicle is stationary, average speed, maximum load carried etc.

In an alternative arrangement the vehicle mounted device 7 stores at predetermined intervals the same data as mentioned previously but instead of dialling into the device 7 the device 7 sends this data back to the monitoring station 8 via SMS. It can be programmed to send this information at regular time intervals ranging from daily to hourly or even every minute. The monitoring station 8 can also request information. This means that the monitoring station sends an SMS to the device 7 and the device 7 immediately responds with an SMS containing the last six records of recorded data. So if your interval was set at once an hour this would give the vehicle location every ten minutes. This allows vehicle tracking from any internet enabled device anywhere in the world. This would be the preferred mode if real time reports were required but not the level of detail required in the previously mentioned operating mode. The device 7 can also store the information as it does in the previously mentioned mode and this stored information is available to download if a more detailed report about a vehicle's activity for a particular period is required.

In regions where GPRS is available then the device 7 can take advantage of it. Using GPRS the device 7 can be "online" at all time allowing continuous and always instantly available data about the vehicle that the device 7 is installed in.

It will be appreciated that the device allows a vehicle's journey to be tracked and mapped. Also the driving habits of the driver can be monitored for:

(a) speed limit infringements,
(b) harsh braking,
(c) sudden acceleration,
(d) an overall determination of the driver's style.

Access to the data collected is possible via a telephone download.

The device 7 can be installed in a car and connected to the car electric system before the main switch. Only the GPS antenna would be exposed on the dashboard. When in sleep mode the system consumes less than 13 mA. The onboard local programming connector enables changing of the programme with laptop computer while the unit is installed in the vehicle.

Each device 7 has a unique number, the telephone number and SIM PIN code comprise this number. The SIM PIN code is an optional and for the basic unit the remote monitoring station 8 can gain access to all the data by means of the telephone number of the device 7.

According to another embodiment of the invention there is provided a method of profiling operation of a vehicle over a period of time, including an electronic device located within the vehicle and communication means for communicating data between the electronic device and a database stored at a remote monitoring station, including:

monitoring a plurality of parameters representative of the operating state of the vehicles, said parameters including the location of the vehicle and the corresponding speed of the vehicle at said location, said measured speed and location data being determined using a GPS receiver independent of vehicle operator control, said parameters being measured at selected time intervals,

storing measured parameter data for the vehicle at selected time intervals in the electronic device,

establishing a communication link between the electronic device and the remote monitoring station,

transmitting the stored measured parameter data to the remote monitoring station. Preferably this data is used for generating a report profile of the vehicle operation from the transmitted data.

In another embodiment the invention provides a vehicle monitoring system including means to determine the location of a vehicle and to measure the speed of the vehicle at said location and means for determining the maximum speed allowable for the vehicle at said location.

An important aspect of the present invention is the measurement of speed of the vehicle and the use of the GPS board 15. The GPS board 15, which incorporates a GPS receiver checks the location and speed of the vehicle. At predefined intervals the speed of the vehicle is matched with the location of the vehicle. Therefore, when this information is downloaded for analysis the location of the vehicle can be compared with an electronic map, which can determine what the speed limit is for that location. This is very advantageous in that a third party can analyse whether a vehicle was speeding, in for example a 30mph zone, at a particular time.

The invention further provides the ability to check that a driver is driving within the safe parameters predefined, such as the time taken to go from 0 – 60mph and if the speed limit at the current vehicle location is being adhered to. Various parameters such as the speed, direction, location, vehicle weight, temperature and cargo liquid volume may be sensed and data is stored in a memory located in the system controller board 12. The data stored may be analysed by the electronic device 1 or remotely at the remote monitoring station 8.

It will be appreciated that the modular electronic device 1 will have a micro-processor for processing the information. It will also be appreciated that many communication options can be integrated into the present invention. Further the sensor board 13 can be provided with Input / Output ports with display facilities to show their function.

It will be noted that the panel 11 can display to the driver of a vehicle that the vehicle is exceeding the speed limit in a particular zone or location either by visual or audio means. A head-up display could be provided for showing this information.

