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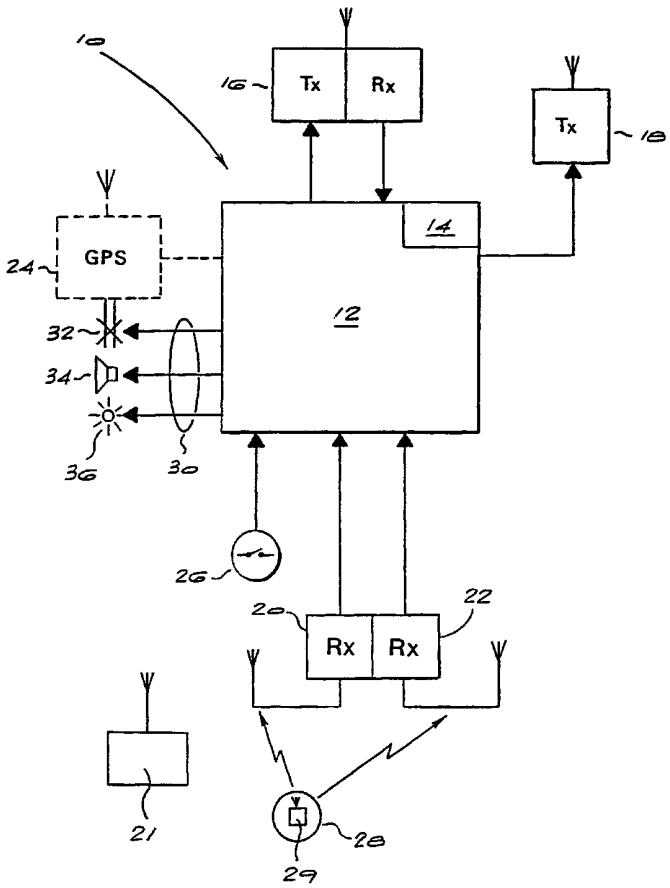

(57) Abstract: A mobile object monitoring and tracking system includes a tracking unit 10 which is fitted to a mobile object. The unit 10 comprises a GSM transceiver 16 for receiving mobile object locating signals from and transmitting mobile object identification signals to an array of GSM sites in a GSM-based area network defining a broad area of coverage. The unit 10 further includes a signpost receiver 20 for receiving mobile object locating signals from a strategically located array of signpost stations in a dedicated area network defining a restricted area of coverage falling within the broad area of coverage. The tracking unit is also provided with a transmitter 18 for transmitting mobile object location and identification signals to a central control station for identifying the mobile object and determining its approximate location. The system provides a number of activating inputs 26 for activating the tracking unit 10 and a number of arming inputs 28 for transmitting emergency signals to the unit 10.

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A MOBILE OBJECT MONITORING SYSTEM

BACKGROUND OF THE INVENTION

THIS invention relates to a mobile object monitoring system for monitoring mobile objects such as vehicles and their associated freight.

South African patent 94/4150 discloses a dedicated vehicle tracking system including an array of signpost stations distributed strategically around an area to be monitored. A vehicle-based receiver receives a signpost identification signal in the event of the vehicle being within the signpost footprint, and a vehicle-based beacon transmitter transmits a vehicle identification signal and a vehicle location signal derived from the signpost identification signal to a central control station for identifying the vehicle and determining its approximate position.

This system has primarily been concentrated in urban areas where a high percentage of vehicle thefts occur, and where the high density of users is able to keep the costs per user to a minimum. The advantage of a dedicated network of this type is that it is not clogged by other data traffic using the network. As a result, mobile homing equipment carried on recovery vehicles and aircraft can easily monitor a regularly transmitted signal from a particular stolen vehicle and home in on it to recover the vehicle.

In low density rural areas, the costs associated with establishing a dedicated network are prohibitively high on a per user basis.

It is an object of the invention to provide a mobile object tracking and monitoring system which provides a larger coverage area, whilst at the same time affording users the benefits associated with a dedicated network.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a tracking unit arranged to be fitted to a mobile object, the unit comprising:

transceiver means for receiving mobile object locating signals from and transmitting mobile object identification signals to a first array of stations in a broad area network defining a broad area of coverage;

receiver means for receiving mobile object locating signals from a second array of stations in a restricted area network defining a restricted area of coverage falling within the first broad area of coverage; and

transmitter means for transmitting mobile object location and identification signals to a central control station for identifying the mobile object and determining its approximate location.

Typically, the broad area network is a non-dedicated network and the restricted area network is a dedicated network.

Conveniently, the first array of stations is an array of GSM sites defining a GSM-based network, and the transceiver means is a GSM transceiver arranged to receive mobile object locating GSM signals from at least one of the GSM sites and to transmit GSM signals to at least one of the GSM sites.

Preferably, the second array of stations includes a strategically located array of signpost stations, the receiver means being arranged to receive signpost identification signals from the signpost stations for locating the mobile object.

Advantageously, the tracking unit includes a pager receiver for receiving pager signals from a pager network forming part of the restricted area network.

Typically, the tracking unit is linked to a message management system for allowing messages to be sent between the central control station and the tracking unit via the first array of stations in the broad area network.

Conveniently, the message management system includes a data logger for storing the mobile object locating signals from the first and second array of stations.

Preferably, the tracking unit includes a GPS receiver.

Advantageously, the tracking unit includes a plurality of sensors for sensing unauthorized entry into or operation of the mobile object, the transmitter and transceiver means being responsive to the sensors.

Typically, the tracking unit includes at least one manually arming and activating input for enabling the transmitter and transceiver means to transmit emergency condition signals or codes.

Conveniently, the tracking unit includes mobile object immobilizing and/or alarm outputs responsive to the sensors or manually activating inputs.

According to a second aspect of the invention there is provided a mobile object tracking system including:

a first array of stations in a broad area network defining a broad area of coverage;

a second array of stations in a restricted area network defining a restricted area of coverage within the broad area of coverage;

a central control station; and

a mobile object tracking unit associated with a mobile object, the unit comprising transceiver means for receiving locating signals from and transmitting identification signals to the first array of stations, receiver means for receiving locating signals from the second array of stations, and transmitter means for transmitting location and identification signals to the central control station for identifying the mobile object and determining its approximate location.

Conveniently, the first array of stations is an array of GSM sites defining a GSM-based network, the GSM network including a GSM exchange linked to the central control station for relaying mobile object identification and location signals thereto.

Preferably, the second array of stations includes a strategically located array of signpost stations, each signpost station including a signpost transmitter arranged to transmit a signpost identification signal to the receiver means in the event of the mobile object traversing a signpost footprint defined by the signpost station.

Typically, the second array of signpost stations includes "border" signpost stations located at the periphery of the restricted area of coverage, the "border" signpost stations being arranged to transmit a signal indicating to the tracking unit that it is leaving or entering the restricted area of coverage.

