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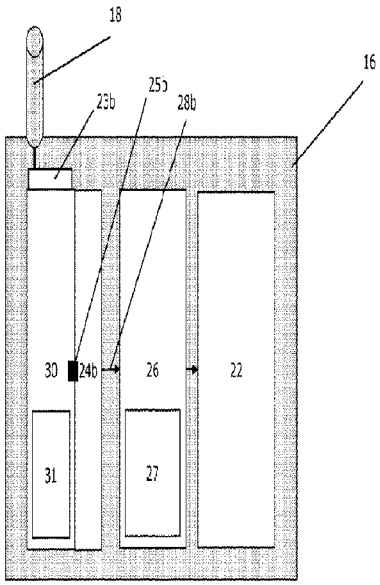

Figure 3

(57) **Abstract**: A positioning device for use with a navigation device, the positioning device comprising input means arranged to receive data signals from a source other than a navigation system; conversion means arranged to convert the received data signals into positional data; and output means arranged to output the positional data for use by the navigation device. The output means outputs the positional data in a communications protocol format, the navigation device is arranged to process the positional data in the communications protocol format.

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IMPROVEMENTS RELATING TO NAVIGATION SYSTEMS

FIELD OF THE INVENTION

The present invention relates to navigation devices. In particular, the invention relates to the use of navigation devices in situations where navigation signals are unavailable or not adequate to allow a navigation device to calculate its location.

BACKGROUND TO THE INVENTION

A typical known satellite navigation system 10 is shown in Figure 1. The system 10 comprises a plurality of satellites 12a, 12b and a navigation device 16. Only two satellites are shown for clarity, but in practice, in a given satellite navigation system, there may be many more satellites in orbit around the Earth. Each satellite 12a, 12b transmits a unique radio signal 14a, 14b which is detected by an aerial 18 and processed by a receiver 20. The receiver 20 is engaged with the navigation device 16. Information regarding the position of the device 16 is shown graphically on a screen 22. The graphically displayed information may also include directions (routing) information.

The navigation device 16 may be suitable for route planning and/or navigation. For example, the navigation device 16 may be a satellite navigation device such as a TomTom® which comprises a receiver, aerial and screen for receiving satellite signals and displaying the position of the device 16 and/or a route to a user of the TomTom®.

In practice, a minimum of four satellites must have line-of-sight with the device 16 in order for the receiver 20 to determine its location in three dimensions. In overview, the signal 14a, 14b transmitted by each satellite 12a, 12b contains information on the position of that satellite. The receiver 20

calculates the flight time of each signal to calculate its position relative to the satellites 12a, 12b.

Examples of satellite navigation systems which function worldwide, i.e. Global Navigation Satellite Systems (GNSS), are the Global Positioning System (GPS) developed by the USA; the Global Navigation Satellite System (GLONASS) developed by the former USSR and now maintained by Russia; Galileo which is currently being developed by the European Union and the European Space Agency; and Compass which is currently being developed by China. An example of a regional satellite navigation system is the Indian Regional Navigational Satellite System (IRNSS) which is scheduled for completion in 2012.

Each of the satellite navigation systems mentioned above has its own format for the signals 14a, 14b signals. For example, GPS uses a system of codes known as Gold codes.

With reference to Figure 2, which shows the device 16 in more detail, the device 16 also comprises a communications port 24a which communicates with the receiver 20. The communications port 24a may comprise a physical connection or alternatively the communications port 24a may be a Bluetooth® or other radio-based terminal, with which the receiver 20 is wirelessly connectable. The receiver 20 comprises input means 23a which is arranged to receive the satellite signals 14a, 14b via the aerial 18, as described above.

In use, the receiver 20 receives input signals from the satellites 12a, 12b and outputs 'raw' positional data 28a. The positional data 28a is transmitted via output means 25a to the communications port 24a which allows data to be transmitted from the receiver 20 to a navigation processing means 26. The positional data 28a relates to the position of the device in a format compatible

with the navigation processing means 26. For example, some navigation devices require the positional data to be in a National Marine Electronic Association format (NMEA). Alternatively, some devices may require the positional data to be in accordance with a proprietary protocol defined by the manufacturer of the device. For example, SiRF Technology, Inc. has its own proprietary protocol compatible with its own devices, as does Garmin Ltd.

The NMEA standard describes the particular fields that must be populated for the positional data 28a to be valid and includes the longitude, latitude, velocity and bearing etc. of the receiver 20 in the positional data 28a. Further information on NMEA can be found at:

http://www.nmea.org/content/nmea_standards/nmea_083_v_400.asp

The navigation processing means 26 comprises a data store 27 that contains mapping information and/or information regarding the environment in which the navigation device will operate. The processing means 26 processes the 'raw' positional data 28a so that the position of the device 16 and/or a route is displayed on a map on the screen 22.

A known problem with satellite navigation systems is the loss of signal from the minimum number of satellites. This may happen when the device 16 is used in a built-up or mountainous area, as discussed later with reference to Figure 4, such that line-of-sight between the minimum number of satellites and the device 16 is not maintained. Similarly, in a woodland environment, trees and their foliage may obscure, refract or otherwise absorb signals 14a, 14b transmitted from the satellites 12a, 12b.

In the above situations, the receiver 20 may be unable to determine the position of the device 16, and so the device 16 may not be able to provide route

or positional information to a user of the device 16. This will likely result in delay to the user, or even result in the user becoming lost.

The consequences of a loss of signal may be more serious if, instead of an automotive satellite navigation device, the receiver 20 is part of an emergency hand-held satellite navigation device, say for mountain rescue. Any deterioration or interruption of the signals 14a, 14b from the satellites 12a, 12b may cause a delay resulting in injury or the loss of life.