The electronic devices 1 of the invention can collect and store other information to provide additional information like car speed and acceleration and deceleration co-ordinated with electronic maps and speed limits for an emergency call on sensing a collision to ensure better control over large fleets of vehicles, weight measurement of goods carrying vehicles and heavy vehicles, record of number of miles as well as notifying when a service is due for the vehicle.

In the present invention when the term vehicle is used, it is used to encompass cars, motor cycles, trucks, buses and trains or any other vehicle which can be used for transport.

It will be appreciated that speed data obtained from the GPS receiver 15 is accurate and importantly is not vulnerable to outside interference or mechanical failure or fault.

This is particularly important to ensure the integrity of the data and that it has not been interfered or tampered with.

It will be appreciated that various aspects of the invention may be embodied on a computer that is running a program or program segments originating from a computer readable or usable medium, such medium including but not limited to magnetic storage media (e.g. ROMs, floppy disks, hard disks, etc.), optically readable media (e.g. CD-ROMs, DVDs, etc.) and carrier waves (e.g. transmissions over the internet). A functional program, code and code segments, used to implement the present invention can be derived by a skilled computer programmer from the description of the invention contained herein.

It will be appreciated therefore that a computerised program may be provided providing program instructions which, when loaded into a computer, will constitute the means in accordance with the invention and that this computer program may be embodied on a record medium, a computer memory, a read only memory or carried on an electrical carrier signal.

In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "includes, included and including" or any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation.

The invention is not limited to the embodiments hereinbefore described but may be varied in both construction and detail within the scope of the appended claims.

CLAIMS

1. A method of profiling operation of a vehicle over a period of time for insuring the vehicle comprising an electronic device located within the vehicle and communication means for communicating data from the electronic device to a profile database stored at a remote monitoring station comprising the steps of:

   monitoring a plurality of parameters representative of an operating state of the vehicle, said parameters including the location of the vehicle and the corresponding speed of the vehicle at said location, said measured speed and location data being determined using a GPS receiver independent of vehicle operator control, said parameters being measured at selected time intervals,

   storing measured parameter data for the vehicle at selected time intervals in the electronic device;

   establishing a communication link between the electronic device and the remote monitoring station;

   transmitting the stored measured parameter data to the remote monitoring station;

   generating a report profile of the vehicle operation from the transmitted data; and

   calculating from the report profile an insurance premium for insuring the vehicle.

2. A method as claimed in claim 1 comprising the further steps of:

adjusting the selected time intervals between recordal of measured parameters in response to the measured speed of the vehicle.

3. A method as claimed in claim 2 including the step of adjusting the selected time intervals in inverse proportion to the speed of the vehicle.

4. A method as claimed in any preceding claim including the step of adjusting the selected time intervals in response to the rate of change of the speed of the vehicle.

5. A method as claimed in claim 4 including the step of adjusting the time intervals in inverse proportion to the rate of change of the speed of the vehicle.

6. A method as claimed in claim 4 or 5 including:

sensing a sudden deceleration of the vehicle;

recording the measured parameters at reduced time intervals in response to a sensed sudden deceleration of the vehicle;

7. A method as claimed in claim 4 or 5 including:

sensing a sudden acceleration of the vehicle;

recording the measured parameters at reduced time intervals in response to a sensed sudden acceleration of the vehicle;

8. A method as claimed in any preceding claim comprising the further steps of:

periodically sending an SMS message from the remote monitoring station to the electronic device;

polling the stored measured parameter data;

sending an SMS message containing the stored measured parameter data from the electronic device to the remote monitoring station.

9. A method as claimed in any preceding claim comprising the further step of establishing a communication link between the electronic device and the remote monitoring station using a GPRS platform.

10. A method as claimed in any preceding claim comprising the further steps of:

storing at the remote monitoring station a GPS map having defined maximum speed limits associated with each location on the map,

comparing the transmitted measured location data for the vehicle with the GPS map and assigning the relevant maximum speed limit to each measured location,

generating the report profile of the vehicle operation indicating the measured speed of the vehicle, the associated location of the vehicle and the maximum allowable speed limit for that location.

