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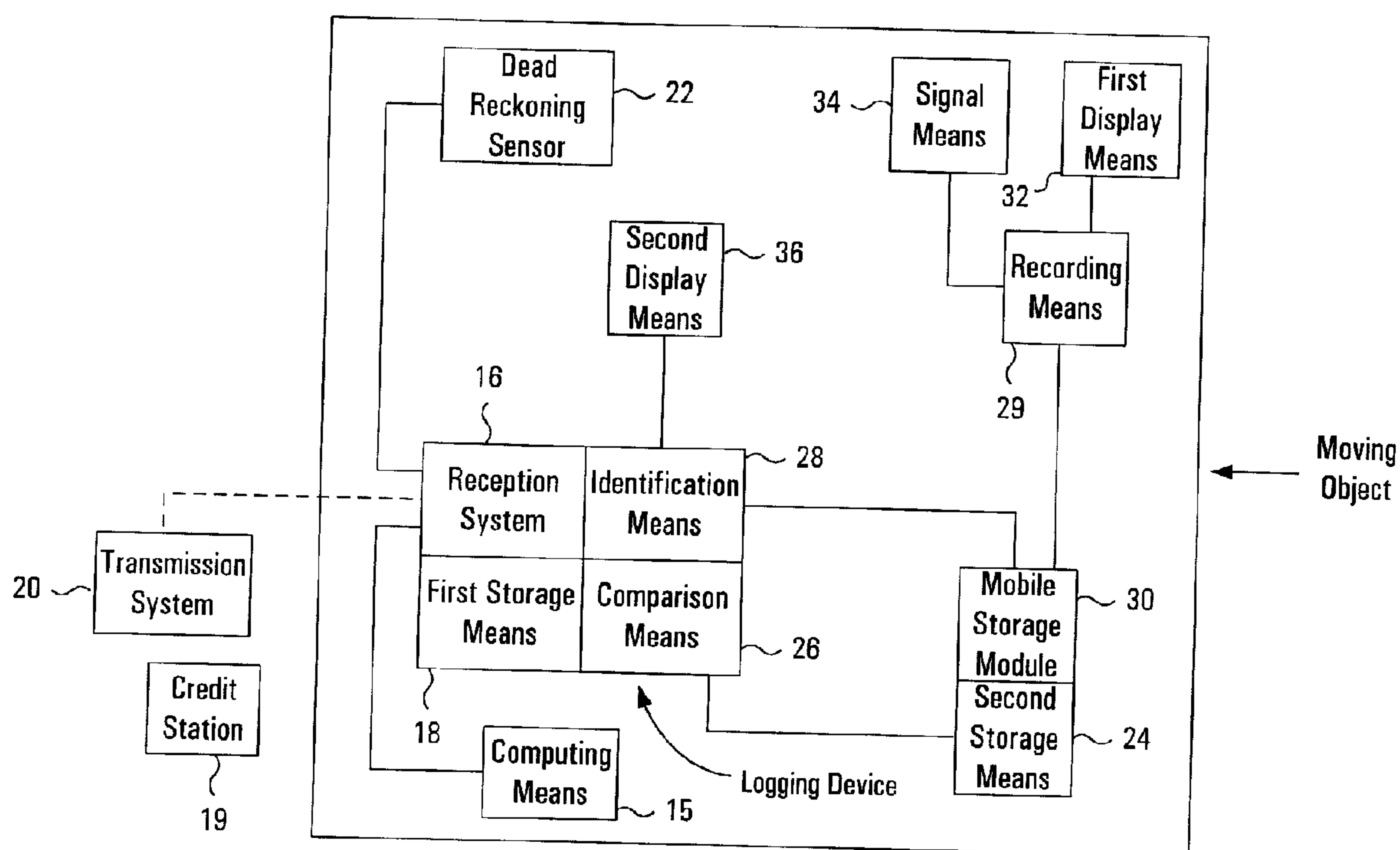
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(54) **DISPOSITIF POUR SYSTEME DE FACTURATION A  
L'UTILISATION**

(54) **ARRANGEMENT FOR A USE BILLING SYSTEM**



(57) The present invention relates to a system that is part of a user-pay system and is used to identify stretches of a route that are travelled by a moving object within a network of roads, or established geographic zones that are entered by the object. In order to create an accounting system that can be used universally as far as possible and which requires little outlay for infrastructure, it is proposed that a system that is installed independently is used for the wireless transmission of the information that is used to identify the current geographical position of the object; and in that the moving object carries a receiving system for the wireless transmitted information as well as a memory device for the temporary storage of data; and in that within the object there is a second memory device for permanently storing preset data; and in that the object also carries a comparison device for comparing this data. It is also proposed that an identification system for identifying the particular stretch of a route that has been travelled is also carried by the object, and that a mobile memory module that can be connected to the identification system is also used.

