(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 425 961 B2

(12) **NEW EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the opposition decision:
06.10.1999 Bulletin 1999/40

(45) Mention of the grant of the patent:
02.10.1996 Bulletin 1996/40

(21) Application number: **90120224.2**

(22) Date of filing: **22.10.1990**

(51) Int Cl.[6]: **G07B 15/00**, G07C 9/00

(54) **Automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks**

Automatisches Zollabgabesystem für städtische und ausserstädtische Autobahnen, für Brücken und Tunnel und für Zugänge zu städtischen Gebieten und Parkplätzen

Système de péage automatique pour autoroutes se trouvant en ville et en dehors des villes, pour ponts et tunnels, et pour accès aux zones urbaines et aux parkings

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IT LI LU NL SE

(30) Priority: **25.10.1989 IT 2212289**

(43) Date of publication of application:
08.05.1991 Bulletin 1991/19

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Description

[0001] The present invention relates to an automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks.

[0002] As is known, through the years, in view of the fact that the highway system has a strategic role of development and integration of the territory, an extensive integrated network capable of providing the necessary assurances of ease of transit as well as new services related to stops and to increasingly complete tourist-cultural information and information on road conditions has been developed. In particular, in order to increase fluidity, safety and comfort on the highway network, and in order to reduce the congestion of traffic near stations, which is endured by highway users with rising intolerance, there has been a constant commitment aimed at the adaptation of the structures and to the development of automation. A further fluidizing factor is constituted by the possibility of paying the toll by means of electronic money either in the form of a "prepaid charge-deduction" card or of charging, either directly or by means of contracted organizations or finally with charging to a bank account (VIACARD system).

[0003] US-A-4 303 904 discloses an automatic toll paying system which comprises the technical elements as included in the preamble of the appended claim 1. Such system starts with a lump sum paid in advance to a permanently assigned collection agency's representative. This sum is inserted, electronically, into the memory of a microwave transponder-data-processor, normally kept in the vehicle. A code identifying the user is fixedly stored in the transponder-data-processor and thus cannot be easily changed. As the vehicle passes suitably equipped toll collection facilities, a toll transponder receives billing information from the vehicle transponder, calculates the toll, and transmits it back to the vehicle transponder where the toll is electronically subtracted from the stored balance.

[0004] EP-A-323 326 discloses an on-board vehicle transponder in which a removable microprocessor card is insertable. The microprocessor card comprises a memory with prepaid units which are subtracted from the card when the transponder receives appropriate signals from an emitting station. The removable card stores a code identifying the vehicle which is transmitted by the on-board transponder to the emitting station for example for identifying a stolen vehicle

[0005] The present invention provides a system and a process for the automatic exaction of toll for urban and extraurban highways. for bridge and tunnel crossings and for accesses to urban areas and car parks, which are specified in claims 1 and 12 respectively and allow a dynamic exaction of the toll even with different cards.

[0006] In particular, the present invention provides an automatic toll exaction system which can:

- simultaneously provide the diffusion of precise and timely information on road conditions and on the services offered:
- ensure greater fluidity, safety, reduction of pollution near stations and energy saving, since the vehicle no longer needs to stop in the lane but can pass at the speed enforced by safety regulations:
- have great reliability and modularity to allow the progressive introduction of the various provided services and the easy implementation of new ones;
- be easily integrated in the existing structures, as regards both the vehicles and the road, and in particular the configuration of the stations.

[0007] The system according to the invention is furthermore compatible and interactive with currently installed 5 exaction systems, allows to maintain the currently existing monetics circuits and allows opening to integration with information processing systems.

[0008] The characteristics and advantages of the invention will become apparent from the description of a preferred embodiment, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a schematic view of the three essential components of the system according to the invention;
figure 2 is a block diagram of the onboard apparatus;
figure 3 is a schematic view of the configuration of a station executed according to the invention, illustrating the division of the areas affected by the system;
figure 4 is a block diagram of the ground-based apparatus; and
figures 5-8 are block diagrams of the steps for automatic toll exaction according to the invention.

[0009] With reference to figure 1, the system according to the invention is substantially composed of three parts. and precisely an onboard apparatus (composed of the units shown in figure 2) mounted inside a motor vehicle 1 in a position which can be accessed by the driver, a personal card 2, which must be inserted in the onboard apparatus in order to use the toll exaction system according to the invention, and a ground-based apparatus (represented in figure 1 by a buoy 3 on which an antenna 4 is mounted and schematically indicated in figure 4) which ensures linkup with the onboard apparatus and the processing of the data for toll exaction This ground-based apparatus also allows connection to existing information-processing and automation units.

[0010] The onboard apparatus has the function of ensuring the reception and transmission of the messages. the handling and storage of the transactions and the interaction with the user (generally the driver). In detail, said apparatus (see figure 2) comprises a ground-to-ve-

hicle radio-link section (composed of an antenna 5 and of a reception and transmission device 6 of a known type), an information processing section (composed of a control unit 7 with a memory 8 of its own), a section for reading and encoding the card (card reader 9) and a man-machine interface 10 which is typically constituted by a display unit, which includes a red LED and a green LED for displaying messages sent by the ground-based apparatus or generated by the control unit 7, and by a two-tone acoustic alarm system for attracting the user's attention and repeating the visual indication provided by the LEDs. A third yellow LED can furthermore be provided: when lit, said LED indicates that the card can no longer be removed from the reader. Finally, means suitable for allowing the user to receive further information concerning road conditions and traffic may be provided. Said means may be constituted for example by displays and/or loudspeakers or other solutions suitable for the purpose, as well as by elements for connection to the devices which are already available on board (radio, etc.).

[0011] The personal card, which for example can be executed as an extension of the VIACARD (Trade Mark) cards, has the function of activating the onboard apparatus, of identifying the user and of storing the operative data (such as the operativity or locking of the card as well as the transactions for the payment of the toll or of other goods or services). Conveniently, in order to ensure that the dialogue is confidential, to protect access to the system and store the operative data, said card is executed according to the technology of microprocessor-equipped cards which also contain electrically rewritable memories. The card furthermore conveniently has, on the same support, magnetic tracks recorded according to the currently applicable codings to allow the use of the same card (which is removable from the onboard apparatus) even with conventional station apparatuses for automatic toll exaction and with those being installed for the payment of fuels and refreshments.