11. A vehicle monitoring system, including:

means for measuring a number of pre-selected parameters associated with operation of the vehicle,

data storing means connected to the measuring means for recording data relating to said measured parameters,

means for polling the measuring means and recording the measured parameters received at selected time intervals in the data storing means,

said parameters including the location of the vehicle and the corresponding speed of the vehicle at said location, a GPS receiver being provided for determining both of said measured location and measured speed of the vehicle,

means for communicating recorded data from the data storing means to a remote monitoring station.

12. A system as claimed in claim 11 wherein means is provided for adjusting the selected time intervals between recordal of data in response to the measured speed of the vehicle.

13. A system as claimed in claim 12 wherein the selected time intervals are inversely proportional to the speed of the vehicle.

14. A system as claimed in any of claims 11 to 13 wherein means is provided for adjusting the selected time intervals between recordal of data in response to the measured rate of change of speed of the vehicle.

15. A system as claimed in claim 14 wherein the selected time intervals are adjustable in inverse proportion to the rate of change of the speed of the vehicle.

16. A system as claimed in claim 14 wherein means is provided for sensing a sudden deceleration of the vehicle, said means being operably connected to the means for adjusting the time interval between recordal of data to reduce said time intervals in response to a sudden deceleration of the vehicle.

17. A system as claimed in claim 14 wherein means is provided for sensing a sudden acceleration of the vehicle, said means being operably connected to the means for adjusting the time interval between recordal of data to reduce said time interval in response to a sudden acceleration of the vehicle.

18. A system as claimed in any of claims 11 to 17 wherein the communicating means is an SMS system.

19. A system as claimed in any of claims 11 to 17 wherein the communicating means is a GPRS system.

20. A system as claimed in any of claims 11 to 19 wherein the remote monitoring station has a GPS map with defined maximum speed limits associated with each location on said GPS map,

means for comparing measured vehicle location data communicated to the remote monitoring station with the GPS map and assigning the relevant maximum speed limit to each measured location, and

means for generating a report profile of vehicle operation indicating the measured speed of the vehicle, the associated measured location of the vehicle and the maximum speed limit for said measured location.