## Abstract

The present invention relates to a system that is part of a user-pay system and is used to identify stretches of a route that are travelled by a moving object within a network of roads, or established geographic zones that are entered by the object.

In order to create an accounting system that can be used universally as far as possible and which requires little outlay for infrastructure, it is proposed that a system that is installed independently is used for the wireless transmission of the information that is used to identify the current geographical position of the object; and in that the moving object carries a receiving system for the wireless transmitted information as well as a memory device for the temporary storage of data; and in that within the object there is a second memory device for permanently storing preset data; and in that the object also carries a comparison device for comparing this data. It is also proposed that an identification system for identifying the particular stretch of a route that has been travelled is also carried by the object, and that a mobile memory module that can be connected to the identification system is also used.

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The present invention relates to a user-pay system that incorporates a device for identifying stretches of a communications route that are being travelled by a moving object, for example, a car, motorcycle, truck, bus, ship, train, aircraft, person, or item of freight, that is located within a communications network, e.g., a road network, a water-way network, or a railway system) or geographical areas such as inner-city areas, air transport zones, large national parks) that are entered by said object.

EP-A-O 519 630 describes a motor-vehicle positioning system for that determines positional data from the GPS location system and then displays it. This GPS location system is also used for positioning system as described in EP-A-O 519 630. The data can be displayed by way of a memory card or a PC.

Finally, mention should be made of DE-A-35 37 730, which discloses a system for automatic guidance to a target. In this system, radio direction finding using a transmitter at a known location is used and the current course of the moving object is determined from the data that is obtained in this way.

Pay stations [toll booths] that are similar to border posts are used to collect fees for using bridges or tunnels; the particular fees are collected at such stations either by personnel or by coin-collection machines. France and Italy collect such fees by a system in which a ticket is issued to the driver of a vehicle at



entry points to the Autobahn and at transition points from a section of the Autobahn for which no fees are charged to a section for which fees are charged. The entry point is recorded on such a ticket in machine-readable form. At the exit point, or at a transition point from a section of the Autobahn that is subject to user fees to a section for which no fees are charged, the total distance that has been travelled can then be determined from this ticket and the particular user fee can be calculated and collected. Whilst it is true that this system permits reliable accounting, it does, however, require the commitment of substantial investment funds in order to create the necessary infrastructure, and in particular for the construction of toll booths with automatic ticket machines, barriers, and light systems. It also entails considerable personnel costs for day and night operation of the toll booths. An additional major disadvantage is that the flow of traffic is made considerably slower, particularly at peak traffic times, because of the accounting activity that has to take place.

In order to avoid such outlays, for several years now Switzerland has been using a different system for collecting Autobahn user fees; this system is based on a lump-sum payment for a specific period of time. When this lump-sum payment is paid, the driver of a vehicle receives a tag that is displayed on the vehicle and thus shows that the vehicle is permitted to travel on the Autobahn, and does so in a manner that can be verified. This system requires no substantial infrastructure costs since existing facilities can be used to sell the tags (e.g.,

post offices, border posts), and for purposes of verification (e.g., Autobahn transition points, police patrols). This means, however, that no accounting that corresponds to the actual scope of use is possible, so that the user-pay principle cannot be taken into account sufficiently when assigning costs.