[0012] As will be explained in greater detail hereinafter, once the card is inserted in the onboard apparatus, it is checked upon entering the highway and stores the characteristic data in replacement of the ticket for the completion of the exit transaction. It furthermore stores each individual transaction supporting each charge, thus constituting a memorandum of the trips made for the user, contains the restrictions of use (limit differentiated by service and in time) and also verifies and stores the occurrence of the enabling on the part of the system to the fruition of the service by means of checks on a blacklist or "white list", according to the preset procedures.

[0013] The ground-based apparatus, as already mentioned, has the function of communicating with the onboard one for the exchange of the data and messages required to ensure the dynamic exaction of the toll and the transmission of general information on road conditions and traffic, as well as of performing the necessary processing of the data. In particular, two different transmission modes, which are simultaneously present with automatic passage from one to the other, are provided according to the content of the messages. The first mode is aimed at a single user for the dynamic exaction of the toll by means of a selective linkup (in particular with the identification and classification of the vehicle and with the association thereof with the card inserted in the onboard apparatus). This entails the need to locate the vehicle and to maintain a one-to-one correspondence between the physical parameters detected by means of the ground-based instruments and the user identification data gathered by radio. The second transmission mode is aimed at many users (circular transmission) for the broadcasting of news of general interest, such as the state of the roads or the availability of services. In particular, in this case, the ground-based apparatus allows to send information on road conditions, on the presence of road yards, traffic blocks and detours, on travel times, recommended alternate paths, availability of services and weather conditions, and on the presence of personal messages at the nearest service station. This system, in a simpler configuration, allows to carry this information along the highway and possibly, by means of appropriate installations, even along the ordinary road system.

[0014] Consequently, each individual station executed according to the present automatic exaction system has the structure shown in figure 3. In said figure, the reference numerals 16 indicate two portions of highway which can be followed in the outgoing direction (typically they represent the two junction roads with the carriageways or lanes of the highway), 17 indicates the portion after the toll station which can be followed in the ingoing direction toward the actual highway, 18 represents a road (e.g. a provincial road) which is linked to the highway by means of the portions 16 and 17, and 19 indicates the station. The station, according to the invention, comprises a plurality of areas in which the messages necessary for automatic exaction are exchanged. In detail, three areas are provided and correspond to three logic steps which are repeated both in entry and in exit in case of a closed highway system:

a) a first approach step, during which the ground-based system broadcasts circular signals to communicate the availability of the service and activate the onboard apparatus which, passing from a listening state to an active one, performs all the auto-diagnostics checks and the card functionality checks. The positive outcome of these checks, which is notified to the user, authorizes said user to continue toward the gate enabled for the tele-toll service: otherwise an alarm indication requests him to move toward another gate with manual or automatic exaction. This step is performed in the areas indicated by AREA 1E (for entering the highway) and AREA 1 U (for leaving said highway). The areas 1E and 1

U are chosen so that in this step the vehicle is normally not routed, and the radioelectric coverage is extended enough to ensure linkup with all the passing vehicles which are potentially interested in the message. In this region, transmission is of the one-way type, from the ground to the vehicle.

b) a second presentation step, during which the onboard apparatus communicates the user's identification data while the ground-based apparatuses determine the class of the vehicle for the application of the toll fare. In this step, which is performed in the regions indicated by AREA 2E (for entry) and AREA 2U (for exit), the correspondence between the data acquired by radio and those measured on the ground must be ensured: the link is of the two-way type and the traffic is already routed.

c) a third validation step, during which the ground-based system authorizes transit, on the basis of the checks performed on the data acquired in the preceding step, and transfers the related identification data to the vehicle. In case of failed authorization, the ground-based apparatus enables the acquisition and storage of a frame which contains the registration plate of the vehicle involved. This step is performed in the regions indicated by AREA 3E (for entry) and AREA 3U (for exit).

[0015] The station illustrated in figure 3 is part of a closed system (i.e. in which toll exaction is performed by calculating the distance covered and the tariff class and each area is repeated in entry and in exit); however, the same scheme is used for open systems (i.e. systems in which there are one or more stations in which the payment of the toll related to a certain highway segment is performed as a function of the segment itself and of the class of the vehicle). In particular, the same three steps described above, which correspond to the three areas of approach, presentation and validation, are identified in this case as well, but the entire transaction is performed in a single station, as will be explained in greater detail hereinafter.

[0016] Figure 4 schematically illustrates the units which compose the ground-based apparatus. In particular, the entry buoy (BOA 1E) arranged at the AREA 1E and the exit buoy (BOA 1U) located at the AREA IU are represented. Said buoys are arranged physically remote from the related station, so that an RS422 line is provided for exchanging data with the station computer. One or two additional buoys (BOA 1S) which replicate the entry and/or exit buoy proximate to the station are possibly provided. A monitor is furthermore connected to the computer for control on the part of an operator The ground-based apparatus furthermore comprises a lane processing unit. indicated by 20. which is arranged at each lane and is therefore provided at least twice, for the entry lane and the exit lane. Said unit 20 comprises a lane computer, a CTV unit which constitutes a classification and unlocking system, a logical unit for the control of the buoys (BUOY LOGIC - CONTROLLERS) and a unit for communication between the lane computer and the station computer. The entry or exit presentation and validation buoys (BOA 2, BOA 3), according to the type of lane, lane sensors which are arranged proximate to the entry and exit buoys BOA 2 and BOA 3 and are typically constituted by a pair of contiguous optical barriers and by a presence sensing coil, and a TV camera with the respective SART computer for detecting the registration plates are connected to the processing unit 20 as will be explained hereinafter.

[0017] All the buoys have highly directive and very small antennas which operate typically between 5 and 11 GHz.

[0018] The automatic toll exaction system according to the invention operates as described hereafter with reference to the block diagrams of figures 5-8.