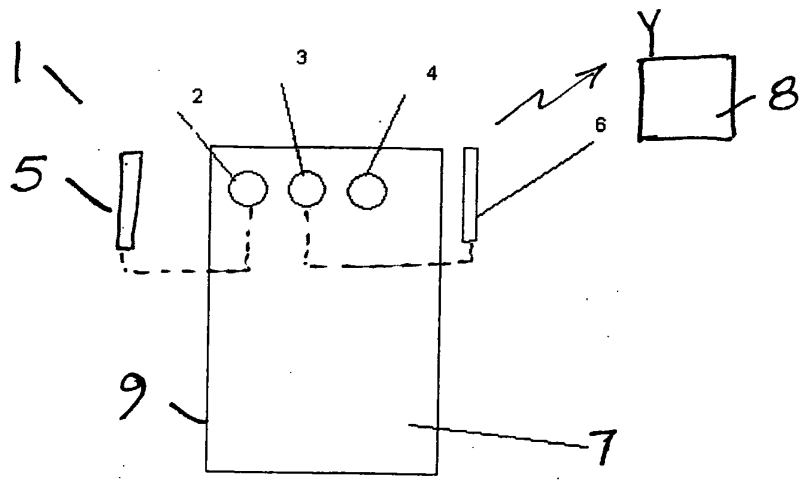

1
2
3
4
5
6
8
9
7

Fig 1

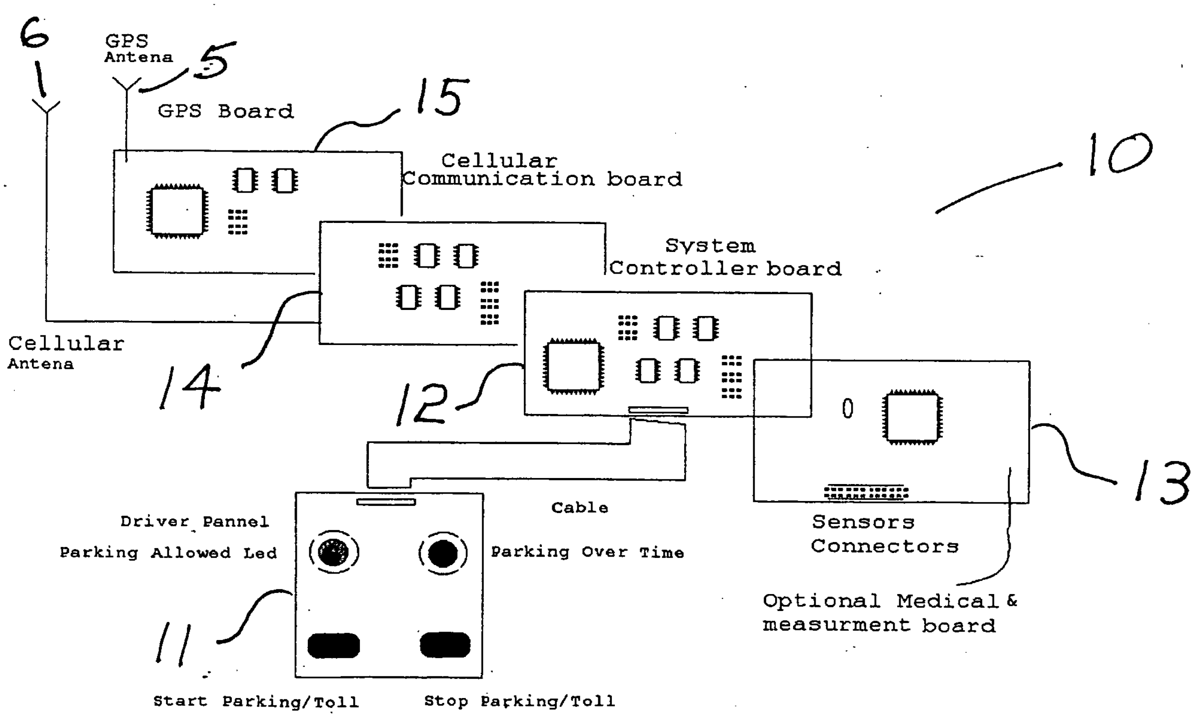

6
GPS
Antena
5
GPS Board
15
Cellular
Communication board
10
System
Controller board
Cellular
Antena
14
12
0
13
Cable
Driver Pannel
Parking Allowed Led
Parking Over Time
Sensors
Connectors
Optional Medical &
measurment board
11
Start Parking/Toll
Stop Parking/Toll

Fig 2

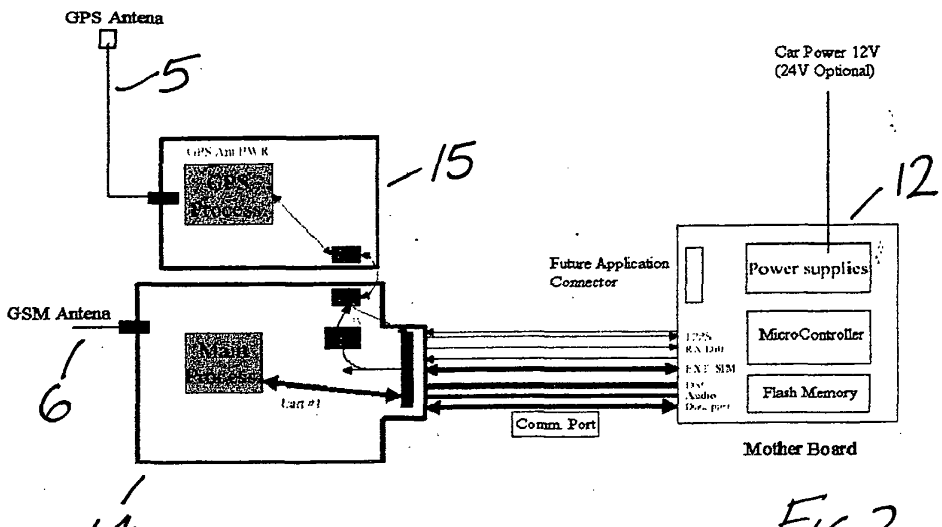

GPS Antena
5
15
GSM Antena
6
14
Comm. Port
Future Application Connector
Car Power 12V (24V Optional)
12
Power supplies
MicroController
Flash Memory
EXT SIM
Mother Board