Systems that permit individual payment based on actual use have already been proposed. However, these systems require the establishment of a suitable local infrastructure since they are based, for example, on infrared systems or so-called HF or RF transponder systems, which is to say on special machine systems that are used to spot and identify individual vehicles on the particular stretches where fees are due, or in appropriately established geographic zones, such as an inner-city area, for example, in which it is intended to reduce the amount of traffic. Transponder technology has been known for many years in the domain of military aircraft, where it is used as a means of distinguishing between friendly or hostile flying objects. The underlying principle in this technology is that an object that is to be identified is "illuminated" by a monitoring point (e.g., a ground station, a ship, or another aircraft) by radar, for instance, whereupon it automatically returns an appropriate recognition signal to the monitoring point. If such a system were to be used, for example, in an Autobahn fee calculation system, this would mean appropriate machine monitoring points would have to be located at particular points (in particular, entry and exit points) in order to permit total coverage and acquisition of all



the data required for calculating user fees. Thus, a system of this kind requires considerable outlay for the establishment of a wide-area, specialized infrastructure.

It is the task of the present invention to propose a system of the type described in the introduction hereto that is suitable not only for calculating Autobahn fees, but also for determining other uses in defined areas (sections of highway, areas, spaces) by moving objects, and which requires comparatively little outlay for infrastructure.

10       According to the present invention, there is provided a use billing system including an arrangement for identifying road section subject to toll travelled by a moving object within a system of road sections and for identifying fixed geographical zones subject to toll entered by the object, the system comprising: a transmission system arranged external to the moving object independent of the road sections and fixed geographical zones for a wireless transmission of information for determining a current geographical position of the object; a reception system carried by the moving object and operative to  
20 receive the information from the transmission system for determining the position; first storage means carried by the object for temporarily storing data concerning the current geographical position of the object; second storage means carried by the object for permanently storing predetermined geographical positions called identification points for

unequivocal identification of individual road section subject to toll of the system of road sections and the fixed geographical zones subject to toll; comparison means carried by the object for comparing respective geographical positions of the object determined at regular intervals with position data of the identification points; identification means carried by the object for identifying the road section subject to toll travelled by the object and the fixed geographical zone subject to toll entered or exited by the object based upon the  
10 geographical positions passed by the object and determined by the comparison means and agreeing with identification points and for determining billing information on the basis of the identified road sections subject to toll and the identified geographical zones; and a mobile storage module connectable with the identification means for the receiving and storing the billing information.

The invention will now be described in greater detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a stretch of Autobahn;  
20 and

Figure 2 is a block diagram illustrating the main components of the toll payment system.

Referring to Figure 2, the system according to the present invention comprises three main functional blocks namely:

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- a positioning system that is installed in the vehicle;
- an accounting system that is installed in the vehicle;
- a mobile memory medium as the accounting-data repository.

The positioning system comprises a reception system 16 for receiving information that is used to identify the current geographical position of the vehicle, a computing means 15 for  
10 computing the geographical position, and a first memory device 18 for the temporary storage of the current position. The reception system 16 receiving the information for identifying the position of the vehicle which is transmitted by wireless from a transmission system 20 that is installed independently of the Autobahn network. This system exists already or can be modified at comparatively little cost to transmit the appropriate information. Examples of this are existing  
satellite-navigation systems (e.g., GPS, Glonass) or radio direction-finding systems that are based on existing radio  
20 telephone networks (e.g., C-, D-, E-Network) when a very precise determination of a position can be effected on the basis of the different amounts of time it takes a signal to reach adjacent ground stations. This information with respect to geographic position may be integrated into a cellular radio-telephone network and position identification is effected on the basis of



the amounts of time taken for the signals to travel from the object to individual receiving stations of the radio-telephone network by a computer system within the cellular radio-telephone network, the positions being transmitted as position data to the object, the radio-telephone being provided with a system for the regular transmission of its recognition data and for receiving position data, this also being done apart from actual telephone use. In a case of satellite-navigation systems, in order to increase the accuracy with which the position is determined, it  
10 may be expedient to provide a capability for receiving correction signals (e.g., for the differential GPS system). This makes it possible to correct errors that may be caused by faulty satellite orbits, errors in time measurement, and signal-radiation aberrations, and thus permits local precision of less than ten metres. Such a correction signal could, for example, be transmitted by radio (e.g., RDS) or by way of a GSM radio-telephone network. There are also systems that determine the position of a vehicle on the basis of radio contact and sensor technology that is installed in the vehicle itself. As an  
20 example, a sensor for determining the distance travelled by a vehicle (e.g., by counting the rotations made by the rear wheels) and

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a magnetic-field sensor can be used so as to permit precise positioning on the basis of a digitalized road network when, prior to the start of the journey, the vehicle position is established by way of a communications device installed in the vehicle. In order to permit continuous acquisition of position data during down-time periods when the positioning system is down (e.g., because of shielding or an unfavourable position of the satellite), a dead-reckoning sensor 22 can be provided (e.g. in the form of a magnetic-field sensor) that is  
10 also carried in the vehicle.