As examples of the technological background to the invention, US Patent No. 7,228,139 discloses a method for determining the location of a mobile telephone user in the event of an emergency using a conventional satellite navigation system; German Patent Application Publication No. DE 101 11 967 A1 and US Patent Application Publication No 2008/0032706 A1 describe using a mobile telecommunications network to obtain the position of a mobile telephone; and US Patent Application Publication No 2009/0156229 A1 and International Patent Application Publication No. 2004/0747799 A1 are examples of how conventional navigation techniques are used to find a location or provide navigation.

An alternative method and apparatus that use mobile telephony signals to find a location are disclosed in CSR Plc's International Patent Application Publication No. WO 03/008990. Furthermore, CSR Plc supply a method and apparatus commercially under its eGPS® technology brand which uses mobile telephony signals to calculate the position of a device when GPS signals are weak or unavailable.

However, CSR's method and apparatus requires a database located either in a handset or on a server in a mobile telephone network, which contains base station location data and a timing model of the network.

The apparatus supplied by CSR is not compatible with existing satellite navigation devices. Therefore, it is unable to make use of the functionality of existing satellite navigation systems. Also, eGPS® requires at least a knowledge of the mobile telephone network in which it operates.

The above problems described for satellite navigation systems also apply to terrestrial radio navigation systems. An example of a regional terrestrial radio navigation system is the LORAN (LOng RAnge Navigation) system. A problem with such systems is that their signals may be blocked within the system's coverage areas by geography or foliage, or signals may be distorted by ionospheric variations.

OBJECT OF THE INVENTION

It is therefore an objective of the present invention to provide an apparatus and method for using a navigation device when navigation system signals are unavailable. It is also an objective of the invention to provide an improved apparatus and method for overcoming the problem of the unintentional loss or degradation of navigation system signals.

SUMMARY OF THE INVENTION

The invention resides in a positioning device for use with a navigation device, the positioning device comprising input means arranged to receive data signals from a source other than a navigation system; conversion means arranged to convert the received data signals into positional data; and output means arranged to output the positional data in a format compatible with the navigation device.

The invention enables data signals, which may not be compatible with a navigation device, and which may not have been designed for navigational

purposes, to be converted into data which may be used by a navigation device. For example, the navigation device may be a satellite navigation device, and the source may be other than a satellite navigation system, in which case the invention provides the advantage that the device can receive and process non-navigation data signals and convert them into a form which is suitable for processing by a satellite navigation device, such as a TomTom® automotive satellite navigation device. Similarly, the navigation device may be a navigation device arranged to process navigation signals from another navigation system, such as the LORAN terrestrial radio navigation system.

An example of the above process is as follows. A functioning satellite navigation receiver provides positional data in proprietary communications protocol format to a navigation device that displays navigational data in the form of a dynamic map. During use, the receiver moves into a region where its navigation signals are blocked, but where other signals, for example medium wave radio signals, are available.

The invention uses the phases of these radio signals to determine the movement of the receiver and/or the navigation device during this period where the navigation signals are blocked. The invention does this by converting the position and/or direction of travel from the radio waves and converting it into positional data which is in the proprietor communications protocol format compatible with the navigation device, and outputs the positional data. The positional data is sent to the navigation device displaying the dynamic map. Therefore, the navigational device updates the map as if the positional data had been generated by the satellite receiver.

The invention also provides the ability to upgrade existing “slave” systems (such as the dynamic map of the navigation device described above) reliant on a specific navigation system. Therefore, new and future navigation

systems may be used with such "slave" systems without the need to reprogram or redesign the slave system.

The positioning device may be separate or discrete from the navigation device. Alternatively, the positioning device may be an internal component of the navigation device. The positioning device may be external to the navigation device. In a preferred embodiment, the source of the data signals may be external to the positioning device.

The navigation device may be a satellite navigation device or a terrestrial radio navigation device. The navigation system may be a satellite navigation system or a terrestrial radio navigation system, such as LORAN. The data signals may not be compatible with the navigation device, and are preferably non-navigational data signals.

As mentioned above, the invention is particularly useful when adequate satellite or other navigation signals are unavailable, for example, where due to foliage or geography full reception of data signals is not possible. For example, the invention provides an advantage over a method such at that described in US Patent No. 7,228,139 in that if a person using the method of this patent is not within the range of the satellite signals, the method of fails. The invention overcomes this problem by providing a device which does not rely on signals from a conventional navigation system to obtain a position, but can instead convert non-navigational signals into data compatible with a conventional navigation device.

The invention provides an advantage over systems which use signals generated by a mobile telecommunications network to find the position of a mobile telephone. In the event that a user does not have a mobile phone, the

invention provides the ability to convert signals generated by a mobile telecommunications network into positional data compatible with a device other than a mobile phone, such as conventional navigation device.

Preferably, the output means is arranged to output the positional data in a communications protocol format, and the navigation device is arranged to process the positional data in the communications protocol format. Navigation devices, such as the TomTom® device mentioned above, are arranged to receive positional data in a particular communications protocol format. The invention may be arranged to output the positional data in the particular protocol format suitable for that navigation device. This means that the navigation device does not detect any difference in the information it receives and therefore continues to operate normally and without interruption. For example, by continuing to provide routing information and directions.

The communications protocol format is preferably in a format suitable for processing by a navigation device. An example of a communications protocol that defines positional data for use with marine equipment is NMEA 0183. Alternatively, the communications protocol format may be a proprietary protocol, such as that used by SiRF Technology, Inc or Garmin Ltd.

Preferably, the received data signals are wireless signals, which may be terrestrial signals, and which may comprise one or more of the following: Enhanced Observed Time Difference (E-OTD) signals, cellular mobile signals, radio or television signals, WiFi™ signals, beacon transmitters or any other signals pervasive in the environment. As will be appreciated, the invention enables these non-navigational signals to be used for navigation. Accordingly, the received data signals may be obtained from the known or estimated position of particular public radio transmitters or from the broadcast channels of mobile radio base stations or repeater stations.