[0019] In particular, figure 5 illustrates the block diagram related to the operations performed by the onboard apparatus during the approach step both for the closed system (and related to both entry and exit) and for the open system. In detail, the buoy BOA 1 broadcasts its own activity signal in a continuous cycle; said signal contains a variable text to be recorded on the onboard apparatus. The onboard apparatus, which was previously in the listening state, is activated when the vehicle enters the AREA 1E or 1U and receives the buoy activity signal. Lack of reception does not enable for transit on the dedicated lanes. Reception of the activity signal instead causes the beginning of the self-test sequence of the assembly constituted by the onboard apparatus and the inserted card. The correct insertion of the card in the reader is initially checked, with a possible indication in case of negative outcome, then the self-test sequence continues in order to check the read/write capability, possible hindrances to the use of the card and the non-corruption of the recorded data. Then the outcome of the test is indicated by means of the display and/or of an acoustic signal and possibly, in case of positive outcome, the message of the buoy is examined and indicated to the user.

[0020] Figure 6 illustrates the block diagram related to the operations performed by the ground-based apparatus during the entry presentation step. At the beginning of this step, the ground-based apparatus is waiting for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 2. As soon as a vehicle is sensed, the buoy broadcasts a cyclic code which has the function of a query for the vehicle. The onboard apparatus replies by providing its own card code plus the cyclic code assigned thereto and furthermore stores on the card said cyclic code and a marker to indicate the locked condition. This means that the card cannot be removed until the end of the writing of said card during the validation step. The onboard apparatus furthermore stores the code of the card in its non-volatile memory (memory 8 of figure 2) to avoid exchanges of the card itself between the entry station and the exit station. as

will be explained hereinafter. The units which control the buoy. which after the broadcasting of the cyclic code has set itself to standby for the data supplied from the vehicle, upon the reception of said data perform the matching between the cyclic code and the card code and the transfer of these data to the lane computer SCP. If the data are not received, this fact is indicated to the SCP and the dialogue is terminated. Then the buoy continues with the querying of the following user by means of the following number of the cyclic code. The SCP, after the reception of the data from the buoy, performs the formal checks on the card, checks the inclusion of the received code in blacklists and in allowance ranges and furthermore classifies the vehicle.

[0021] Figure 7 illustrates the block diagram of the entry validation step (and of the exit validation step, as will become apparent hereinafter). At the beginning of this step, the ground-based apparatus is standing by for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 3. As soon as a vehicle is sensed, if the transit is not a violation (for example due to the absence of the onboard apparatus or of the card, or to the lack of enabling of the latter or other transit anomalies) and if the card code is acceptable, the buoy sends the message for the awaited vehicle: in this case said message contains the data related to the highway entry, such as the station code, the date and time, the detected class, the inclusion in the blacklist and the inclusion in the allowance ranges as well as the cyclic code to which the data refer. These data can thus be stored on the card. Then the buoy sets itself to a state of standby for the reception of a return confirmation on the part of the vehicle. The confirmation of the correct reception and correspondence of the data (cyclic code equal to the one received during the presentation step) retuning from the onboard apparatus must be received by the lane system before the vehicle leaves the lane control sensors. Otherwise, the lane computer activates the registration plate identification and at the same time transfers the value of a counter, which is provided in BOA 3E and stores the progressive number of transits, to the computer which is responsible for the acquisition of the photographs. Registration plate detection is also activated when an illegal transit is sensed, the card has an unacceptable code or there is an unrecoverable error in ground-vehicle data exchange. The reception of confirmation or the acquisition of the registration plate in case of illegal transit or in case of failed confirmation cause the shutdown of the operations related to the transit.

[0022] At the end of the writing of the data on the card, the onboard apparatus finally erases the marker on the card, which can therefore be removed from the reader if required.

[0023] As regards the exit steps of a closed highway system, these steps are again divided into an approach step, which is equal to the one already described with reference to figure 5, a presentation step, which is now described with reference to figure 8, and a validation step which is similar to the one described with reference to figure 7.

[0024] The exit presentation step is very similar to the entry one. Consequently, at the beginning of this step the ground-based apparatus is standing by for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 2U. As soon as a vehicle is sensed, the buoy broadcasts the cyclic code. The onboard apparatus replies by providing its own card code plus the cyclic code assigned thereto as well as the other data stored at highway entry and furthermore stores on the card said cyclic code and a marker to indicate the locked condition. The units which control the buoy, which after the broadcasting of the cyclic code has set itself to standby for the data supplied from the vehicle, when said data are received, sends them to the lane computer SCP. In the absence of data reception, this fact is indicated to the SCP and the dialogue is terminated. Then the buoy continues with the querying of the following user by means of the following number of the cyclic code. The SCP performs the formal checks on the card, checks the inclusion of the received code in blacklists and in allowance ranges as well as the correspondence of the data with the entry data (in particular as regards the times, the entry and exit stations and the class of the vehicle) and furthermore calculates the toll as a function of the class and distance covered.

[0025] At the beginning of the validation step (see again figure 7), the ground-based apparatus is in stand by for the sensing of the passage of a vehicle at the sensors arranged in AREA 3. As soon as a vehicle is sensed, the buoy sends the querying message for the awaited vehicle; said message contains the exit data related to the payment of the toll, such as the amount of the toll, the exit station code, the exit lane code, the exit date and time, the class detected in exit, inclusion in the blacklist and inclusion in the allowance ranges. These data are sent to the onboard apparatus, which stores them, and then sends a confirmation toward the buoy. The reception of this confirmation on the part of the ground-based apparatus terminates the transaction. Anomalies in communications cause the activation of the registration plate detection in exit as well.

[0026] Finally, at the end of the writing of the data on the card, the onboard apparatus erases the marker on the card, which can thus be removed from the reader. and erases the card number stored in the memory of the on-board apparatus, which can therefore perform the subsequent transactions even with different cards.