Preferably, the mobile object tracking system includes a pager network forming part of the restricted area network, the tracking unit including a pager receiver.

Conveniently, the mobile object tracking system includes a message management system for allowing messages to be sent between the central control station and the tracking unit via the first array of stations in the broad area network.

Advantageously, the message management system includes a data logger for storing the mobile object locating signals from the first and second array of stations.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a highly schematic diagram of a vehicle-based beacon unit according to a first embodiment of the invention;

Figure 2 shows a detailed block diagram of a beacon unit according to a second embodiment of the invention;

Figure 3 shows a diagrammatic layout of a dual network vehicle monitoring system of the invention;

Figure 4 shows a block diagram of a communications network according to a third embodiment of the invention;

Figure 5 shows a block diagram of a message management system of the communications network shown in Figure 4; and

Figure 6 shows a flow chart of an application layer of the message management system shown in Figure 5.

DESCRIPTION OF EMBODIMENTS

Referring to Figure 1, a vehicle-based tracking or beacon unit 10 comprises a central processing unit 12 in the form of an integrated module provided with memory 14, and having a number of different inputs and outputs. These include a GSM-based transmitter and receiver unit 16 arranged to transmit and receive signals in either the 900MHz or 1800MHz bands, a beacon transmitter 18, a signpost receiver 20 for receiving signals from a signpost station 21, a pager receiver 22 and an optional GPS receiver 24.

The beacon unit 10 is also provided with a number of activating inputs 26, with the signal on these inputs resulting in activation of the beacon unit. The activating inputs 26 are of a contact closure nature and will be programmable high or low. These may include a hijack button, a door switch, a brake switch, an ignition switch, boot or bonnet switches, a movement sensor, a "hotwiring" sensor, an airbag sensor or any other intrusion or activation sensor which senses unauthorized entry into or operation of the vehicle.

A number of arming inputs 28 are also provided, including a keyring activator 29 or a short range "call for assistance" activator for transmitting various emergency condition codes, including "hijack/police", "breakdown", "medical aid" and/or "accident" codes, as well as to transmit arm and disarm signals. Typically, the keyring activator provides a separate button for each emergency condition code, which assists in determining the nature of the emergency, as will be explained with reference to the message management system. The arming inputs 28 may be received by the existing signpost receiver 20 or alternatively by the pager receiver 22. Alternatively, the beacon unit 10 may

be armed via the GSM-based unit 16 by means of a telephone call being made to the unit 16, the call being accompanied by the input of a security PIN code. Various alarm and immobilizing outputs 30 may also be provided for, respectively, operating a fuel cut-off solenoid 32 and a siren 34 and for flashing the vehicle lights 36 in response to an alarm condition arising. Typically, a relay contact or a solid state driver can be used to operate the lights 36 and the remaining outputs.

Figure 2 shows a second preferred embodiment of a beacon unit 37, wherein similar components which have been described above with reference to Figure 1 have been indicated with similar reference numbers. The GSM and GPS modules 16 and 24 are combined in a single main module 38. The main module 38 includes four wired inputs from the activating inputs 26, four wired outputs leading to the immobilizing outputs 30 and two RS232 serial ports 40 and 42. A separate dedicated transceiver module 44 includes a 915MHz beacon transmitter 18 and a 403.9MHz receiver 46 for receiving signals from the keyring activator transmitter 29, together with a supporting central processing unit 48 and RAM 50. The dedicated module 44 is connected to the main module 38 by means of the serial port 40. The serial port 42 is used to connect optional modules to the main module 38, such as an on-board computer 41A of the vehicle, a voice handset 41B to allow cellular telephone calls to be made or a personal digital assistant 41C for facilitating Internet and other digital communications. The serial port connections 40 and 42 may take the form of BLUETOOTH® links or similar wireless links. The receiver 46 is also used to receive signals from signpost stations 21 in order to provide positional information, as will be described further below. As described above, the keyring activator transmitter 29 is typically used to arm and disarm the beacon unit 37. Alternatively, a RF device carried by the driver of the vehicle which is mounted with the beacon unit 37 could continuously emit a signal which could automatically arm the beacon unit 37 if the driver is out of range, further than, say, 5m from the beacon unit 37.

The vehicle-based beacon unit 37 may also include an associated cargo-based cargo tracking unit 52 and a data logger 54, which is typically based at a central control station. The cargo tracking unit 52 includes a 915MHz transmitter 56, a low power 403.9MHz transmitter 58 which communicates with the receiver 46, a 915MHz receiver 60 which communicates with the beacon transmitter 18, and an associated central processing unit 62 and RAM 64. The data logger 54 includes a low power 403.9MHz transmitter 66, a 915MHz receiver 68, as well as a central processing unit 70 and RAM 72. A serial port 74 connects the data logger 54 to a data terminal such as a personal computer.

The vehicle-based beacon unit 37 will now be described with reference to the dual network illustrated in Figure 3. The unit 37 is fitted to a vehicle 76 which follows a route 78 through the network. The dual network comprises a GSM network in the form of a plurality of pre-existing GSM sites 80 which in combination define a broad area of coverage. An array of signpost stations 82 having respective footprints 84 form part of a dedicated network providing a restricted area of coverage 86 within the broad coverage area defined by the GSM network. The restricted area of coverage 86 typically covers a more densely populated urban area. Border signpost stations 82.1 are arranged at strategic locations around the outer periphery of the restricted area 86. Also located within the restricted area 86 is a receiver network comprising a number of fixed receiver stations 90 which are more sparsely arranged than the signpost stations 82. The receiver stations 90 act as relay stations for relaying signals from the vehicle beacon unit 37 to a central control station 92. The control station 92 is linked directly to a central GSM exchange 94, which in turn controls call routing through the GSM network constituted by the GSM sites 80. The restricted area of coverage 86 also includes a commercial pager network providing a paging service via a number of pager transmitters 96.

The operation of the dedicated network within the restricted area 86 is essentially identical to that described in South African patent 94/4150. In brief, the respective signpost and pager receivers 20 and 22 respectively listen actively for signals from the signpost beacons 82 and pager transmitters 86. The signals from the signpost beacons 82 include signpost identification information, which is combined with the vehicle identification code. In the event of the beacon unit being activated, a combined signal is transmitted to the central control station 92 from the transmitter 18 via one of the receivers 90 or relay stations, as is shown at 98.