Furthermore, the invention may be used with navigation devices that employ mobile telephony signals or WiFi™ signals merely to indentify the cell in which the device is being used (a method referred to as "Cell-ID"). The invention enables a position to be calculated more accurately, and that position to be formatted and output in a format compatible with such navigation devices. This provides full reverse compatibility with navigation devices that are reliant on Cell-ID data, while increasing the accuracy of the positional data provided to those devices. The result would be a system that still appeared to be reliant on Cell-ID technology, and still utilised the Cell-ID positional data formats, but which has a much higher accuracy, for example in the region of 10 metres.

Rather than use terrestrial wireless signals, for example, for pedestrian navigation, sensors such as an attitude sensor (digital compass) giving the orientation and heading of a pedestrian may be used, possibly with a digital step counter or accelerometer for measuring the distance travelled. This technique is known as “dead-reckoning”. The information can be received as data signals by the positioning device and converted into positional data which may be output for use by the navigation device.

The invention further resides in a combination of a navigation device and at least one positioning device as described above, or a navigation device comprising at least one positioning device as described above. The at least one positioning device and the navigation device may be separate from each other, or the at least one positioning device may be integrated with the navigation device. The positioning device may be removeably integrated with the navigation device.

Preferably, the combination further comprises at least one communications means to facilitate communication with the at least one

positioning device. According to a preferred embodiment, the at least one communication means is arranged to combine positional data from a plurality of sources into a single data stream. The one or more of the at least one communications means may be arranged to communicate wirelessly with the at least one positioning device. In a preferred embodiment, one or more of the at least one communications means is a Bluetooth® terminal.

The combination may further comprise a receiver for receiving satellite or other navigation system data signals, wherein the receiver is arranged to generate and output positional data. Preferably, the combination comprises receiver communication means to enable communication between the navigation device and receiver.

In a preferred embodiment, the combination further comprises a processing means arranged to receive and process the positional data. The processing means may comprise a data store containing mapping and route information.

The combination may comprise a screen arranged to display the results of the processing of the positional data by the processing means. The processing means may be arranged to combine positional data from a plurality of sources for processing by the processing means.

The combination may further comprise a receiver for receiving satellite navigation system data signals, wherein the receiver is arranged to generate and output satellite positional data. The processing means may be arranged to receive and process the satellite positional data. The navigation device may comprise receiver communication means. The processing means may be arranged to combine satellite positional data and positional data.

The invention also resides in a navigation system comprising a navigation device as described above.

According to another aspect of the invention, there is provided a method of determining geographical position, the method comprising receiving data signals from a non-navigation system; converting the received data signals into positional data compatible with a navigation device; and transmitting the positional data to the navigation device.

Preferably, the positional data is in a format compatible with a satellite or a terrestrial radio navigation device, and the satellite or the terrestrial radio navigation device navigation device is arranged to process the positional data.

The positional data may be in a communications protocol, and the communications protocol format may be in NMEA 0183 format, or the communications protocol format may be a proprietary protocol as mentioned above.

The method may further comprise receiving and processing positional data generated by a receiver for receiving satellite or other navigation system data signals. Preferably, the method also comprises selecting whether to process the positional data or the positional data generated by the receiver.

In a preferred embodiment, the method further comprises selecting whether to process the positional data generated by the receiver or the positional data. The method may further comprise monitoring the flow of at least one of the positional data and the positional data generated by the receiver. The method may therefore also comprise processing either the positional data or the positional data generated by the receiver in the event that, respectively, the flow

of the positional data generated by the receiver or the flow of the positional data stops.

A consequence of the above apparatus and method is that navigation devices dependent on satellite signals are able to operate at higher update rates, by virtue of not being limited to satellite navigation algorithms and protocols, which typically operate at 1Hz. The update rate of the positional data for use with the navigation device is only limited by the chosen baud rate of the navigation device. The applicant has found that update rates can rise to approximately 20Hz when mobile cellular signals are used, or over 50Hz using MW radio waves. This advantageously provides faster and more accurate positioning of the navigation device.

In yet a further embodiment of the invention, at least some of the data signals may be pre-defined. The pre-defined data signals may be input by a user of the invention or obtained from a database of pre-defined data values. Examples of pre-defined data values include altitude and route. The ability to use pre-defined data serves to verify and correct, if necessary, the resultant positional data. Furthermore, the accuracy of the positional data may be increased by the use of pre-defined data.

BRIEF DESCRIPTION OF THE FIGURES

Apparatus and methods of using the apparatus according to preferred embodiments of the present invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagram showing a known satellite navigation system comprising a plurality of satellites and a navigation device, according to the prior art;

Figure 2 is a diagram showing the navigation device of Figure 1 in more detail;

Figure 3 is a diagram of the navigation device, wherein a positioning device according to a first embodiment of the present invention is engaged with the device;

Figure 4 is a diagram illustrating the first embodiment of the present invention in use; and

Figure 5 is a diagram of a positioning device according to a further embodiment of the present invention and a satellite navigational receiver, wherein the positioning device and the receiver are both engaged with a satellite communications device.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Figure 3 shows a navigation device 16 generally as previously described. However, a positioning device 30 according to an embodiment of the invention is engaged with the navigation device 16, rather than the receiver 20. In Figure 3, the positioning device 30 is shown integrated with the navigation device 16. However, alternatively, the positioning device may be separate from the navigation device 16 and communicate with the navigation device wirelessly.

Instead of using satellite signals to determine position, the positioning device 30 is arranged to receive mobile telephony signals 34, for example GSM, W-CDMA or UMTS signals, from mobile telephone base stations 32, as illustrated in Figure 4. The positioning device 30 estimates its location using multilateration positioning techniques on the signals 34.

In an alternative embodiment of the invention, the positioning device 30 may use television signals to determine its location. For example, Rosum, a company based in the US, provides apparatus which use television signals to determine location.