FIG 3

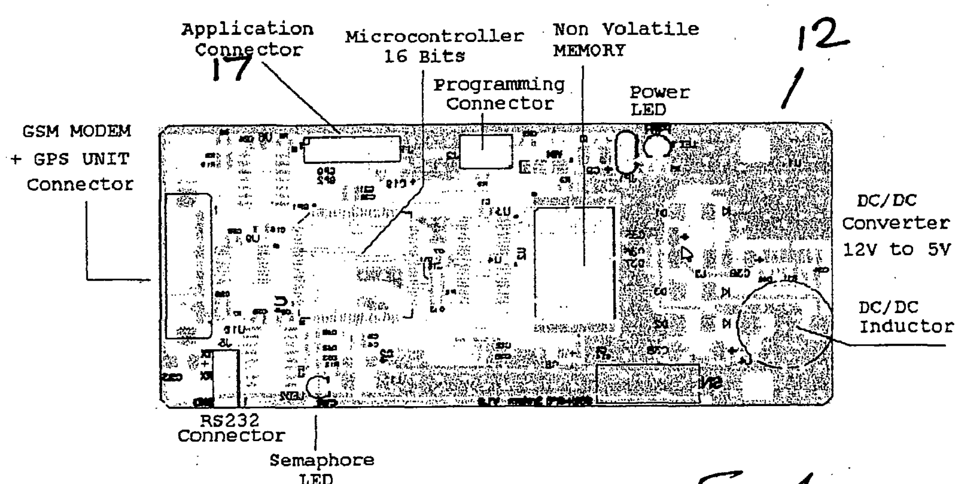

Application Connector
17
Microcontroller 16 Bits
Non Volatile MEMORY
12
Programming Connector
Power LED
GSM MODEM + GPS UNIT Connector
DC/DC Converter 12V to 5V
DC/DC Inductor
RS232 Connector
Semaphore LED

FIG 4

Summary Report

Driving Profile

84.34% Time spent driving within guidelines
8.62% Up to 10 mph above guidelines
4.69% Between 10 and 20 mph above g/lines
1.33% Between 20 and 30 mph above g/lines
0.99% Between 30 and 40 mph above g/lines
0.00% Over 40 mph above guidelines

TABLE 1

Maximum Speeds

Zone	Speed
30 MPH	65.5
40 MPH	65.7
50 MPH	63.5
60 MPH	68.5
70 MPH	79.8

TABLE 2

Vehicle Moving

	Hours Between		
	7:00-23:00	23:00-7:00	Total
2-10-02	2.13	0.15	2.28
3-10-02	2.60	0.05	2.65
4-10-02	3.97	0.05	4.02
5-10-02	4.98	0.01	4.99
6-10-02	3.44	0.05	3.49

TABLE 3

Vehicle Parked

	Hours Between		
	7:00-23:00	23:00-7:00	Total
Haddington Rd	6.84	0.00	6.84
Kildare	0.35	0.00	0.35
Lr Mount St	17.82	0.00	17.82
Maynooth	32.37	37.12	69.49
Other	0.82	0.00	0.82
Palmerstown	4.74	0.00	4.74

TABLE 4

Sudden Acceleration

Date	Time	From MPH	To MPH	Time Taken in Seconds
05/10/02	11:14:51	20.3	48.8	5
05/10/02	10:40:57	12.0	38.3	7
04/10/02	19:42:52	17.0	38.0	6
05/10/02	13:44:34	9.0	36.9	8

TABLE 5

Harsh Braking

Date	Time	From MPH	To MPH	Time Taken in Seconds
04/10/02	6:46:14	38.4	3.0	5
04/10/02	0:18:23	40.2	14.0	4
06/10/02	8:25:17	32.8	2.8	5
05/10/02	1:14:55	48.8	25.2	4
05/10/02	3:08:31	28.8	0.6	5
05/10/02	4:54:53	31.0	3.2	5