In the event of the signpost receiver 20 receiving a specially designated signpost identification signal from a border signpost station 82.1, this serves to indicate that the vehicle is leaving the restricted area of coverage 86. On receipt of the border signpost signal, the beacon unit 37 effectively switches from the dedicated network to the GSM network by activating the GSM transceiver unit 16. At the same time, a signal is transmitted to the central control station 92 via the border signpost station 82.1 indicating that the vehicle 76 is leaving the restricted area of coverage. Subsequent communication is via the GSM network constituted by the GSM sites 80. The GSM network is capable of providing positional accuracy in the region of 1km, by monitoring which GSM sites are communicating with the transceiver 16. On the basis of relative signal strengths, it may be possible to obtain accuracy to 100m to 200m for medium accuracy positioning. The GPS receiver 24 is the only practical means by which 20m accuracy may consistently be achieved. The beacon unit 37 will also switch over to the GSM network in the case where the signpost receiver 20 does not receive a signpost identification signal from a signpost station 82 within a fixed period of time, typically three minutes.

When the vehicle is outside the dedicated network but within GSM coverage, its tracking unit will periodically send a message to the central control station 92 from the GSM transceiver 16 via the GSM sites 80 and a conventional land

line network to confirm that the vehicle is secure. As was mentioned above, the position of the vehicle is known approximately on the basis of the identification of the currently active GSM site(s). If the vehicle is stolen, this is sensed by one of the sensors 26, or via the signpost receiver 20 in conjunction with the signposts 82. Alternatively, activation takes place via one of the remote activators 28, which immediately results in a violation message being sent via the transceiver 16 to the central control station 92. Recovery is initiated by sending recovery forces with a mobile tracking unit such as a vehicle 93.1 or a helicopter 93.2. A stand-alone pager transmitter or alternatively the GSM network itself can be used to activate the transmitter 18 of the beacon unit 37, enabling the mobile tracking unit to home in on the vehicle.

When the vehicle enters the dedicated coverage area 86 at point A, it receives a signal from the border signpost station 82.1 via the signpost receiver 20, and automatically switches so that it is responsive to signals from the signpost stations 82 within the restricted area of coverage.

In the event of the vehicle 76 being stolen whilst it is within the dedicated network, it may automatically be remotely activated by sending a pager message via the pager receiver 22. In the activated state, the beacon transmitter 18 continuously transmits emergency messages to the receivers 90, which are then relayed to the central control station 92. As is described in South African patent 94/4150, whenever the vehicle passes a signpost beacon 82, the identity of the beacon is attached to the transmitted message, and the control room 92 can thus determine the location and direction of the travel as at least the last and previous signpost beacon identifications are always transmitted. Recovery forces can then be dispatched with a suitable homing receiver, after which the vehicle may be recovered.

In the event of the vehicle exiting the dedicated network 86 at point B, this is signaled by the border signpost station 82.1. In addition, loss of a signal on the constantly monitored pager channel via the pager receiver 22 is also indicative of the vehicle leaving the dedicated coverage area. The beacon unit 37 will switch back to GSM mode in which it can continue sending messages to the control room via the GSM transceiver 16 and the GSM network.

The dual mode vehicle monitoring system of the invention has a number of associated benefits. This will be discussed with reference to Figures 4, 5 and 6, in which similar components that have been described above have been indicated with similar reference numbers. By relying on GSM communications, two-way messaging and voice communications are available, with a link 99 typically being provided between the central control station 92 and client premises 100. In particular, there are two types of messages that can be sent, namely short message service (SMS) messages and data messages. SMS messages are limited to 160 bytes and have a relatively low per-message transaction cost, whereas data messages can be of any length and are charged for on a time-basis.

SMS messages originating from a mobile site, such as a vehicle 76, are received by the cellular GSM sites 80 and are transferred via the central GSM exchange 94 to short message service centres 102 comprising a plurality of servers. Depending on the destination of the message, it is routed by the servers to the recipient, via a gate 104, a switching arrangement 106 and firewall 108, and then through an electronic data interface 110, such as a Diginet link interface 112 or an Internet connection 114. Data messages are sent directly to the electronic data interface, as shown at 116. The SMS message is then processed by a message management system 118, which is shown in more detail in Figure 5. The SMS and data messages may also be sent directly from a cellular site 80 to the message management system 118 via a GSM modem 120.

Referring now to Figure 5, the data and SMS messages entering the message management system 118 via the Diginet 112, the Internet 114 or the GSM modem 120 first passes through a message scheduler 122 which combines and schedules the incoming messages. A plurality of vehicle units can be used from various manufacturers, with the messages then entering a vehicle unit identifier 124 which identifies what type of vehicle unit has sent the message, with the various vehicle units shown generally at 126. Each unit identifier 124 includes a table of characteristics of all the different types of vehicle units used within the system. Using the characteristics of the identified unit, a message translator 128 converts the message to a standardised message format 130. The standardised message format 130 is 160 characters long, which conveniently allows for it to be sent as an SMS message via the GSM network. The standardised message is then checked to see if it is a violation message, as shown at 132, such as theft, hijack, tampering etc., in which case the message undergoes some further processing at 134 and is then routed to the control station 92 via a modem, RF link or wire link 136 where the necessary action is initiated. If the standardised message is not a violation message, it gets routed to an application layer 138, shown in Figure 6, for further processing.

The control station 92 is the same as that described in patent no. 94/4150, save that not only does it receive signals from the fixed receiver stations 90 but also the message signals via the GSM network, as described above. In short, the control station 92 comprises a receiver 140 for receiving these two types of signals as well as a mobile object tracking communications interface 142 which is in communication with the pager network, shown generally at 144. Signals received from the receiver stations 90 are sent to the interface 142 via link 146, whereas signals received from the GSM network are sent via link 148 to a decision interface 150 which is also in communication with the interface 142 via link 152. The interface 150 is in turn connected to an operation

management database 154 which receives information from the beacon units and which acts as a subscriber database and logger.

The interface 150 plays an important role in facilitating the sending of messages from the control station 92 to the vehicle 76 via the GSM network. These signals are sent to an SMS converter 156, via the link 136, which converts the signal to an SMS message. This message is then sent via the message translator 128, unit identifier 124, the message scheduler 122, the electronic data interface 110, and ultimately via the GSM exchange 94 back to the vehicle 76.

If at 132 it is determined that the incoming message is not a violation message, the message passes onto the application layer 138, which is shown in more detail in Figure 6. The first check is to determine whether the message includes a service request or not. If so, the type of service request is then determined, by determining which button of the keyring activator 29 has been pressed, with the message, including the vehicle's position, then being forwarded to the appropriate agency. If the driver is lost, or if he or she is looking for the best route in current traffic conditions, the request would be routed to an assistance centre 158. Requests for facility information such as nearby restaurants, hotels, hospitals, tourist attractions and garage facilities could be handled in a similar manner. If, however, the message is not a service request, the message is first checked to see if it is a vehicle status message which is defined as a message which is intended for the vehicle dealer or manufacturer and typically relate to servicing and other warranty issues of the vehicle. For example, the vehicle might report that it is due for a service and allow the dealer the opportunity to contact the driver and advise him or her to bring the vehicle into a service centre. In the event of a breakdown, the dealer may send a self-test request from which he could determine what kind of repair is necessary.