The positioning device 30 comprises input means 23b which is arranged to receive the telephony signals via the aerial 18. The positioning device 30 also comprises conversion means 31 which calculates the position of the positioning device 30 from the mobile telephony signals 34, and converts the results of those calculations into positional data 28b. The positional data 28b is transmitted via output means 25b to a communications port 24b. The positional data 28b is in a communications protocol format, such as NMEA format which, as mentioned above, is a format that the processing means 26 is configured to receive. The format of the positional data 28b generated by the positioning device 30 is identical to the format of the positional data 28a generated by the receiver 20 in the example of Figure 1. Consequently, the processing means 26 receives and processes the positional data 28b generated by the positioning device 30 in exactly the same way as if it is positional data 28a generated by the receiver 20, and calculates a route and/or data for display on the screen 22.

In an alternative embodiment, the positioning device 30 calculates its position from a single mobile telephone base station 32. Since the location of the single base station 32 is known and transmitted to the positioning device 30, the positioning device 30 can calculate the cell in which it is located and therefore approximate the position of the device 16.

The position of the device 16 in the cell may be refined using user defined information. For example, before setting off on their journey a user may input a route into the device 16, which could be the route of a railway line. During use, after the positioning device 30 has calculated the approximate position of the device 16, all points that do not fall on the pre-defined route may

be discarded, thus improving the accuracy of the calculated position. In another example, in which the device 16 is only used on the Earth's surface, altitude data at any calculated co-ordinates may be provided by a topological map or a digital elevation model of the Earth, which may be stored in the device 16.

In further alternative embodiments of the invention, other methods, such as Enhanced Observed Time Difference (E-OTD) may be used by the positioning device 30 to determine its position. The positioning device 30 may also determine positional information from audio radio signals, for example, AM medium wave radio signals, television signals, WiFi™ signals, non-navigation satellite system signals or signals broadcast by dedicated beacons placed by the user.

In a further alternative embodiment, any signal containing some known code word (such as a synchronisation or identification marker) can be used to calculate the position of the positioning device 30. In this further alternative embodiment, the positioning device 30 measures the arrival times of these known code words within each broadcast to its position.

In the above embodiments of the invention, the positioning device 30 determines its location using non-satellite data signals 34, for example, from a terrestrial wireless network. This is in contrast to a satellite navigation system 10 which is a space-based wireless network. In the above embodiments, the positioning device 30 converts the non-satellite data signals 34 into positional data 28b relating to the position of the device 16 in a format compatible with the navigation processing means 26, and transmits that data to the navigation processing means 26.

The positioning device 30 may work in tandem with a receiver 20 as described above. As illustrated in Figure 5, an alternative navigation device 17

comprises a first communications port 24a and a second communications port 24b, and the receiver 20 and the positioning device 30 are respectively engaged in each port.

As described above, the receiver 20 processes information from satellite signals 14a, 14b in a satellite navigation system 10 and produces first positional data 28a which is transmitted to the processing means 26. Concurrently, the positioning device 30 processes non-satellite data signals 34 from a terrestrial wireless network and produces second positional data 28b which is transmitted to the processing means 26. The processing means 26 calculates a route and/or the position of the device 17 from the first positional data 28a and the second positional data 28b, for display on the screen 22.

Typically, the receiver 20 updates at a rate of 1Hz and the positioning device 30 updates at a rate in excess of 10Hz. However, if the alternative device 17 cannot get an adequate signal from the satellite network, similarly to the device 16 shown in Figure 4, the processing means 26 of the alternative device 17 may calculate a route and/or the position of the device 16 from the second positional data 28b only.

Alternatively, both the receiver 20 and the positioning device 30 may engage with a single communications port (not shown). The single communications port combines the data obtained from both the receiver 20 and the positioning device 30 into a single positional data stream which is sent to the processing means 26.

In yet a further embodiment (not shown), a first positioning device (i.e. a positioning device 30) and a second positioning device (i.e. a further positioning device 30) are engaged with the alternative device 17. The first positioning device processes data from a mobile telephone network, which operates

concurrently with a second positioning device that processes different non-satellite data signals, for example, from another terrestrial wireless network.

In any of the above embodiments, one or more of the communications ports 24a, 24b may be wirelessly engageable with the receiver 20 or positioning device 30. Furthermore, where there are more than one receivers 20 or positioning devices 30 engaged with the navigation device 16, 17, one or more of the communications ports 24a, 24b are arranged to receive and combine positional data 28a, 28b from a plurality of receivers 20 or positioning devices 30 into a single stream of positional data for processing by the processing means.

Although the above specific description describes the invention in relation to a satellite navigation device and system, it will be clear to the skilled person that the invention may be used in relation to a LORAN navigation device and system. Accordingly, the present invention may be embodied in other specific forms without departing from its essential attributes. Therefore, reference should be made to the appended claims and other general statements herein rather than to the above specific description as indicating the scope of the invention.

CLAIMS

1. A positioning device (30) for use with a navigation device (16, 17), the positioning device (30) comprising:

input means (23b) arranged to receive data signals (34) from a source other than a navigation system (10);

conversion means (31) arranged to convert the received data signals (34) into positional data (28b); and

output means (25b) arranged to output the positional data (28b) in a format compatible with the navigation device (16, 17).

2. The positioning device (30) according to claim 1, wherein the source of the data signals (34) is external to the positioning device (30).

3. The positioning device (30) according to claim 1 or 2, wherein the navigation device (16, 17) is a satellite navigation device (16, 17).

4. The positioning device (30) according to claim 1 or 2, wherein the navigation device (16, 17) is a terrestrial radio navigation device.

5. The positioning device (30) according to any preceding claim, wherein the navigation system is a satellite navigation system (10).

6. The positioning device (30) according to any of claims 1 to 5, wherein the navigation system (10) is a terrestrial radio navigation system.

7. The positioning device (30) according to any preceding claim, wherein the data signals (34) are not compatible with the navigation device (16, 17).

8. The positioning device (30) according to any preceding claim, wherein the data signals (34) are non-navigational data signals.