[0027] In the case of open systems, the structure of the toll station is similar to the one shown in figure 3, with the difference that the stations do not have entry and exit areas but only exit areas 1, 2, 3 for the vehicles traveling in both directions, and the logic steps of each transaction substantially correspond to those described for closed systems and are constituted by an approach step, similar to the one described with reference to figure

5, by a presentation step, identical to the one described with reference to figure 6, and by a validation step which is identical to the one for exit in closed systems described with reference to figure 7. The main differences are: the vehicle encounters the exit system directly; during the presentation step, the entry data are not sent from the vehicle to the ground; the toll is determined only on the basis of the class of the vehicle.

[0028] Conveniently, according to the invention, all the dialogues between the onboard apparatus and the ground-based apparatus provide the possibility of repeating the messages at least one second time in case of error.

[0029] As can be seen from the preceding description, the invention fully achieves the proposed aim and objects. A system has in fact been provided which can perform the dynamic exaction of the toll and in particular is capable of automatically acquiring the data related to entry and exit for the definition of the distance covered, of identifying the physical characteristics of the vehicle and the assignment of the tariff class, of recognizing the user, checking the user's inclusion in allowance lists and recording the transaction, performing the charging, directly or by means of contracted organizations or on banking circuits, in a known manner.

[0030] The system is compatible with both manual and automatic currently installed exaction systems, operates with both open and closed highways and is capable of providing a complete service by virtue of the possibility of informing the user of the presence of enabled gates and of authorizing him to transit.

[0031] The system according to the invention is furthermore extremely reliable by virtue of the detection of the class both in exit and in entry, of the automatic comparison in exit and of the automatic recording of the registration plate for every operation which is found negative by the set of correspondence checks performed, as well as of the validity check of the cards both in entry and in exit.

[0032] The invention thus conceived is susceptible to numerous modifications and variations within the scope of the appended claims.

[0033] In particular details may be replaced with other technically equivalent ones.

[0034] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks, comprising: an onboard apparatus (5-10) mounted onboard a motor vehicle (1) for the reception and transmission of messages, the handling and storage of payment transaction data, the interaction with a user and the sending of messages to said user; a ground-based apparatus (3,4) suitable for ensuring the linkup with the onboard apparatus (5-10) for the exchange of data and messages therewith, for sensing physical parameters related to the vehicle, for classifying the vehicle, for processing the data and parameters supplied by said onboard apparatus (5-10) and sensed by said ground-based apparatus (3,4), and central data processing means connected to said ground-based apparatus for performing the charging of the toll to a user of the system as a function of the class of the vehicle, which user is identified by a code transmitted by said onboard apparatus (5-10) to said ground-based apparatus (2,3), the ground-based apparatus also being suitable for transmitting and receiving messages in connection with said central data processing means, the system being characterized in that it further comprises a personal removable card (2) storing said code identifying said user of said removable card, which is any one of a number of different personal removable cards, each suitable, when inserted in said onboard apparatus (5-10), for activating it and for storing said payment transaction data, said onboard apparatus (5-10) comprises a card reader (9) for reading said code stored in said personal removable card (2), and said messages which are transmitted and received by the ground-based apparatus in connection with the central data processing means comprise data relating to formal checks on the code read from the removable card including blacklist inclusion thereof and/or allowance ranges associated thereto.

2. System according to claim 1, characterized in that said onboard apparatus (5-10) comprises a reception and transmission unit (6) connected to an antenna (5), a control unit (7) provided with a memory (8) of its own, a reader (9) for the card, a display (10) for messages which are generated by said control unit (7) and/or sent by said ground-based apparatus (3,4), and acoustic alarm means (10).

3. System according to claim 1, characterized in that said personal removable card (2) has a microprocessor of its own and an electrically rewritable memory.

4. System according to any of the preceding claims, characterized in that said card (2) has magnetic tracks and the reader (9) of said onboard apparatus is suitable for reading said magnetic tracks of a card inserted therein.

5. System according to any of the preceding claims, with a plurality of exaction stations (19), characterized in that each exaction station (19) comprises at least one first approach area (AREA 1E,AREA 1 U), a second presentation area (AREA 2E,AREA 2U) and a third validation area (AREA 3E,AREA 3U).

6. System according to claim 5, characterized in that said at least one approach area (AREA 1E,AREA 1U) comprises a radioelectric buoy (BOA 1E, BOA 1U) which has its own antenna for broadcasting circular messages.

7. System according to claim 5 or claim 6, characterized in that each of said presentation (AREA 2E, AREA 2U) and validation areas (AREA 3U,AREA 3E) comprises its own radioelectric buoy (BOA 2, BOA 3) provided with an antenna for the exchange of data and messages with the onboard apparatus as well as sensors for sensing the presence and the movements of a vehicle and for its classification.

8. System according to claim 7, characterized in that said sensors comprise a pair of contiguous optical barriers and a presence-sensing coil.

9. System according to any of claims 5 to 8, characterized in that said validation area (AREA 3U,AREA 3U) comprises a TV camera for the acquisition of the registration plate of the vehicle.

10. System according to claim 9 when dependent upon claims 6 and 7, characterized in that said ground-based apparatus (3,4) comprises a lane computer (20) which is associated with said presentation and validation areas and is connected to said radioelectric buoys (BOA 2, BOA 3) of the presentation and validation areas, to said sensors and to said TV camera, said lane computer (20) being connected by means of a local network to a central station computer connected to said radioelectric buoy (BOA E, BOA U) of the approach area.

11. System according to claim 7, characterized in that said radioelectric buoy (BOA 2) of the presentation area (AREA 2E, AREA 2U) comprises a counter for generating cyclic codes which are sent by means of said antenna to said onboard apparatus, and in that said radioelectric buoy (BOA 3) of the validation area (AREA 3E,AREA 3U) comprises a counter for generating a progressive transit number.