If it is determined that the message is intended for fleet management purposes, it is routed to a fleet management server 160. This server 160 would support a number of fleet management oriented services which could then be accessed by a fleet manager. In one application, the fleet manager may simply want to know what route a particular vehicle travelled in the previous 24 hour period. As a vehicle drives around the network, it collects signpost information which may then be downloaded onto the data logger 54 and which ultimately gets stored on the operation management database 154. A software-based application will then allow the manager to view this data, with the data typically being displayed on a map. In addition, a fleet manager will also be able to check the position, load status and the like of their vehicles, and to relay instructions to their drivers at any time. The fleet management facility may be extended to provide an alarm in the event of the vehicles straying off a designated route, or into undesirable areas.

The beacon unit 37 includes a self-test function which allows it to monitor itself to ensure that it is operating correctly. First level testing will be done each time the unit 37 is armed. Whenever a fault is detected, a warning will be given via the siren, with the unit also sending an appropriate message to the central control station 92. As mentioned above, it is also possible for a test to be initiated via the GSM network by either the control station 92 or any other authorised person. Typically, the following features will be tested: the correct operation of the CPU and memory, the RF power output level from the transmitters, the sensitivity of the receivers, regular cycling of the inputs and outputs and the correct operation of the serial links.

As indicated above, the present invention may also be used for the monitoring of assets which have been fitted with a beacon unit. Thus, when the beacon unit is detected by a signpost station, the position of the asset can then be determined, and transmitted to the central control station, as described above. In one particular application, the monitoring of freight on a trailer which is being

towed by a vehicle which is fitted with a beacon unit 37 includes the cargo tracking unit 52 which is fitted to the trailer. At regular intervals, a message would be sent to the beacon unit on the vehicle, which would then in turn acknowledge the message. Thus, should the trailer be violated in some manner or be separated from the vehicle by more than, for example, 100m, an alarm signal would be sent to the control station 92. Advantageously, the transmitter 56 of the cargo tracking unit 52 continues to transmit a violation message which can then be independently tracked by recovery forces with a homing receiver.

The invention described herein has a number of other potential applications. As traffic volumes on highways grow to congestion levels, and because of the high cost and environmental implications of new construction, ways are being sought to use technology to utilise highways more efficiently. A number of relevant applications have been identified in this regard, including electronic toll collection, electronic road pricing, electronic license plates, public transportation management, commercial vehicle operations, advanced traffic management, advanced traffic information systems and so on. All of these systems require devices on the vehicle that allow at least short range communications and preferably long range communication and position information.

By way of example, electronic tolling and road pricing by means of the present invention will be described. Both of these applications require a vehicle to announce its entry into a tolled zone, and to pay the toll in an acceptable manner. Using the present invention, signposts are located at entry and exit points to tolled roads or zones. As a vehicle approaches the zone, it reads the signpost and initiates a financial transaction via the long range communications link, in this case a GSM network, using either a pre-registered credit card or a cash-loaded smartcard. As soon as this transaction is confirmed, it signals the access control equipment, which then allows passage.

When the vehicle leaves the zone, a similar transaction can be used to calculate the toll amount which could be based on time in the zone, distance traveled, time of day, vehicle type etc. The primary advantage of the present invention in this regard is that a single in-vehicle device can be used to achieve many objectives, thereby avoiding the multiplicity of devices currently contemplated.

The most significant advantage of the dual network tracking system of the invention is that it combines the advantages of a dedicated tracking network in high density urban areas, and a GSM or similar non-dedicated broad area network in less dense rural areas to provide "universal" coverage.

CLAIMS

1. A tracking unit arranged to be fitted to a mobile object, the unit comprising:

transceiver means for receiving mobile object locating signals from and transmitting mobile object identification signals to a first array of stations in a broad area network defining a broad area of coverage;

receiver means for receiving mobile object locating signals from a second array of stations in a restricted area network defining a restricted area of coverage falling within the first broad area of coverage; and

transmitter means for transmitting mobile object location and identification signals to a central control station for identifying the mobile object and determining its approximate location.

2. A tracking unit according to claim 1 in which the broad area network is a non-dedicated network and the restricted area network is a dedicated network.

3. A tracking unit according to either one of the preceding claims 1 or 2 in which the first array of stations is an array of GSM sites defining a GSM-based network, and the transceiver means is a GSM transceiver arranged to receive mobile object locating GSM signals from at least one of the GSM sites and to transmit GSM signals to at least one of the GSM sites.

4. A tracking unit according to any one of the preceding claims in which the second array of stations includes a strategically located array of signpost stations, the receiver means being arranged to receive signpost identification signals from the signpost stations for locating the mobile object.

5. A tracking unit according to any one of the preceding claims which includes a pager receiver for receiving pager signals from a pager network forming part of the restricted area network.

6. A tracking unit according to any one of the preceding claims which is linked to a message management system for allowing messages to be sent between the central control station and the tracking unit via the first array of stations in the broad area network.

7. A tracking unit according to claim 6 wherein the message management system includes a data logger for storing the mobile object locating signals from the first and second array of stations.

8. A tracking unit according to any one of the preceding claims which includes a GPS receiver.

9. A tracking unit according to any one of the preceding claims which includes a plurality of sensors for sensing unauthorized entry into or operation of the mobile object, the transmitter and transceiver means being responsive to the sensors.

10. A tracking unit according to any one of the preceding claims which includes at least one manually arming and activating input for enabling the transmitter and transceiver means to transmit emergency condition signals or codes.

11. A tracking unit according to either one of the preceding claims 9 or 10 which includes mobile object immobilizing and/or alarm outputs responsive to the sensors or manually activating inputs.

12. A mobile object tracking system including:

a first array of stations in a broad area network defining a broad area of coverage;

a second array of stations in a restricted area network defining a restricted area of coverage within the broad area of coverage;

a central control station; and

a mobile object tracking unit associated with a mobile object, the unit comprising transceiver means for receiving locating signals from and transmitting identification signals to the first array of stations, receiver means for receiving locating signals from the second array of stations, and transmitter means for transmitting location and identification signals to the central control station for identifying the mobile object and determining its approximate location.

13. A mobile object tracking system according to claim 12 in which the first array of stations is an array of GSM sites defining a GSM-based network, the GSM network including a GSM exchange linked to the central control station for relaying mobile object identification and location signals thereto.

14. A mobile object tracking system according to either one of the preceding claims 12 or 13 in which the second array of stations includes a strategically located array of signpost stations, each signpost station including a signpost transmitter arranged to transmit a signpost identification signal to the receiver means in the event of the mobile object traversing a signpost footprint defined by the signpost station.