The accounting system that is installed in the vehicle contains a second memory device 24 for the permanent storage of pre-set geographic positions (identification points) that permit a unique description of the individual sections of the communications network and/or the zones that have been established. It also comprises a computation unit that operates as a comparison system 26 that is used to compare the current position of the vehicle with the position data (coordinates) of the identification points that are  
20 stored in the memory; it does this continuously at very short intervals (e.g., once or twice a second). If this results in a sufficiently precise match with the position data, the computation unit identifies in an identification means 28 the section of the Autobahn that can be associated with this identification point and which is being travelled at that particular moment. This process is described in greater detail below.

The use of an identified stretch of Autobahn is recorded by a recording means 29 on a mobile storage medium 30 by the computation unit. Such a mobile storage medium is understood to be a system that can be carried by the driver of the vehicle and when required can be connected to the computing system by way of a read/write device when required. It is preferred that this mobile storage medium be in the form of a magnetic-strip or chip-type memory card. However, other media, for example programmable memory blocks such as PAL-,  
10 FPLA-, or FPLS blocks, can also be used.

The computation unit also calculates the coordinates of the particular vehicle position from this information even if the information received externally from the positioning system does not consist of position data in the narrowest sense. The second memory unit with the position data for the identification points can be physically integrated into the first memory device. However, it can also be advantageous to integrate the second memory device in the mobile memory module.

20 A first display 32 can be used to warn a driver perhaps with the use of an alarm signal 34, that user credits are almost expended and a second display can be provided to warn the driver when the vehicle enters a zone for which fees are charged.

The principle underlying the calculation of user fees can be clarified on the basis of the section of a road network that is shown in Figure 1, in addition to an Autobahn 1 for which fees are collected, this also shows roads 4, 5,



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and 6 that cross the Autobahn 1. The entry/exit points 2a and 2b for the Autobahn 1 are marked with squares. The geographical positions of these identified points are stored as identification points in the second memory device. If a current vehicle position is identified by the computation unit and this agrees with the position of

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the squares 2a or (with a sufficient degree of precision) this can mean that the vehicle is on a section of Autobahn for which fees are charged. However, it could also mean that the vehicle is simply crossing over the Autobahn 1 on a road 4 or 5, for which no fees are charged. Even if a subsequent second square is subsequently passed, this still does not provide a definite indication in this respect. Thus, for example, it is possible to move from the square 2a along the roads 4 and 5 to the square 2b in the same way as along the Autobahn 1. For this reason, provision is made such that at least one identification point 3a, 3b (marked by a circle) that is located on the Autobahn 1 is established between two immediately adjacent entry/exit points on the Autobahn 1. These additional identification points, when passed after an identified entry/exit points, provide an unmistakable indication as to which section of Autobahn is being used at the time, so that appropriate registration for cost calculations can be made on the mobile memory medium. In order to provide a complete description of the section of Autobahn with all sections of the route, Autobahn crossovers and Autobahn merge points are identified with their position coordinates and used as identification points.

In principle, it would be possible to provide for effective calculation of user fees, for example, on a monthly basis, on the basis of utilization as recorded, at the fee-payment centres. However, it is more advantageous to use the mobile memory medium in the same way as a telephone debit card. This means that such an "Autobahn fee card" is purchased by the user, who thereby purchases

in advance the right to use the Autobahn to an established extent (user credits). In the event that the Autobahn is, in fact, used, then the fees for each section that is travelled are deducted successively from the remaining user credits.

If, in addition to the identification points on the Autobahn network, the scale of user fees has also been stored the mobile memory medium, this entails the major advantage that graduated user authorizations can be put into effect in a simple manner. As an example, it is possible to issue special Autobahn fee cards for the use of specific regions or for specific sections of the network (e.g., a transit Autobahn). To the extent that different fee scales are to be used for various types of vehicles (cars, motorcycles, buses, trucks) this can be taken into account without any problem by issuing appropriately configured Autobahn fee cards that have other scales stored in them.