TABLE 6

Area of Main Use

Location	Use %
Kildare	30.36
DublinCounty	25.41
DublinCity	9.78
Meath	9.76
Galway	9.75
Westmeath	8.14
Kilkenny	2.70
Roscommon	1.85
Carlow	1.66
Offaly	0.58

TABLE 7

Snapshot Graph

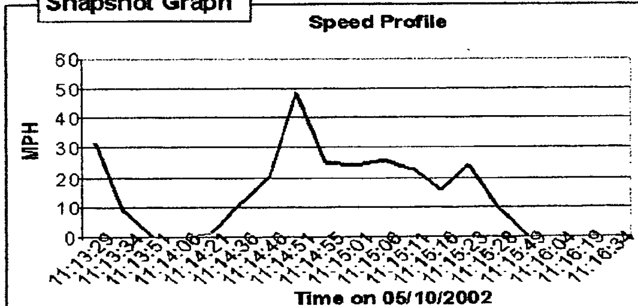


TABLE 8

Data Snapshot

+53°21'25.64,-06°22'12.66,10:13:29,05:10:02,,111.9,032.1,06
+53°21'24.94,-06°22'09.98,10:13:34,05:10:02,,114.7,008.7,05
+53°21'24.99,-06°22'09.72,10:13:51,05:10:02,,012.4,000.0,04
+53°21'25.06,-06°22'09.72,10:14:06,05:10:02,,226.8,000.1,04
+53°21'25.12,-06°22'09.61,10:14:21,05:10:02,,104.8,001.3,04
+53°21'22.28,-06°22'07.54,10:14:36,05:10:02,,170.3,011.4,07
+53°21'18.83,-06°22'04.73,10:14:46,05:10:02,,179.2,020.3,09
+53°21'15.15,-06°22'04.48,10:14:51,05:10:02,,175.4,048.8,08
+53°21'12.72,-06°22'04.87,10:14:55,05:10:02,,184.8,025.2,06
+53°21'09.85,-06°22'05.71,10:15:01,05:10:02,,188.7,024.4,07
+53°21'06.82,-06°22'06.52,10:15:06,05:10:02,,189.7,025.8,05
+53°21'03.85,-06°22'07.19,10:15:11,05:10:02,,188.7,022.9,06
+53°21'03.12,-06°22'09.78,10:15:16,05:10:02,,274.6,015.8,07
+53°21'04.07,-06°22'16.26,10:15:23,05:10:02,,283.2,024.4,09