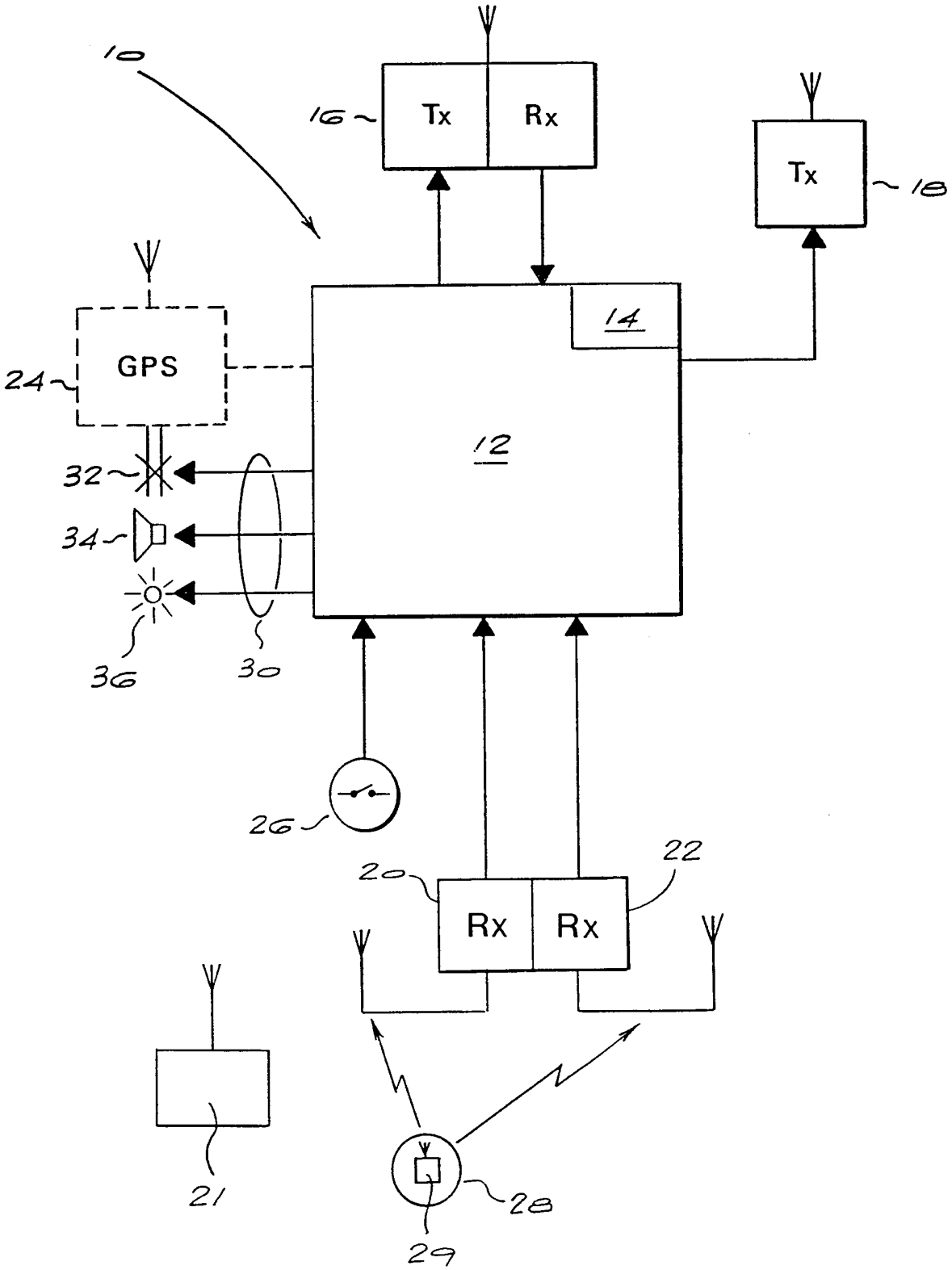
15. A mobile object tracking system according to claim 14 in which the second array of signpost stations includes "border" signpost stations located at the periphery of the restricted area of coverage, the "border" signpost stations being arranged to transmit a signal indicating to the tracking unit that it is leaving or entering the restricted area of coverage.

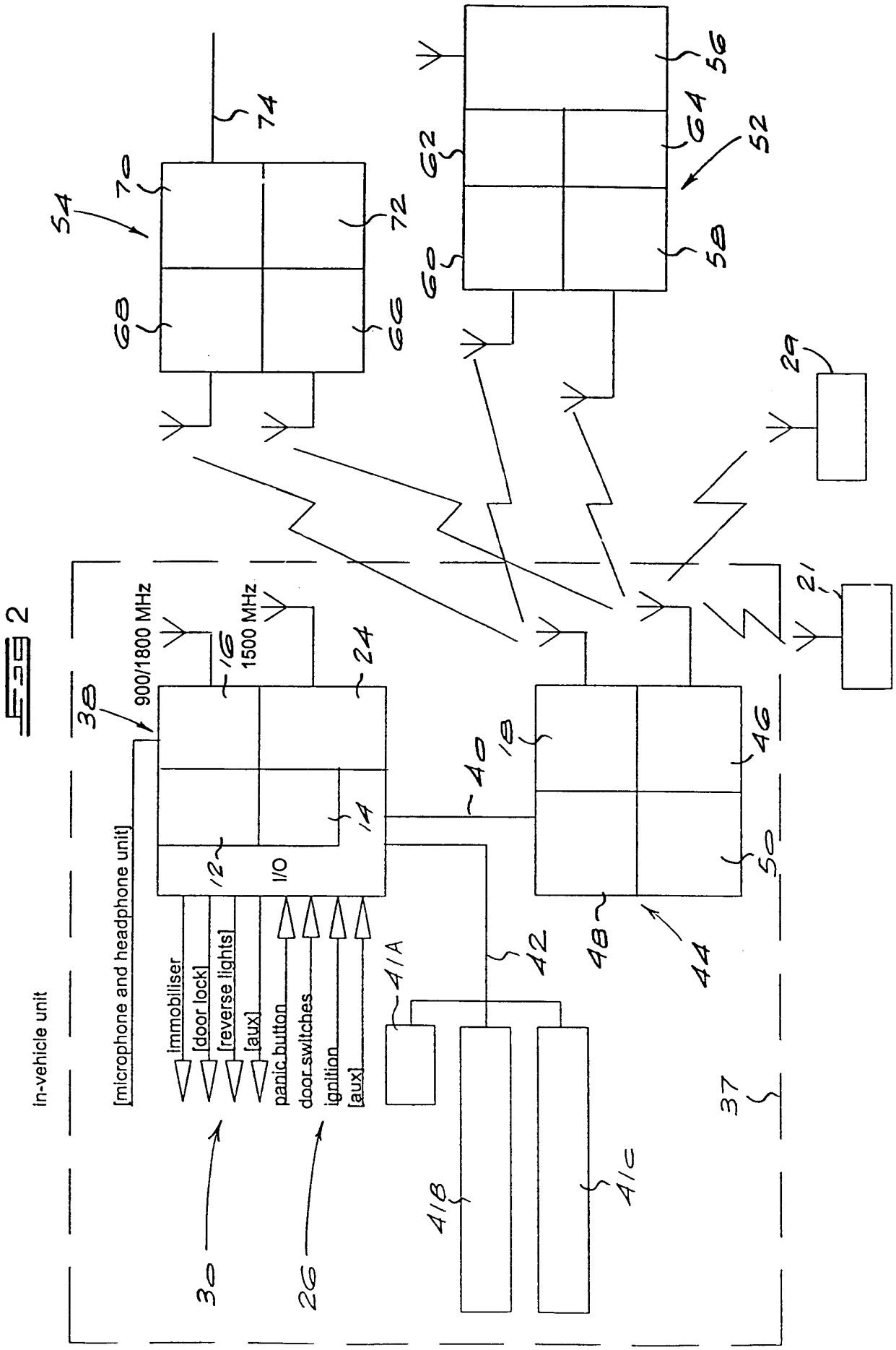
16. A mobile object tracking system according to any one of the preceding claims 12 to 14 which includes a pager network forming part of the restricted area network, the tracking unit including a pager receiver.