12. Process for the automatic exaction of toll for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks, in a system according to any of the preceding claims, comprising an onboard apparatus (5-10) mounted onboard a motor vehicle, a ground-based apparatus (3,4), a personal removable card (2) which is any one of a number of personal removable cards, each readable by the onboard apparatus (5-10) and storing a code identifying a user of the system, and central data processing means, the process comprising a step of approach during which said ground-based apparatus transmits a signal to the onboard apparatus to activate it, a step of presentation during which the onboard apparatus transmits the code stored in said card to the ground-based apparatus, the ground-based apparatus senses physical parameters related to the vehicle and classifies the vehicle, the ground-based apparatus transmits said code of the card to the central data processing means and the central data processing means performs formal checks on the code of the card including blacklist inclusion thereof and/or allowance ranges associated thereto, and a step of validation during which the central data processing means performs the charging of the toll to the user identified by said code of the card as a function of the class of the vehicle, the ground-based apparatus authorises the vehicle to transit or acquires the registration plate of the vehicle and the ground-based apparatus transmits payment transaction data to the onboard apparatus which stores these data in said personal removable card.

13. Process according to claim 12, characterized in that said approach step comprises the transmission of an activity signal by the ground-based apparatus, the activation of the onboard apparatus upon the reception of said activity signal, the execution of auto-diagnostics checks and of card functionality checks by said onboard apparatus and the indication, on said onboard apparatus, of messages which are related to the result of said checks and/or are sent by the ground-based apparatus.

14. Process according to claim 12 or claim 13, characterized in that said step of presentation in entry in a closed system or in an open system comprises the sensing of physical parameters related to the motor vehicle by the ground-based apparatus, the broadcasting of a cyclic code by the ground-based apparatus, the storage of a locking marker on the card, the storage of said code of the card and of the cyclic code in the onboard apparatus, the transmission of the code of the card and of the cyclic code to the ground-based apparatus and to the central data processing means, the execution by the central data processing means of said formal checks on the card and the classification of the vehicle.

15. Process according to claim 14, characterized in that said validation step in entry to a highway system of the closed type comprises the sensing of the vehicle by the ground-based apparatus, the transmission

to the ground-based apparatus of the cyclic code stored by the onboard apparatus during the entry presentation step and of said code of the card, the execution of formal checks on these data, the transmission by the ground-based apparatus of entry data related to the highway entry to the onboard apparatus, the transmission to the ground-based apparatus of the confirmation of reception on the part of the onboard apparatus and possibly the acquisition of the registration plate in case of detection of anomalies in the transit or in the transmissions between the ground-based apparatus and the onboard apparatus.

16. Process according to claim 15, characterized in that said presentation step in exit of a closed highway system comprises the sensing of a motor vehicle by the ground-based apparatus, the broadcasting of a cyclic code by the ground-based apparatus, the storage of a locking marker on the card, the transmission by the onboard apparatus of the code of the card, of the cyclic code and of the previously stored entry data to the ground-based apparatus and to the central data processing means, and the execution by the central data processing means of formal checks on the code of the card and on the received data and the calculation of the toll.

17. Process according to any of claims 14 to 16, characterized in that said validation step in exit of a highway system of the closed type or in a highway system of the open type comprises the sensing of the vehicle by the ground-based apparatus, the transmission of the cyclic code stored by the onboard apparatus during the exit presentation step and of the code of the card to the ground-based apparatus, the execution of formal checks on these data, the transmission of data related to the exit from the highway and to the payment of the toll to the onboard apparatus, the transmission of confirmation of reception on the part of the onboard apparatus and possibly the acquisition of the registration plate of the vehicle in case of the detection of anomalies in the transit or in the transmissions between the ground-based apparatus and the onboard apparatus.

18. Process according to any of claims 12 to 17, characterized in that it comprises the sending of messages concerning traffic and road conditions from the ground-based apparatus to the onboard apparatus.

Patentansprüche

1. Automatisches Zollabgabesystem fllr städtische und außerstädtische Autobahnen, für Brücken und Tunnel und für Zugänge zu städtischen Gebieten und Parkplätzen, umfassend:

ein Bordgerät (5-10), welches an Bord eines Motorfahrzeuges (1) montiert ist zum Empfang und zur Übertragung von Meldungen, zum Verarbeiten und Speichern von Zahlungstransaktionsdaten, für die Wechselwirkung mit einem Benutzer und das Absenden von Meldungen an den Benutzer;
ein Bodengerät (3, 4), das geeignet ist, die Verbindung mit dem Bordgerät (5-10) zum Austausch von Daten und Meldungen mit diesem herzustellen, physikalische Parameter, die mit dem Fahrzeug zum Klassifizieren des Fahrzeuges zusammenhängen, zu übertragen, die Daten und Parameter, die von dem Bordgerät (5-10) übertragen und von dem Bordgerät (3, 4) erfaßt werden, zu verarbeiten und
eine zentrale Datenverarbeitungseinrichtung, die mit dem Bodengerät verbunden ist, um die Belastung des Zolls an den Benutzer des Systems als eine Funktion der Klasse des Fahrzeuges durchzuführen, wobei der Benutzer durch einen Code identifiziert wird, der von dem Bordgerät (5-10) an das Bodengerät (3, 4) übertragen wird, wobei das Bodengerät ebenfalls geeignet ist, Meldungen in Verbindung mit der zentralen Datenverarbeitungseinrichtung zu übertragen und zu empfangen, wobei das System **dadurch gekennzeichnet ist, daß**
es ferner eine persönliche, entnehmbare Karte (2) aufweist, die den Code speichert, der den Benutzer identifiziert, der entnehmbaren Karte, die eine beliebige aus einer Anzahl von verschiedenen persönlichen, entnehmbaren Karten ist, wobei jede geeignet ist, wenn sie in das Bordgerät (5-10) eingeführt ist, dieses zu aktivieren und die Zahlungstransaktionsdaten zu speichern, wobei das Bordgerät (5-10) einen Kartenleser (9) aufweist, um den in der persönlichen, entnehmbaren Karte (2) gespeicherten Code zu lesen, und daß die Meldungen, die von dem Bodengerät (3, 4) in Verbindung mit der zentralen Datenverarbeitungseinrichtung übertragen und empfangen werden, Daten umfassen, die einer formalen Überprüfung des Codes, der von der entnehmbaren Karte gelesen worden ist, einschließlich des Vorhandenseins in einer schwarzen Liste und/oder von ihr zugeordneten Zulässigkeitsbereichen gehört.