The components of the system according to the present invention that are carried in the vehicle, and which are preferably configured as a compact, mobile accounting apparatus can, for example, be physically integrated into a car radio, a traffic-management system terminal, or in a mobile radio, and thus be built into a vehicle on a permanent basis. Mobile equipment is recommended, in particular, for accounting for the charges accumulated by foreign vehicles that do not carry appropriate systems. Then, in addition to Autobahn debit cards, such accounting equipment could be rented on payment of an appropriate



deposit. The accounting apparatus would preferably be activated when the Autobahn debit card is inserted into an appropriate read/write system. Provision could also be made such that when the vehicle is stationary, the apparatus is automatically shut down and then reactivated when the journey is resumed. Display devices within the vehicle, which warn the driver when the vehicle enters a zone for which fees are charged, are advantageous and, in addition, they could also provide a timely warning when user credits are almost expended. An on-going indication of actual user credits is useful. It is preferred that there be stations at which the user credits can be replenished--on payment of an appropriate deposit or by the purchase of a new Autobahn debit card--be located along the Autobahn (e.g., at rest points, filling stations, and parking areas).

Should it be necessary, the system according to the present invention makes it possible, to allow for widely differentiated types of use, so that the intensity of use (e.g., identification of the length of time spent in a zone for which fees are charged) can be taken into account. To this end, special input possibilities for appropriate parameters can be provided. As an example, one useful version would be to apply lower fee scales for individual sections or for the total Autobahn network at times when there is little traffic (e.g., during certain seasons or at night) so as to achieve relief at busy periods by shifting traffic to periods that are not as busy.

In order to prevent the unauthorized use of sections or zones that are liable to charges, and to make misuse easier to identify, it is advisable to incorporate signal systems (e.g., HF transmitters, RF transmitters, laser diodes for infrared signals, and the like) that transmit a signal in the event of proper computation of fees and subsequent legal use of the road by sending an "authorized" signal. Receiving stations that are installed externally (e.g., in surveillance vehicles that are located at the exit points from the Autobahn) can thus identify those vehicles that are not carrying a fee-computing system, or that are operating an installed system of this kind in an improper manner and have thus not paid the appropriate fees. As an alternative to this, or in addition to it, a single system that operates [outside the vehicle] (e.g., a coloured indicator light) that is activated automatically if the vehicle continues to use a section for which fees are charged after all user credits have been expended, can also be used. Provision can also be made such that in cases of this kind, a radio signal that identifies the particular vehicle is transmitted to a monitoring station. The extent of continued and unauthorized use of the Autobahn can be displayed on the mobile storage module for purposes of local traffic monitoring.

An important advantage of the solution proposed by the present invention is that it does not require any new infrastructure, or does so only to a limited extent; rather, it permits the use of existing facilities and is thus installed independently of the particular area that



is subject to user fees. A significant additional advantage is the fact that the identification and computation of use for which payment is required takes place autonomously, i.e., within the vehicle itself, so that data can be properly protected; this then precludes any undesired monitoring of driving habits and the like. It is further proposed that no information of the kind that would permit identification of the total distance travelled within the area that is liable to fees by the particular vehicle remains in memory. Temporarily stored information concerning sections of road that have been travelled are deleted once the user fee has been deducted from the user's credits. The coordinates of the last identification point that represents the start of the section currently being travelled and which is passed by the vehicle is recorded in each instance. If, however, it is expressly desired, a special accounting apparatus can be made available, this being of the kind that effects continuous recording of all sections that are travelled in order to permit automatic maintenance of a log book, e.g., for transportation companies.