17. A mobile object tracking system according to any one of claims 12 to 16 which includes a message management system for allowing messages to be sent between the central control station and the tracking unit via the first array of stations in the broad area network.

18. A mobile object tracking system according to claim 17 wherein the message management system includes a data logger for storing the mobile object locating signals from the first and second array of stations.

FIG 1

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46
50
48
44
42
41A
41B
41C
37
30
26

Fig 2

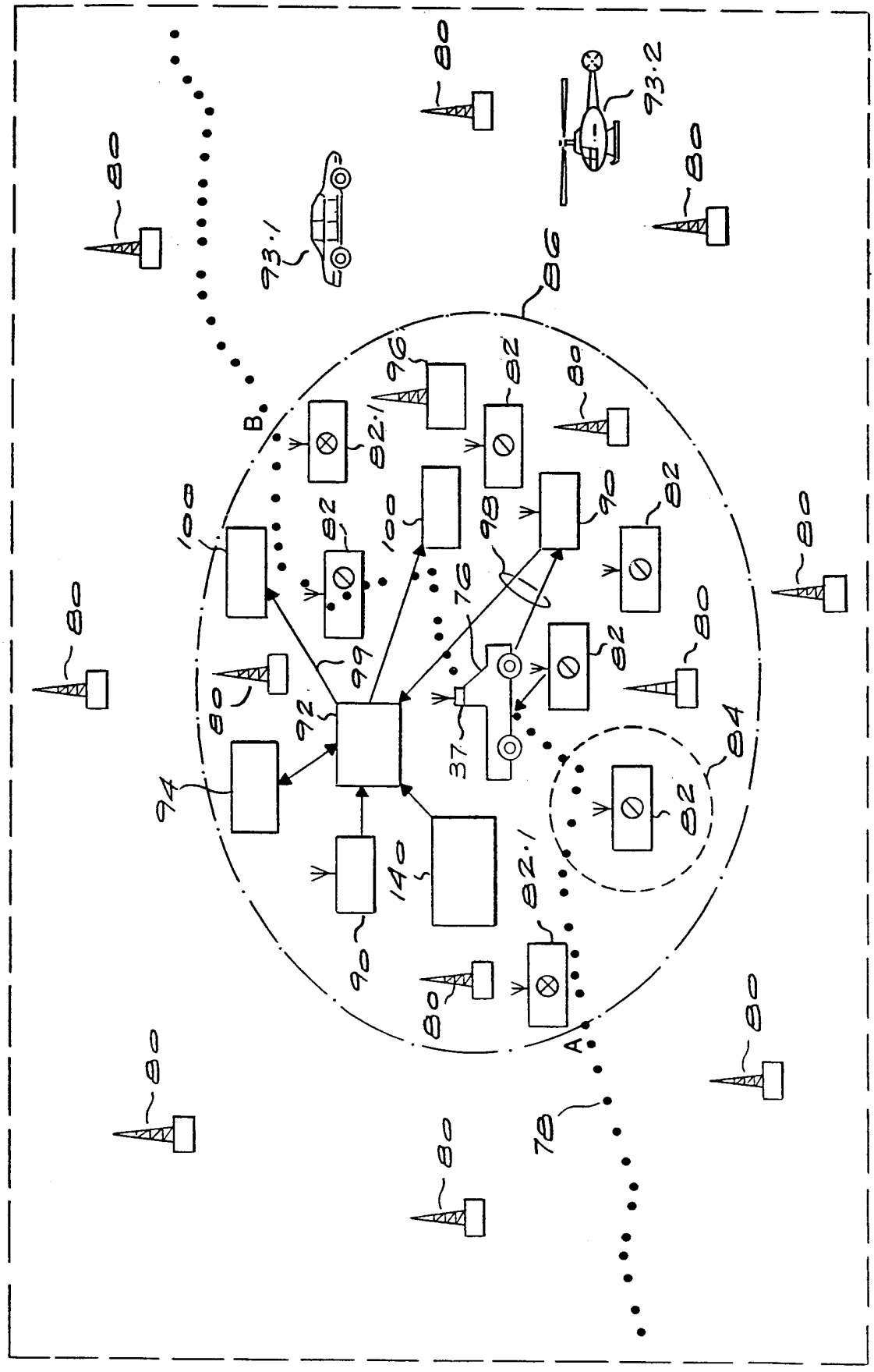

Fig 3

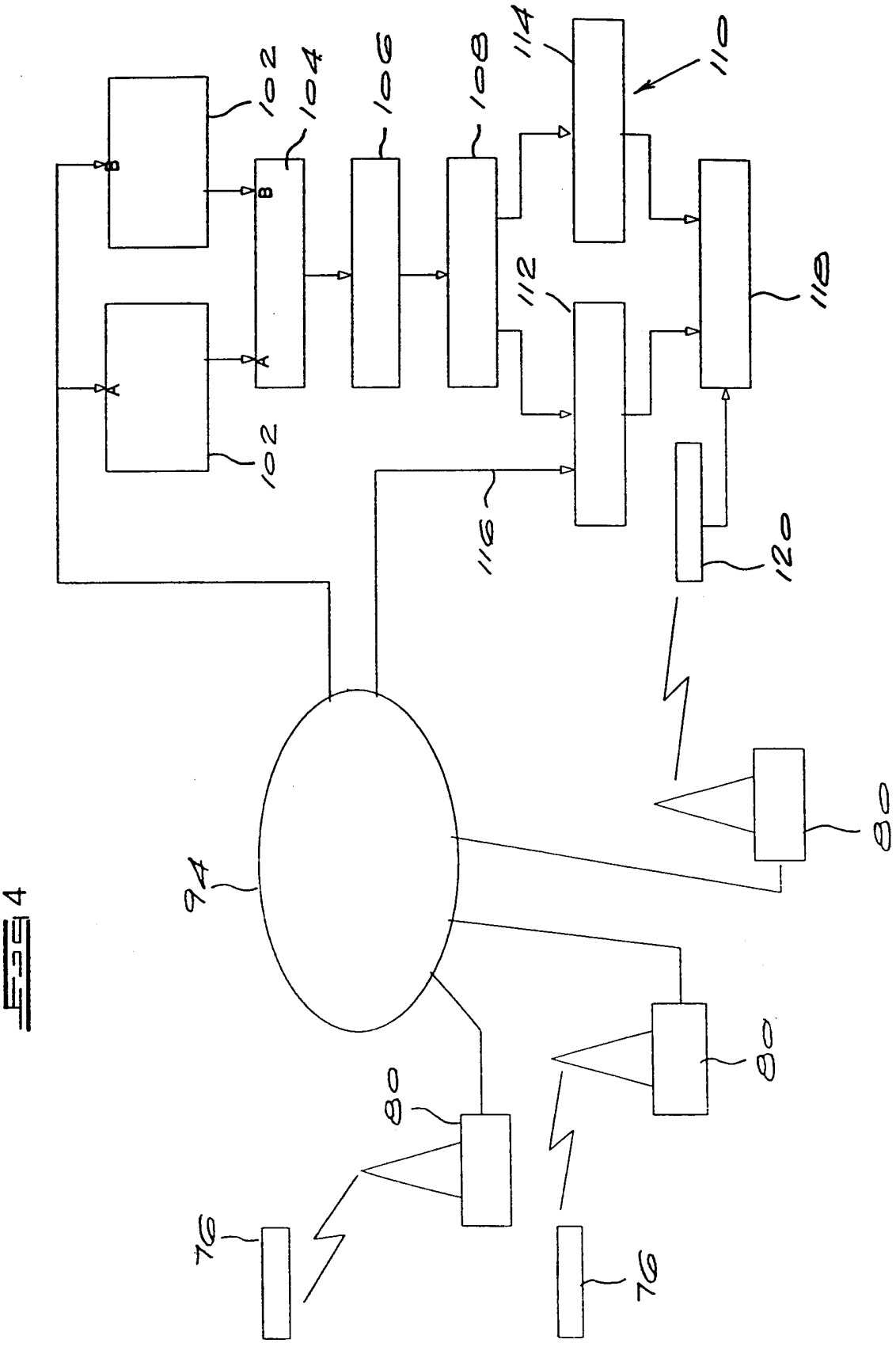

Fig 4

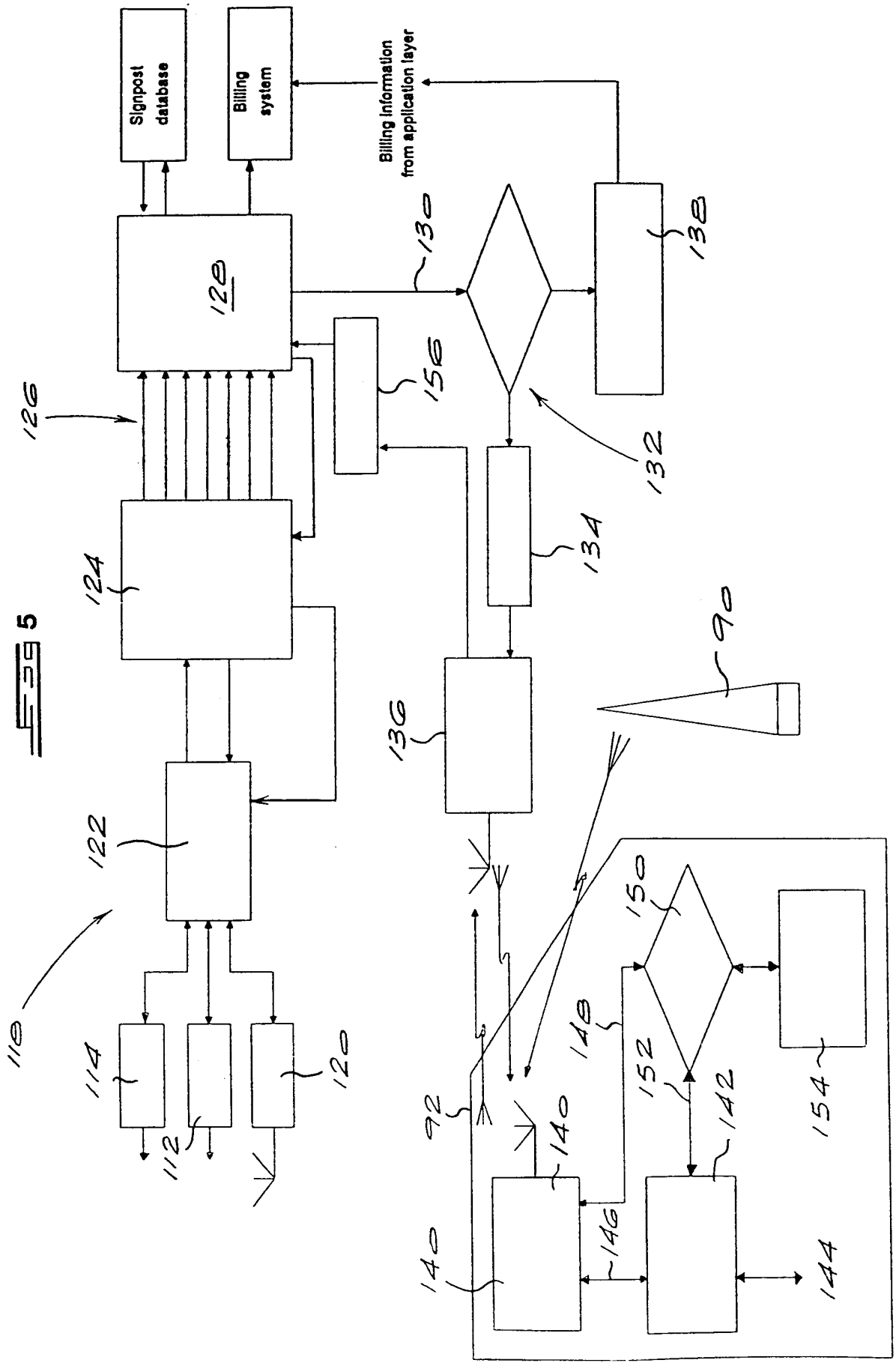
Signpost database
Billing system
Billing information from application layer
128
130
138
156
126
132
124
134
90
136
122
110
114
120
112
92
140
150
148
152
142
154
140
146
144