2. System nach Anspruch 1, **dadurch gekennzeichnet, daß** das Bordgerät (5-10) eine Empfänger- und Sendereinheit (6), die mit einer Antenne (5) verbunden ist, eine Steuereinheit (7), die mit einem eigenen Speicher (8) versehen ist, einen Leser (9) für die Karte, eine Anzeige (10) für Meldungen, die von der Steuereinheit (7) erzeugt und/oder von dem Bo-

dengerät (3, 4) gesendet werden und eine akustische Alarmeinrichtung (10) umfaßt.

3. System nach Anspruch 1, **dadurch gekennzeichnet, daß** die persönliche, entnehmbare Karte (2) einen eigenen Mikroprozessor und einen elektronisch wieder beschreibbaren Speicher umfaßt.

4. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** die Karte (2) Magnetspuren umfaßt, und daß der Laser (9) des Bordgerätes geeignet ist, die Magnetspuren einer darin eingeführten Karte zu lesen.

5. System nach einem der vorhergehenden Ansprüche mit einer Vielzahl von Abgabestationen (19), **dadurch gekennzeichnet, daß** jede Zollabgabestation (19) wenigstens einen ersten Anfahrbereich (AREA 1E, AREA 1U), einen zweiten Präsentationsbereich (AREA 2E, AREA 2U) und einen dritten Gültigkeitserklärungsbereich (AREA 3E, AREA 3U) aufweist.

6. System nach Anspruch 5, **dadurch gekennzeichnet, daß** der wenigstens eine Anfahrbereich (AREA1E, AREA 1U) eine radioelektrische Boje (BOA 1E, BOA 1U) aufweist, die ihre eigene Antenne zur Übertragung von Rundmeldungen aufweist.

7. System nach Anspruch 5 oder 6, **dadurch gekennzeichnet, daß** der Präsentationsbereich (AREA 2E, AREA 2U) und der Gültigkeitserklärungsbereich (AREA 3U, AREA 3E) ihre eigenen radioelektrischen Bojen (BOA 2, BOA 3) aufweisen, die mit einer Antenne versehen sind, um Daten und Meldungen mit dem Bordgerät auszutauschen, und Sensoren aufweist, um die Anwesenheit und die Bewegungen eines Fahrzeuges abzutasten und es zu klassifizieren.

8. System nach Anspruch 7, **dadurch gekennzeichnet, daß** die Sensoren ein Paar von benachbarten, optischen Barrieren und eine die Anwesenheit abtastende Spule aufweisen.

9. System nach einem der Ansprüche 5 bis 8, **dadurch gekennzeichnet, daß** der Gültigkeitserklärungsbereich (AREA 2U, AREA 3U) eine Fernsehkamera aufweist, um das Nummernschild des Fahrzeuges aufzunehmen.

10. System nach Anspruch 9, wenn dieser abhängig ist von den Ansprüchen 6 und 7, **dadurch gekennzeichnet, daß** das Bodengerät (3, 4) einen Bahncomputer (20) aufweist, der den Präsentations- und Gültigkeitserklärungsbereichen zugeordnet ist und rnit den radioelektrischen Bojen (BOA 2, BOA 3) der Präsentations- und Gültigkeitserklärungsbereiche, rnit den Sensoren und der Fernsehkamera verbunden ist, wobei der Bahncomputer (20) über ein lokales Netzwerk rnit einem zentralen Stationscomputer verbunden ist, der mit der radioelektrischen Boje (BOA E, BOA U) des Anfahrbereiches verbunden ist.

11. System nach Anspruch 7, **dadurch gekennzeichnet, daß** die radioelektrische Boje (BOA 2) des Präsentationsbereiches (AREA 2E, AREA 2U) einen Zähler zur Erzeugung von zyklischen Codes umfaßt, die über die Antenne an das Bordgerät gesendet werden, und daß die radioelektrische Boje (BOA 3) des Gültigkeitserklärungsbereiches (AREA 3E, AREA 3U) einen Zähler zur Erzeugung einer progressiven Übergangszahl aufweist.

12. Verfahren zur automatischen Zollabgabe für städtische und außerstädtische Autobahnen, für Brücken und Tunnel und für Zugänge zu städtischen Gebieten und Parkplätzen bei einem System nach einem der vorhergehenden Ansprüche, welche ein Bordgerät (5-10), das an Bord eines Motorfahrzeuges montiert ist, ein Bodengerät (3, 4), eine persönliche, entnehmbare Karte (2), die eine beliebige aus einer Anzahl von verschiedenen persönlichen, entnehmbaren Karten ist, wobei jede von dem Bordgerät (5-10) lesbar ist und einen Code speichert, der den Benutzer des Systems identifiziert, und eine zentrale Datenverarbeitungseinrichtung aufweist, wobei das Verfahren aufweist:

einen Schritt des Anfahrens, währenddessen das Bodengerät ein Signal an das Bordgerät überträgt, um es zu aktivieren, einen Schritt der Präsentation, währenddessen das Bordgerät den in der Karte gespeicherten Code an das Bodengerät überträgt, wobei das Bodengerät physikalische Parameter, die mit dem Fahrzeug zusammenhängen, abtastet und das Fahrzeug klassifiziert, das Bodengerät den Code der Karte an die zentrale Datenverarbeitungseinrichtung überträgt, und die zentrale Datenverarbeitungseinrichtung eine formale Überprüfung des Codes der Karte einschließlich des Vorhandenseins auf einer schwarzen Liste und/oder dieser zugeordneten Zulässigkeitsbereiche durchführt und einen Schritt der Gültigkeitserklärung, währenddessen die zentrale Datenverarbeitungseinrichtung die Berechnung des Zolls an den durch den Code der Karte identifizierten Benutzer als eine Funktion der Klasse des Fahrzeuges durchführt, wobei das Bodengerät das Fahrzeug autorisiert, durchzufahren, oder das Nummernschild des Fahrzeuges erfaßt, und das Bodengerät die Zahlungstransaktionsdaten an das Bordgerät überträgt, welches diese Daten in der persönlichen, entnehmbaren Karte speichert.