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As has already been described, use of the system according to the present invention is in no way confined to road traffic; rather, the system can be adapted to numerous other applications.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A use billing system including an arrangement for identifying road section subject to toll travelled by a moving object within a system of road sections and for identifying fixed geographical zones subject to toll entered by the object, the system comprising:

a transmission system arranged external to the moving object independent of the road sections and fixed geographical zones for a wireless transmission of information for determining a current geographical position of the object;

a reception system carried by the moving object and operative to receive the information from the transmission system for determining the position;

first storage means carried by the object for temporarily storing data concerning the current geographical position of the object;

second storage means carried by the object for permanently storing predetermined geographical positions called identification points for unequivocal identification of individual road section subject to toll of the system of road sections and the fixed geographical zones subject to toll;

comparison means carried by the object for comparing respective geographical positions of the object determined at regular intervals with position data of the identification points;

identification means carried by the object for identifying the road section subject to toll travelled by the object and the fixed geographical zone subject to toll entered or exited by the object based upon the geographical positions passed by the object and determined by the comparison means and agreeing with identification points and for determining billing information on the basis of the identified road sections subject to toll and the identified geographical zones; and

a mobile storage module connectable with the identification means for the receiving and storing the billing information.

2. A system as defined in claim 1, and further comprising computing means carried by the object for calculating the geographical position of the object from the information transmitted by the transmission system when the information does not represent position data.

3. A system as defined in claim 1, wherein the transmission system is a satellite navigation system.

4. A system as defined in claim 3, wherein the reception system is adapted to receive correction signals which facilitate improvement of accuracy of the position detection.



5. A system as defined in claim 3, and further comprising a dead reckoning sensor operatively provided in the object to continue providing position data during a temporary malfunction of the navigation system.

6. A system as defined in claim 5, wherein the dead reckoning sensor is a magnetic field sensor.

7. A system as defined in claim 1, wherein the transmission system is configured as part of a cellular radio-telephone network, the reception system being a radio-telephone and positions of the object being determined based upon different amounts of time taken for signals to travel from the object to individual receiving stations of the cellular radio-telephone network, the mobile telephone having means for regular transmission of identification data and for receiving positioning data done apart from actual telephone use.

8. A system as defined in claim 1, wherein the transmission system is a direction finder system.

9. A system as defined in claim 1, wherein the mobile storage module is one of a magnetic tape card and a chip storage card.

10. A system as defined in claim 1, wherein the second storage means is provided as a component part of the mobile storage module.

11. A system as defined in claim 1, wherein the moving object is a road vehicle and the system of road sections is a highway system, the second storage means being operative to permanently store identification points that relate to connection points of the highway system and to at least one intermediate point located between two immediately successive connection points on a section of a highway in said highway system extending between these two connection points.

12. A system as defined in claim 11, including means for recording at least one of an identified road section actually travelled within the system of road sections and an entry into a fixed geographical zone as a debit of a credit stored in the mobile storage module, the debit being determined along the system of road sections based on fee information which is stored in one of the second storage means and the mobile storage module.

13. A system as defined in claim 12, and further comprising stations arrangeable at rest stops and gas stations along the highway system which are operative to provide additional stored credit.

14. A system as defined in claim 12, and further comprising first display means for emitting a signal in the object that warns of an imminent expiration of credit.

15. A system as defined in claim 14, and further comprising second display means arranged in the object and operatively connected to the identification means so as to be activateable thereby when entering a road section or geographical zone subject to use billing, said second display means emitting a corresponding signal in the object indicating entry in such a road section or geographical zone.

16. A system as defined in claim 12, and further comprising outwardly acting signal means mounted on the object for emitting a signal when at least one of use of a road section subject to billing and presence in a corresponding fixed geographical zone extends beyond a depletion of credit.

17. A system as defined in claim 16, wherein the outwardly acting signal means is operative to emit a visual signal.

18. A system according to claim 17, wherein the outwardly acting signal means is operative to emit an infrared signal.



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19. A system according to claim 16, wherein the outwardly acting signal means is operative to emit a radio signal.

20. A system as defined in claim 12, and further comprising outwardly acting signal means mounted on the object for sending an "OK" signals as long as proper credit is available.

21. A system as defined in claim 20, wherein the outwardly acting signal means is operative to emit a visual signal.

22. A system according to claim 21, wherein the outwardly acting signal means is operative to emit an infrared signal.

23. A system according to claim 20, wherein the outwardly acting signal means is operative to emit a radio signal.

24. A system as defined in claim 1, wherein the reception system, the first storage means, the comparison means and the identification means are configured as a single logging device.