Fig 5

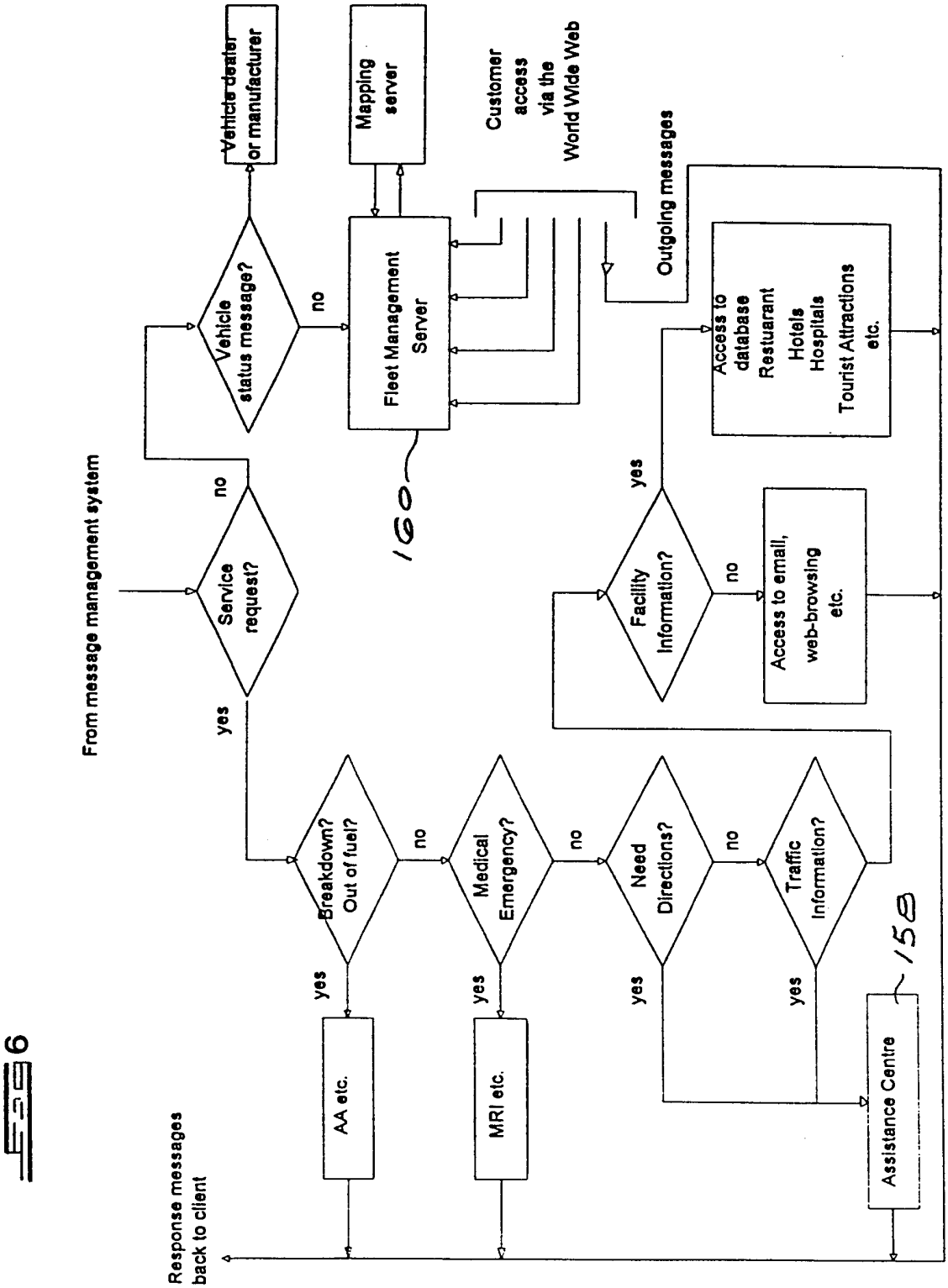
From message management system
Service request?
no
yes
Vehicle status message?
no
Vehicle dealer or manufacturer
Mapping server
Fleet Management Server
160
Customer access via the World Wide Web
Outgoing messages
Facility Information?
yes
no
Access to database Restuarant Hotels Hospitals Tourist Attractions etc.
Access to email, web-browsing etc.
Breakdown? Out of fuel?
Medical Emergency?
Need Directions?
Traffic Information?
yes
no
AA etc.
MRI etc.
Assistance Centre
158
Response messages back to client

Fig 6

INTERNATIONAL SEARCH REPORT

Interna' l Application No
PCT/IB 00/01597

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60R25/10 G08G1/127 G01S5/00

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 B60R G08G G01S

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, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 604 765 A (ENGELBRECHT LLOYD ET AL) 18 February 1997 (1997-02-18) abstract; figure 2 column 2, line 38 - line 41 column 4, line 37 - line 67 column 8, line 47 -column 9, line 14 column 9, line 54 -column 10, line 6 ---	1-3,8, 12-14 5,10,11, 16-18
Y	US 5 631 642 A (BROCKELSBY W KEITH ET AL) 20 May 1997 (1997-05-20) cited in the application abstract; figure 1 column 3, line 54 -column 4, line 47 column 7, line 5 - line 50 --- -/--	5,10,11, 16-18

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

[X] Patent family members are listed in annex.

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"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
14 February 2001	20/02/2001

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	Niemeijer, R

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INTERNATIONAL SEARCH REPORT

Interna' il Application No
PCT/IB 00/01597

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 515 285 A (GARRETT SR CHARLES N ET AL) 7 May 1996 (1996-05-07) abstract; figure 10A column 1, line 54 -column 2, line 3 column 15, line 18 - line 33	1,12
A	EP 0 242 099 A (ADVANCED STRATEGICS INC) 21 October 1987 (1987-10-21) abstract; figure 1 page 2, line 52 -page 3, line 10	1,12

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna il Application No
PCT/IB 00/01597

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 9620542 A	04-07-1996
		US 6111538 A	29-08-2000
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		US 6160837 A	12-12-2000
US 5631642 A	20-05-1997	ZA 9404150 A	13-12-1995
US 5515285 A	07-05-1996	NONE	
EP 0242099 A	21-10-1987	CA 1277400 A	04-12-1990
		JP 63024395 A	01-02-1988