13. Verfahren nach Anspruch 12, **dadurch gekenn-**

zeichnet, daß der Anfahrschritt die Übertragung eines Aktivitätssignals von dem Bodengerät umfaßt, wobei das Bordgerät beim Empfang des Aktivitätssignals aktiviert wird, die Autodiagnoseüberprüfung und Datenfunktionsüberprüfung von dem Bordgerät ausführt und die Anzeigen an dem Bordgerät von Meldungen, die mit dem Resultat der Überprüfungen in Zusammenhang stehen und/oder von dem Bodengerät gesendet werden.

14. Verfahren nach Anspruch 12 oder 13, **dadurch gekennzeichnet, daß** der Präsentationsschritt beim Eintritt in ein geschlossenes oder offenes System das Erfassen von physikalischen Parametern, die mit dem Motor des Fahrzeugs zusammenhängen, durch das Bodengerät, das Übertragen eines zyklischen Codes von dem Bodengerät, die Speicherung einer Sperrmarkierung auf der Karte, das Speichern des Codes der Karte und des zyklischen Codes in dem Bordgerät, die Übertragung des Codes der Karte und des zyklischen Codes in dem Bordgerät, die Übertragung des Codes der Karte und des zyklischen Codes an das Bodengerät und die zentrale Datenverarbeitungseinrichtung, die Durchführung der formalen Überprüfungen der Karte durch die zentrale Datenverarbeitungseinrichtung und die Klassifikation des Fahrzeuges umfaßt.

15. Verfahren nach Anspruch 14, **dadurch gekennzeichnet, daß** der Gültigkeitserklärungsschritt eintritt in ein Autobahnsystem des geschlossenen Typs, die Erfassung des Fahrzeuges durch das Bodengerät, die Übertragung des zyklischen Codes, der von dem Bordgerät während dem Eintreten in den Präsentationsschritt gespeichert wurde und des Codes der Karte an das Bodengerät, die Durchführung von formalen Überprüfungen dieser Daten, die Übertragung der Eintrittsdaten, die mit der Einfahrt der Autobahn in Zusammenhang stehen, an das Bordgerät, die Übertragung der Empfangsbestätigung seitens des Bordgerätes an das Bodengerät und die Möglichkeit der Erfassung des Nummernschildes im Fall der Detektion von Unregelmäßigkeiten in dem Übergang oder dem Übertragenen zwischen dem Bodengerät und dem Bordgerät umfaßt.

16. Verfahren nach Anspruch 15, **dadurch gekennzeichnet, daß** der Präsentationsschritt in einer Ausfahrt eines geschlossenen Autobahnsystems das Erfassen eines Motorfahrzeuges durch ein Bodengerät, das Übertragen eines zyklischen Codes von dem Bordgerät, die Speicherung einer Sperrmarkierung auf der Karte, die Übertragung des Codes der Karte von dem Bordgerät, dessen zyklischen Codes und den vorher gespeicherten Einfahrtsdaten an das Bodengerät und die zentrale Datenverarbeitungseinrichtung und die Durchführung von formalen Überprüfungen durch die zentrale Datenverarbeitungseinrichtung in Bezug auf den Code der Karte und die empfangenen Daten und die Berechnung des Zolls umfaßt.

17. Verfahren nach einem der Ansprüche 14 bis 16, **dadurch gekennzeichnet, daß** der Gültigkeitserklärungsschritt bei der Ausfahrt eines Autobahnsystems des geschlossenen Typs oder eines Autobahnsystems des offenen Typs die Erfassung des Kraftfahrzeuges durch das Bodengerät, die Übertragung des zyklischen Codes, der von dem Bordgerät während des Ausfahrens-Präsentationsschrittes gespeichert worden ist, und des Codes der Karte an das Bodengerät, die Durchführung von formalen Überprüfungen auf diese Daten, die Übertragung der Daten, die mit der Ausfahrt der Autobahn in Verbindung stehen, und die Zahlung des Zolls an das Bordgerät, die Übertragung von einer Empfangsbestätigung von seiten des Bordgerätes und die Möglichkeit der Aquisition des Nummernschildes des Fahrzeuges in dem Fall umfaßt, daß Anomalitäten in dem Übergang oder in den Übertragungen zwischen dem Bodengerät und dem Bordgerät auftreten.

18. Verfahren nach einem der Ansprüche 12 bis 17, **dadurch gekennzeichnet, daß** es die Übertragung von Meldungen, die Verkehrs- und Straßenbedingungen betreffen, von dem Bodengerät zu dem Bordgerät umfaßt.

Revendications

1. Système automatique de paiement de la taxe de péage pour autoroutes urbaines et interurbaines, pour des passages de ponts et de tunnels et pour des accès à des zones urbaines et à des parkings, comprenant: un dispositif embarqué (5-10) installé à bord d'un véhicule automobile (1) pour la réception et l'émission de messages, le traitement et la mémorisation de données de transaction de paiement, l'interaction avec un utilisateur et l'envoi de messages audit utilisateur; un dispositif (3,4) installé au sol, convenant pour garantir la liaison avec le dispositif embarqué (5-10) pour l'échange de données et de messages avec ce dernier, pour la détection de paramètres physiques associés au véhicule pour classifier le véhicule, pour le traitement des données et paramètres délivrés par ledit dispositif embarqué (5-10) et détectés par ledit dispositif (3,4) installé au sol, et des moyens centraux de traitement de données reliés audit dispositif installé au sol pour imputer la taxe de péage à un utilisateur du système, en fonction de la classe du véhicule, lequel utilisateur est identifié par un code émis par ledit dispositif embarqué (5-10) au dispositif (2,3)

installé au sol, le dispositif installé au sol étant également approprié pour émettre et recevoir des messages en liaison avec lesdits moyens centraux de traitement de données, le système étant caractérisé en ce qu'il comporte en outre une carte personnelle amovible (2) mémorisant ledit code identifiant ledit utilisateur de ladite carte amovible qui est l'une quelconque parmi un certain nombre de cartes personnelles amovibles différentes, chaque carte convenant, lorsqu'elle est insérée dans ledit dispositif embarqué (5-10) pour activer ce dernier et pour mémoriser lesdites données de transaction de paiement, ledit dispositif embarqué (5-10) comprend un lecteur de carte (9) pour lire ledit code mémorisé sur ladite carte personnelle amovible (2) et lesdits messages, qui sont émis et reçus par le dispositif installé au sol en liaison avec les moyens centraux de traitement de données. comprennent des données concernant des contrôles formels du code lu à partir de la carte amovible y compris l'insertion de la carte clans une liste noire et/ou des gammes de tolérance qui lui sont associés.