9. The positioning device (30) according to any preceding claim, wherein the output means (25b) is arranged to output the positional data (28b) in a communications protocol format, and the navigation device (16) is arranged to process the positional data (28b) in the communications protocol format.

10. The positioning device (30) according to claim 9, wherein the communications protocol format is in NMEA 0183 format.

11. The positioning device (30) according to claim 9, wherein the communications protocol format is a proprietary protocol.

12. The positioning device (30) according to any preceding claim, wherein the received data signals (34) are wireless signals.

13. The positioning device (30) according to claim 12, wherein the received wireless data signals (34) comprise one or more of the following: Enhanced Observed Time Difference (E-OTD) signals, cellular mobile signals, radio or television signals, WiFi™ signals, beacon transmitters, or any other signals pervasive in the environment.

14. A combination of a navigation device (16, 17) and at least one positioning device (30) as claimed in any preceding claim.

15. The combination according to claim 14, further comprising at least one communications means (24b) to facilitate communication with the at least one positioning device (30).

16. The combination according to claim 15, wherein the at least one communication (24b) means is arranged to combine positional data (28b) from a plurality of sources into a single data stream.

17. The combination according to claim 15 or 16, wherein one or more of the at least one communications means (24b) is arranged to communicate wirelessly with the at least one positioning device (30).

18. The combination according to claim 17, wherein one or more of the at least one communications means (24b) is a Bluetooth® terminal.

19. The combination according to any of claims 14 to 18, further comprising a processing means (26) arranged to receive and process the positional data (28b).

20. The combination according to claim 19, wherein the processing means (26) comprises a data store (27) containing mapping and route information.

21. The combination according to claim 19 or 20, the navigation device (17) comprising a screen (22) arranged to display the results of the processing of the positional data (28a, 28b) by the processing means (26).

22. The combination according to any of claims 19 to 21, wherein the processing means (26) is arranged to combine positional data (28b) from a plurality of sources.

23. The combination according to any of claims 14 to 22, further comprising a receiver (20) for receiving satellite navigation system data signals (14a, 14b), wherein the receiver (20) is arranged to generate and output satellite positional data (28a).

24. The combination according to claim 23, wherein the processing means (26) is arranged to receive and process the satellite positional data (28a).

25. The combination according to any of claims 21 to 24, wherein the navigation device (17) comprises receiver communication means (24a).

26. The combination according to any of claims 19 to 25, wherein the processing means (26) is arranged to combine satellite positional data (28b) and positional data (28a).

27. A method of determining geographical position, the method comprising:

receiving data signals (34) from a non-navigation system;

converting the received data signals (34) into positional data (28b) compatible with a navigation device (16, 17); and

transmitting the positional data (28b) to the navigation device (16, 17).

28. The method according to claim 27, wherein the positional data (28b) is in a format compatible with a satellite or a terrestrial radio navigation device, and the satellite or the terrestrial radio navigation device (16, 17) is arranged to process the positional data.

29. The method of claim 27 or 28, wherein the positional data (28b) is in a communications protocol.

30. The method according to claim 29, wherein the communications protocol format is in NMEA 0183 format.

31. The method according to claim 29, wherein the communications protocol format is a proprietary protocol.

32. The method according to any of claims 27 to 31, the method further comprising receiving and processing positional data (28a) generated by a receiver (20) for receiving satellite or other navigation system data signals (14a, 14b).

33. The method according to claim 32, the method further comprising selecting whether to process the positional data (28a) generated by the receiver (20) or the positional data (28b).

34. The method according to claim 32 or 33, the method further comprising monitoring the flow of at least one of the positional data (28b) and the positional data (28a) generated by the receiver (20).

35. The method according to claim 34, the method further comprising processing either the positional data (28b) or the positional data (28a) generated by the receiver (20) in the event that, respectively, the flow of the

positional data (28a) generated by the receiver (20) or the flow of the positional data (28b) stops.