25. A system as defined in claim 24, wherein the logging device is configured to be activateable by a connection with the mobile storage module.

26. A system as defined in claim 24, wherein the logging device is configured as a component part of a car radio.

27. A system as defined in claim 24, wherein the logging device is configured as a terminal of a traffic control system on board the vehicle.

28. A system as defined in claim 24, wherein the logging device is configured to be removably connected in the use

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billing system so that the logging device is portable.

29. A system as defined in claim 24, wherein the logging device is operative to determine parameters identifying duration and intensity of use of the system of distances by the object.

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PATENT AGENTS



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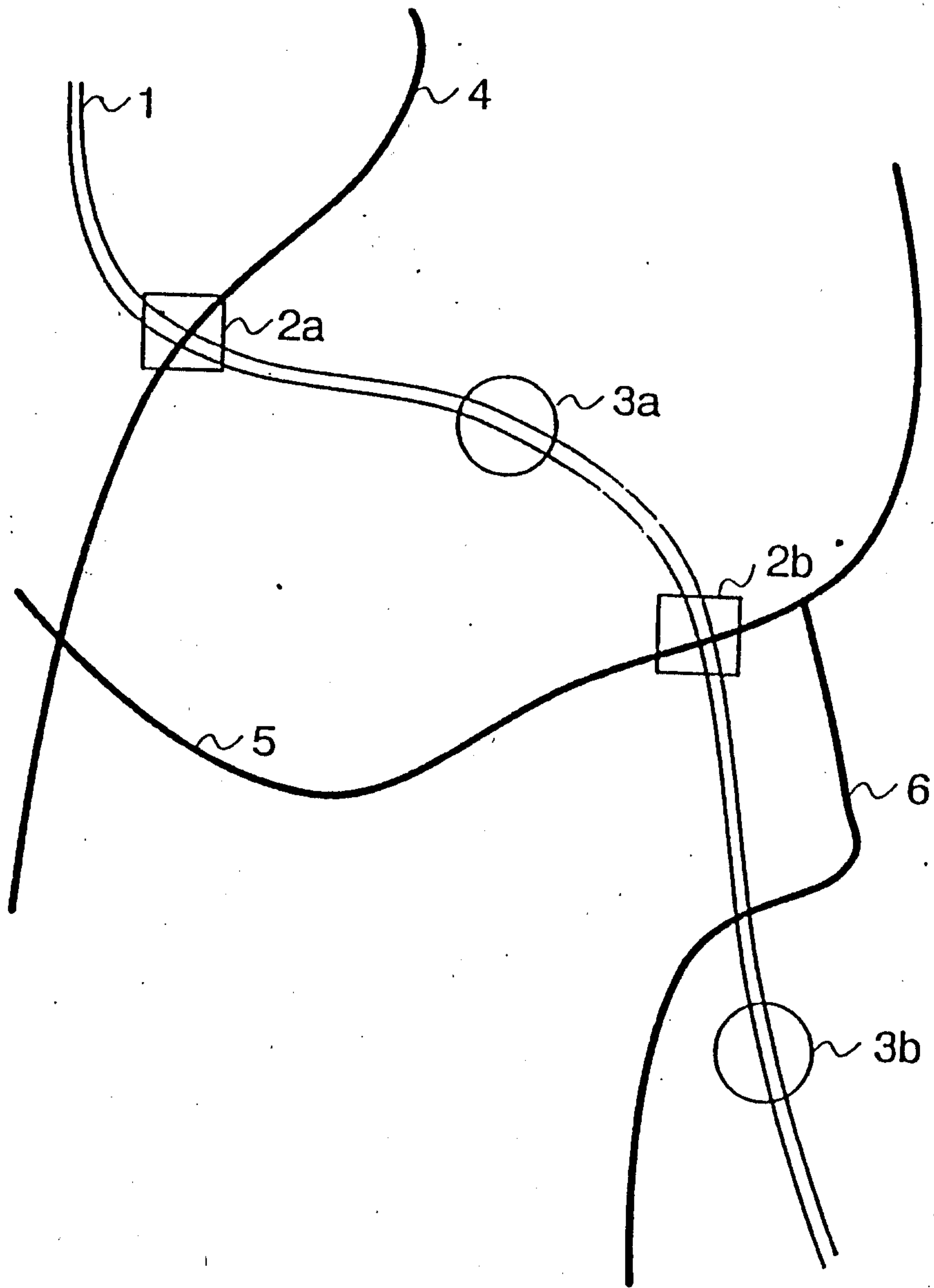