TABLE 9

Map of Snapshot

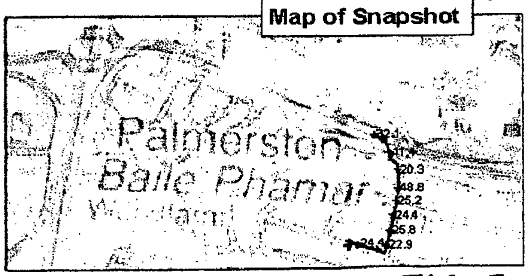


TABLE 10

FIG 5

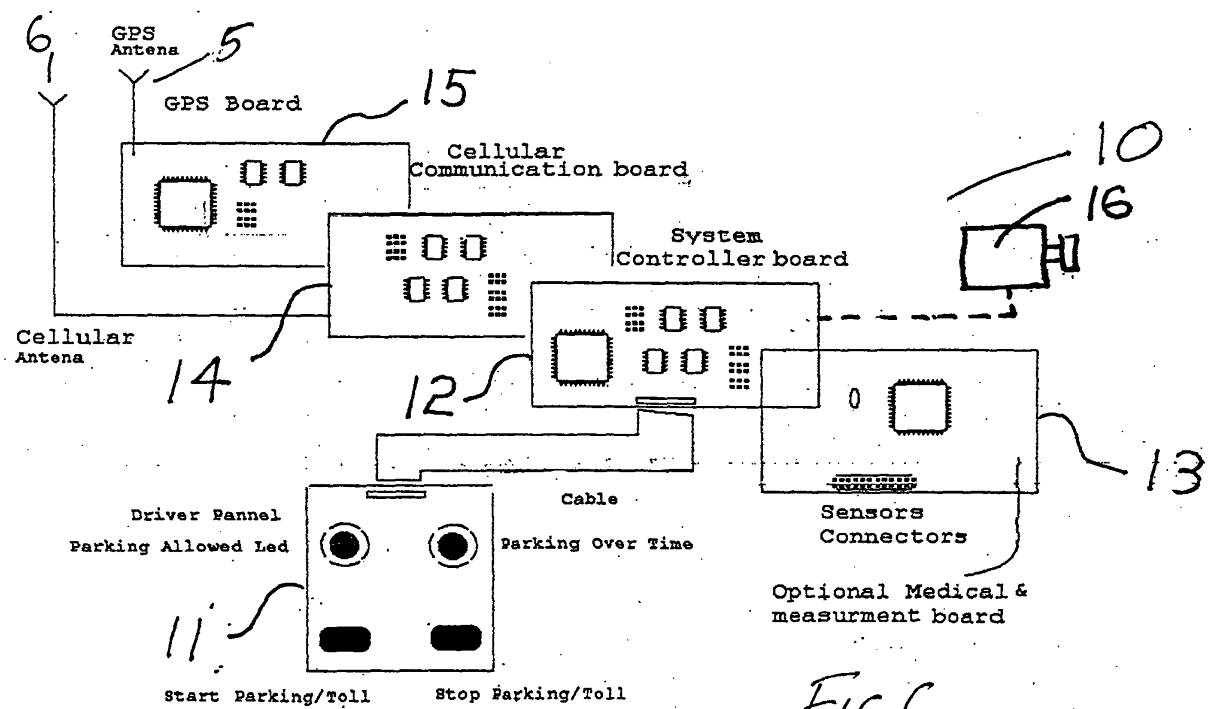

6
GPS
Antena
5
GPS Board
15
Cellular
Communication board
10
16
System
Controller board
Cellular
Antena
14
12
13
Cable
Driver Pannel
Parking Allowed Led
Parking Over Time
Sensors
Connectors
Optional Medical &
measurment board
11
Start Parking/Toll
Stop Parking/Toll

FIG 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 03/00028

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F17/60 G08G1/123 G07C5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G08G G07C G06F

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 160 707 A (PROGRESSIVE DIRECTRAC SERVICE) 5 December 2001 (2001-12-05)	1,8,11, 18
A	paragraphs '0001!,'0018!,'0029!,'0030! paragraphs '0053!-'0056! figures 2,3,5	2-7,9, 10, 12-17, 19,20

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 July 2003	15/07/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Massalski, M

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte   onal Application No
PCT/IE 03/00028

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 101 10 579 A (IBM) 31 October 2001 (2001-10-31) paragraphs '0001!-'0004! paragraphs '0008!-'0012! paragraphs '0022!-'0032! paragraphs '0056!-'0058! figures 1-3,7	1,11 2-10, 12-20
X A	US 6 339 745 B1 (NOVIK YEKUTIEL A) 15 January 2002 (2002-01-15) column 2, line 27,28,62,63 column 4, line 19-63 column 8, line 14-41 column 12, line 59-67 figures 1,4,20	1,11 2-10, 12-20
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A	EP 0 890 937 A (BOSCH GMBH ROBERT) 13 January 1999 (1999-01-13) page 2, line 9-32	1,11
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INTERNATIONAL SEARCH REPORT

Information on patent family members

Int onal Application No
PCT/IE 03/00028

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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CERTIFICATE OF EFS FILING UNDER 37 CFR §1.8
I hereby certify that this correspondence is being electronically transmitted to the United States Patent and Trademark Office, Commissioner for Patents, via the EFS pursuant to 37 CFR §1.8 on the below date:
Date: March 9, 2011 Name: James A. Collins Signature: /James A. Collins/

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of:	Raymond Scott Ling et al.		
Appln. No.:	12/132,487	Examiner:	Robert R. Niquette
Filed:	June 3, 2008	Art Unit:	3695
For:	VEHICLE MONITORING SYSTEM	Conf. No.:	7812
Attorney Docket No.:	12654-42		

TRANSMITTAL

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Attached is/are:

☒ Transmittal (1 pg); Fourth Supplemental Information Disclosure Statement (6 pgs); Form PTO 1449 (5 pgs); copies of Twenty-Nine Foreign Patent References (E51-E79); and copies of Twenty-Five Non Patent Literature References (E80-E104).