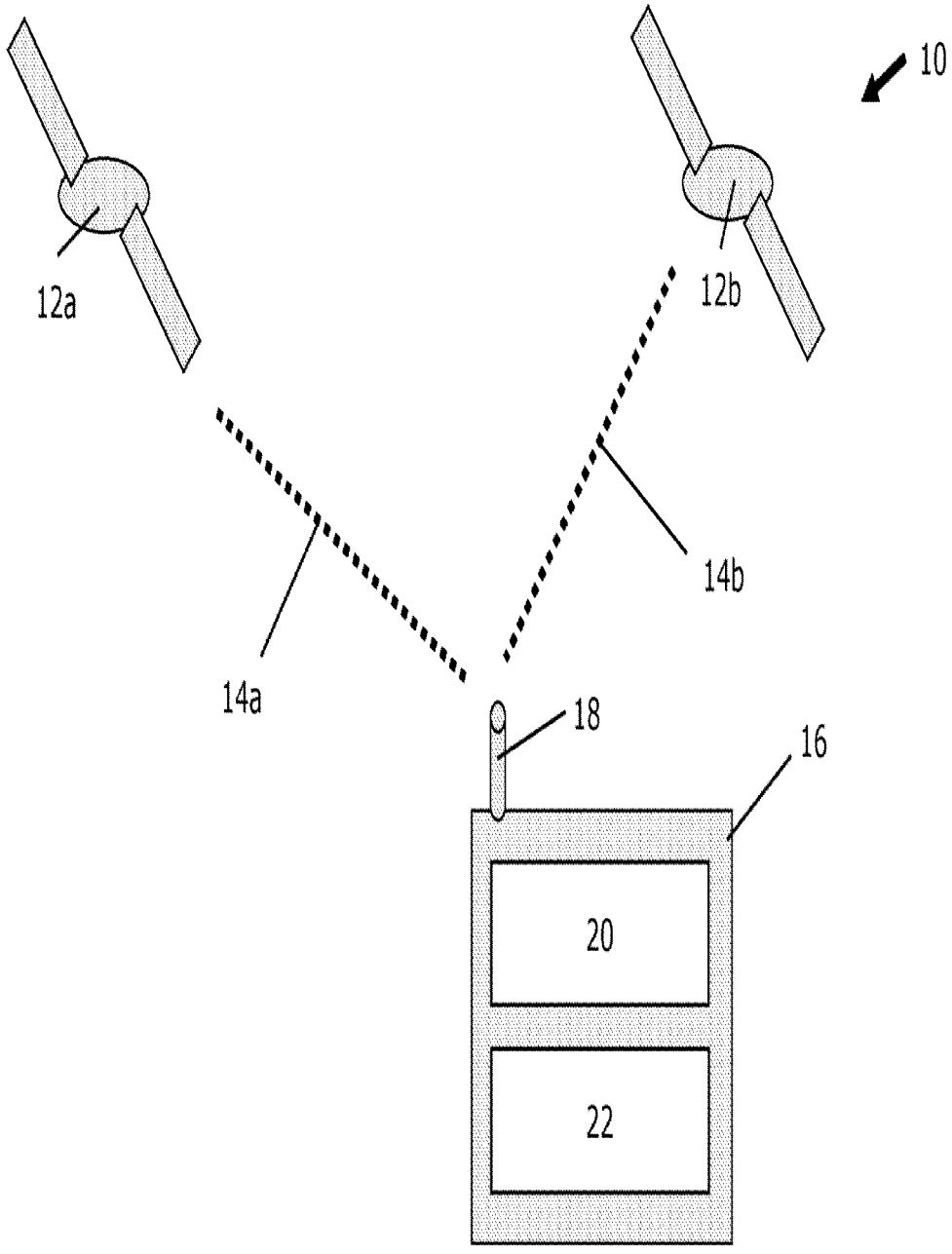

Figure 1 (Prior Art)

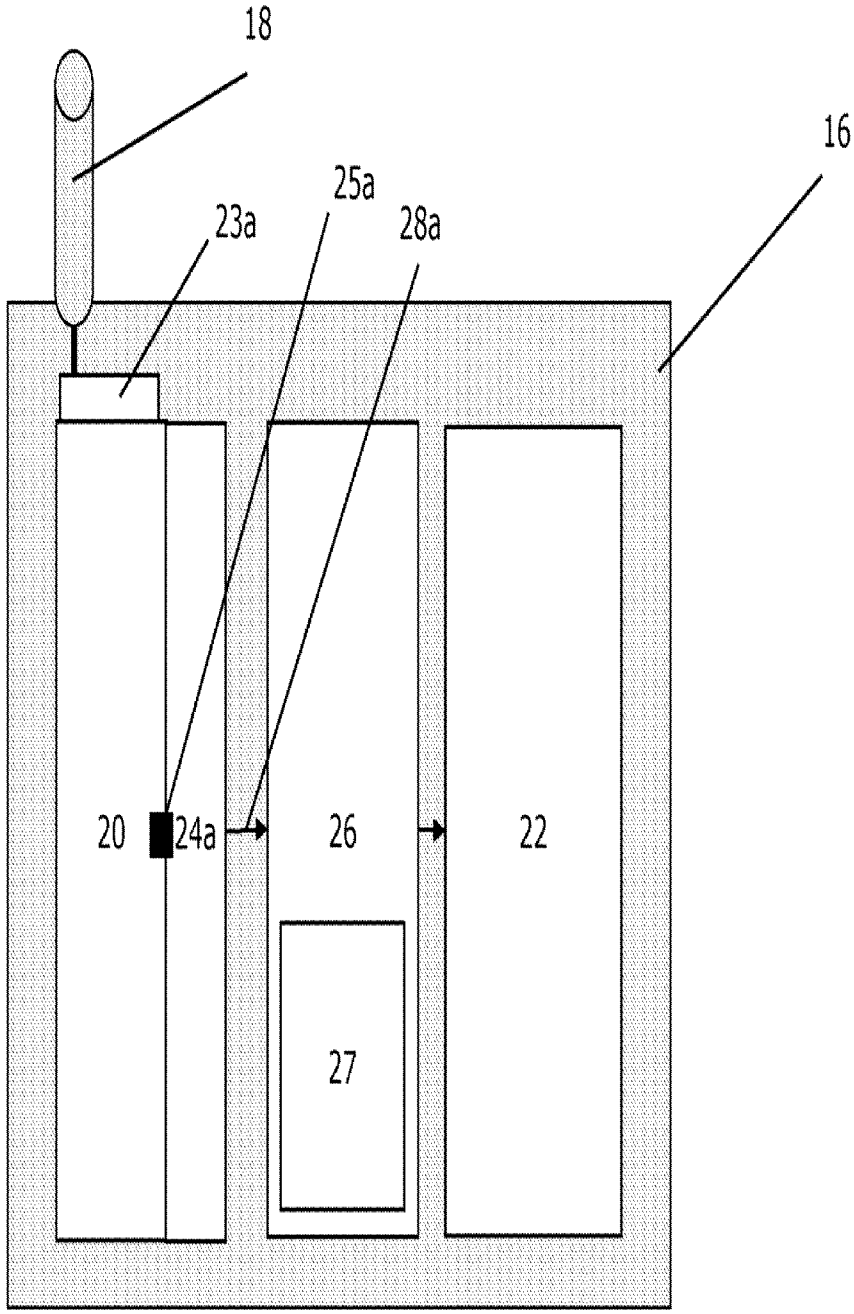

Figure 2 (Prior Art)