Fig. 1

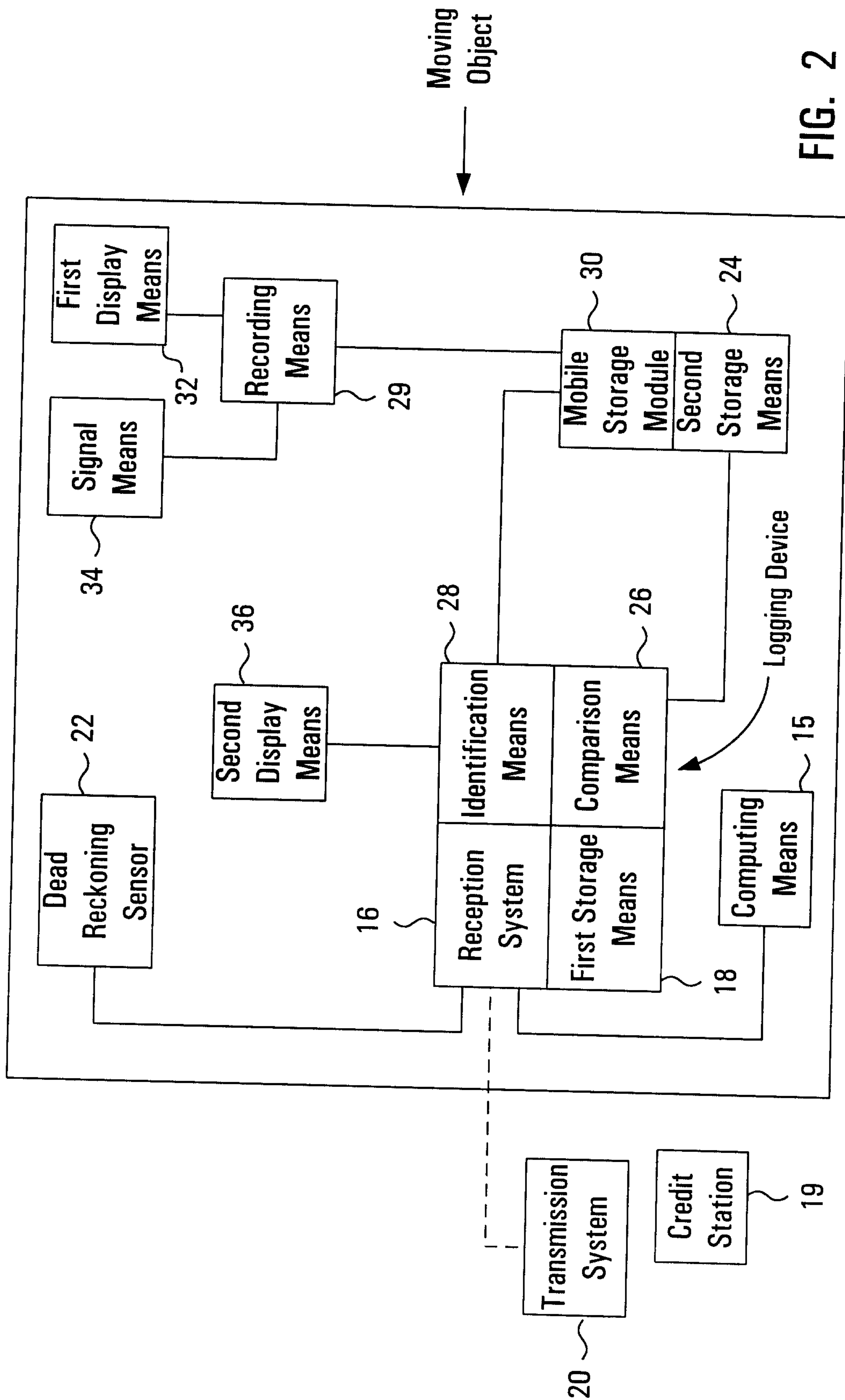


FIG. 2