Fee calculation:

☒ No additional fee is required.

☐ Small Entity.

☐ An extension fee in an amount of $_____ for a ____-_ month extension of time under 37 CFR § 1.136(a).

☐ A petition or processing fee in an amount of $_____ under 37 CFR § 1.17(___)_ .

☐ An additional filing fee has been calculated as shown below:

						Small Entity			Not a Small Entity	
	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra		Rate	Add'l Fee	OR	Rate	Add'l Fee
Total		Minus				x $26=			x $52=	
Indep.		Minus				x 110=			x $220=	
First Presentation of Multiple Dep. Claim						+$195=			+ $390=	
						Total	$		Total	$

Fee payment:

☐ Please charge Deposit Account No. 23-1925 in the amount of $_____ for _____.

☐ Payment by credit card in the amount of $_____ (Form PTO-2038 is attached).

☒ The Director is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925.

Respectfully submitted,

March 9, 2011
Date

/James A. Collins/
James A. Collins (Reg. No. 43,557)

I hereby certify that this correspondence is being Electronically Transmitted on the date noted below to:
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

March 9, 2011
Date of Deposit

James A. Collins
Name of applicant, assignee or Registered Representative

/James A. Collins/
Signature

March 9, 2011
Date of Signature

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of:	Raymond Scott Ling et al.	
Appln. No.:	12/132,487	Examiner: Robert R. Niquette
Filed:	June 3, 2008	Art Unit: 3695
For:	VEHICLE MONITORING SYSTEM	Confirmation No.: 7812
Attorney Docket No: 12654-42		

FOURTH SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

This application claims priority under 35 USC §120 to the following United States patent applications: 08/592,958; 09/135,034; 09/571,650; and 10/764,076. In accordance with 37 CFR §1.98(d), copies of the references cited herein which were submitted to, or cited by, the office, in compliance with 37 CFR §1.98(a)-(c) in the earlier application may not be provided herewith. The Examiner is directed to those references cited in all Information Disclosure Statements filed in the priority United States patent applications cited above in addition to the references cited herein.

In accordance with the duty of disclosure under 37 CFR §1.56 and §§1.97-1.98, and more particularly in accordance with 37 CFR §1.97(b), Applicants hereby cite the following reference(s):

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Progressive's Memorandum in Opposition to Defendants' Motion to Stay Litigation Pending Ex Parte Reexamination of the Patent-In-Suit by the USPTO filed October 28, 2010, Case No. 1:10-cv-01370-PAG: Progressive Casualty Insurance Company versus Safeco Insurance Company of Illinois, Safeco Insurance Company of America, Safeco Corporation, Liberty Mutual Insurance Company, Liberty Mutual Group Inc., The Ohio Casualty Insurance Company, and Open Seas Solutions, Inc., 80 pages.
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Applicants are enclosing Form PTO-1449 (five sheets), along with a copy of each listed reference for which a copy is required under 37 CFR §1.98(a)(2). Pursuant to the undersigned attorney's obligation and duties under 37 C.F.R. §§ 1.56 and 1.98(a)(3) and (c), either English language abstracts, partial translations, or full translations are included for patent documents which are not in English for the express purpose of providing a concise explanation of the references to the Patent and Trademark Office with the opportunity to evaluate the same. Applicants respectfully request the Examiner's consideration of the above reference(s) and entry thereof into the record of this application.

Applicants also respectfully request the Examiner to review the claims and the prosecution history, including any Office Actions issued by the U.S. Patent and Trademark Office and any responses filed by Applicants, for Serial No. 08/592,958 (now U.S. Pat. No. 5,797,134), Serial No. 09/571,650 (now U.S. Pat. No. 6,868,386), Serial