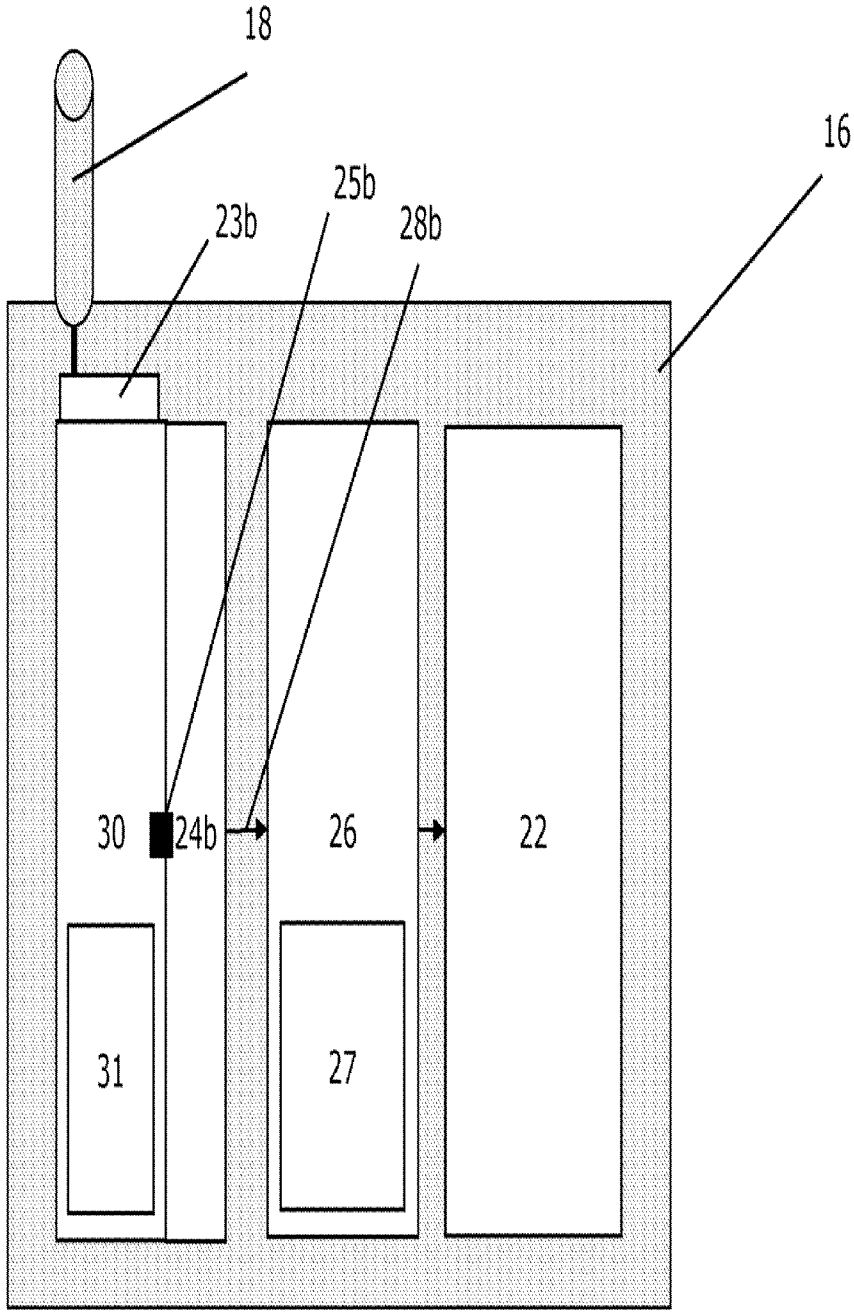

Figure 3

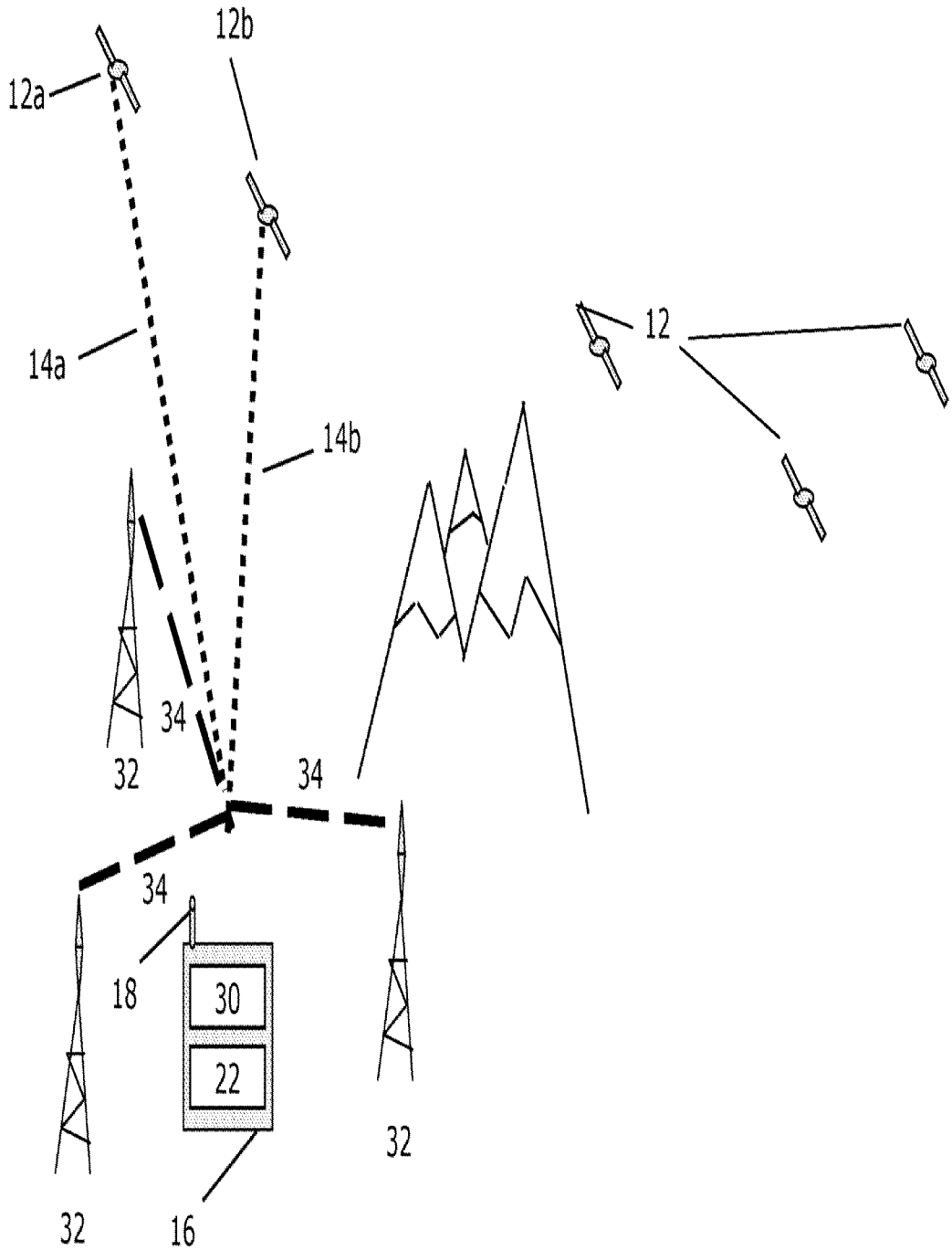

Figure 4

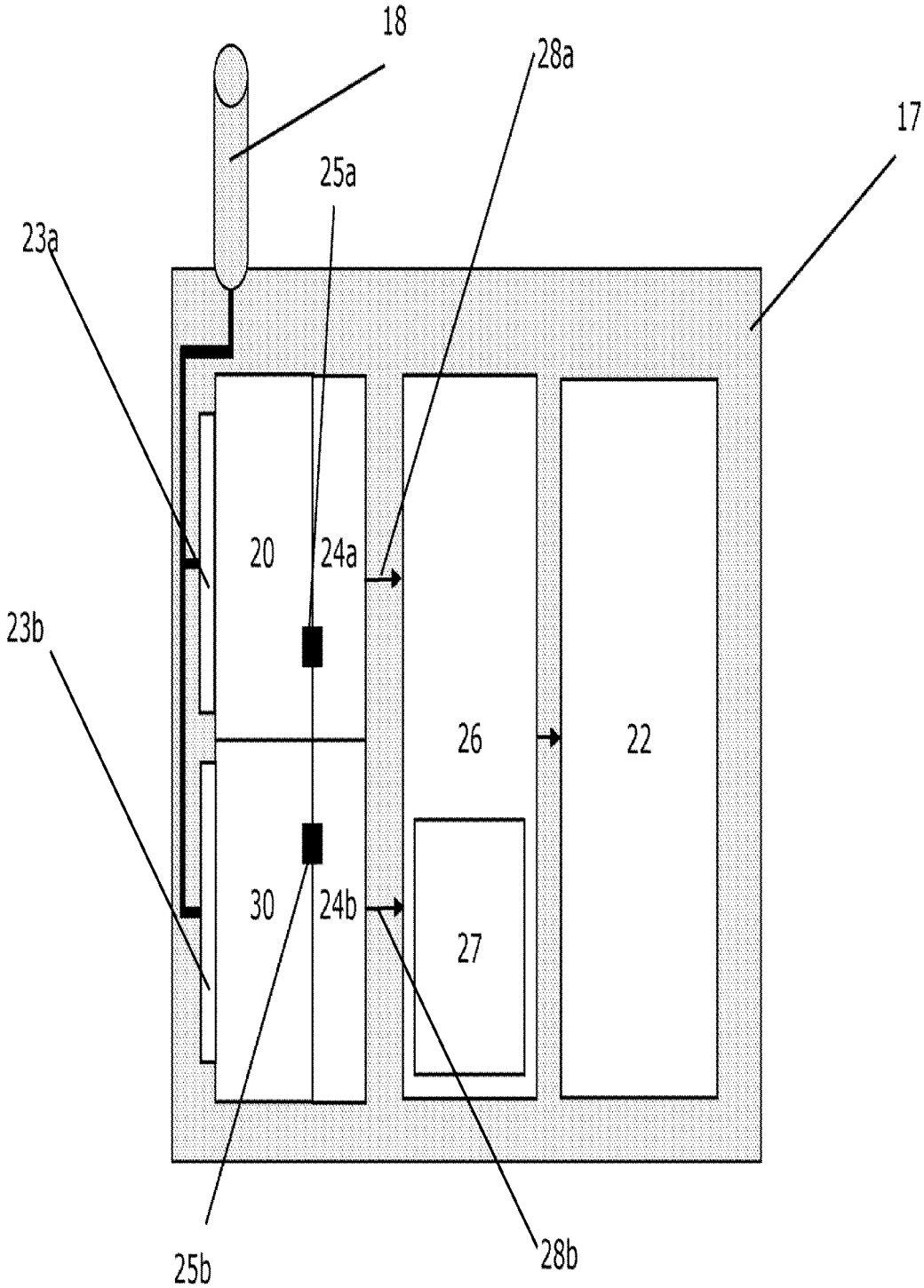

Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2010/051657

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01S19/48 G01S5/02 G01C21/00
ADD.

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)
G01C 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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 228 139 B1 (WORTHAM LARRY C [US]) 5 June 2007 (2007-06-05) column 2, line 33 - column 4, line 33; figure 1 column 5, line 3 - column 6, line 23 column 7, line 42 - line 49 column 9, line 61 - column 11, line 4; figure 5 column 11, line 55 - column 12, line 17 ----- -/--	1,2, 4-15, 17-21, 25,27, 29-31

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

[X] See patent family annex.

* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"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
25 January 2011	01/02/2011

Name and mailing address of the ISA/	Authorized officer
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2009/156229 A1 (HEIN DANIEL D [US] ET AL) 18 June 2009 (2009-06-18) paragraph [0002] - paragraph [0003] paragraph [0011] - paragraph [0024]; figures 1,2 -----	1-3,5-9, 11-15, 19-29, 31,32,34
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