2. Système selon la revendication 1, caractérisé en ce que ledit dispositif embarqué (5-10) comprend une unité de réception et d'émission (6) connectée à une antenne (5), une unité de commande (7) pourvue de sa propre mémoire (8), un lecteur (9) pour la carte, un dispositif (10) d'affichage de messages qui sont produits par ladite unité de commande (7) et/ou envoyés par ledit dispositif (3,4) installé au sol, et des moyens d'alarme acoustique (10).

3. Système selon la revendication 1, caractérisé en ce que ladite carte personnelle amovible (2) comporte son propre microprocesseur et une mémoire réenregistrable électriquement.

4. Système selon l'une quelconque des revendications précédentes, caractérisé en ce que ladite carte (2) comporte des pistes magnétiques et que le lecteur (9) dudit dispositif embarqué convient pour la lecture desdites pistes magnétiques d'une carte insérée dans ce lecteur.

5. Système selon l'une quelconque des revendications précédentes, comprenant une pluralité de postes de transaction (19), caractérisé en ce que chaque poste de transaction (19) comprend au moins une première zone d'approche (ZONE 1E, ZONE 1U), une seconde zone de présentation (ZONE 2E, ZONE 2U) et une troisième zone de validation (ZONE 3E, ZONE 3U).

6. Système selon la revendication 5, caractérisé en ce que ladite ou lesdites zones d'approche (ZONE 1E, ZONE 1U) comprend une balise radioélectrique (BOA 1E, BOA 1U) qui comporte sa propre antenne pour diffuser des messages circulaires.

7. Système selon la revendication 5 ou 6, caractérisé en ce que chacune desdites zones de présentation (ZONE 2E, ZONE 2U) et desdites zones de validation (ZONE 3U, ZONE 3E) comprend sa propre balise radioélectrique (BOA 2, BOA 3) pourvue d'une antenne pour l'échange de données et de messages avec le dispositif embarqué, ainsi que des capteurs pour la détection de la présence et des déplacements d'un véhicule et pour sa classification.

8. Système selon la revendication 7, caractérisé en ce que lesdits capteurs comprennent un couple de barrières optiques contiguës et une bobine de détection de présence.

9. Système selon l'une quelconque des revendications 5 à 8, caractérisé, en ce que ladite zone de validation (ZONE 3E, ZONE 3U) comprend une caméra de télévision pour l'acquisition du numéro minéralogique du véhicule.

10. Système selon la revendication 9, considérée comme indépendante des revendications 6 et 7, caractérisé en ce que ledit dispositif (3,4) situé au sol comprend un ordinateur de voie (20), qui est associé auxdites zones de présentation et de validation et est connecté auxdites balises radioélectriques (BOA 2, BOA 3) des zones de présentation et de validation, auxdits capteurs et à ladite caméra de télévision, ledit ordinateur de voie (20) étant connecté au moyen d'un réseau local à un ordinateur du poste central, connecté à ladite balise radioélectrique (BOA E, BOA U) de la zone d'approche.

11. Système selon la revendication 7, caractérisé en ce que ladite balise radioélectrique (BOA 2) de la zone de présentation (ZONE 2E, ZONE 2U) comprend un compteur pour produire des codes cycliques qui sont envoyés au moyen de ladite antenne audit dispositif embarqué, et en ce que ladite balise radioélectrique (BOA 3) de la zone de validation (ZONE 3E, ZONE 3U) comprend un compteur pour produire un nombre progressif de passages.

12. Procédé pour la transaction automatique de paiement à un péage pour des autoroutes urbaines et inter-urbaines, pour des passages de ponts et de tunnels et pour des accès à des zones urbaines et à des parkings, dans un système selon l'une quelconque des revendications précédentes, comprenant un dispositif embarqué (5-10) monté à bord d'un véhicule automobile, un dispositif (3,4) installé au sol, une carte personnelle amovible (2) qui est l'une quelconque parmi un certain nombre de cartes personnelles amovibles différentes, chaque carte pouvant être lue par le dispositif embarqué (5-10)

et mémorisant un code identifiant un utilisateur du système, et des moyens centraux de traitement de données, le procédé comprenant une étape d'approche, pendant laquelle

ledit dispositif installé au sol émet un signal au dispositif embarqué pour l'activer, une étape de présentation pendant laquelle le dispositif embarqué émet le code mémorisé dans ladite carte en direction du dispositif installé au sol, le dispositif installé au sol détecte des paramètres physiques associés au véhicule, et classifie le véhicule, le dispositif installé au sol envoie ledit code de la carte aux moyens centraux de traitement de données et les moyens centraux de traitement de données exécutent des contrôles formels du code de la carte y compris l'insertion de la cane dans une liste noire et/ou des gammes de tolérances qui lui sont associées, et une étape de validation dans laquelle les moyens centraux de traitement de données réalisent l'imputation de la taxe de péage à l'utilisateur identifié par ledit code de la carte en fonction de la classe du véhicule, le dispositif installé au sol autorise le véhicule à passer ou enregistre le numéro minéralogique du véhicule et le dispositif installé au sol envoie des données de transaction de paiement au dispositif embarqué, qui mémorise ces données dans ladite carte personnelle amovible.

13. Procédé selon la revendication 12, caractérisé en ce que ladite étape d'approche comprend la transmission d'un signal d'activité par le dispositif installé au sol, l'activation du dispositif embarqué lors de la réception dudit signal d'activité, l'exécution de contrôles d'autodiagnostic et de contrôles de fonctionnalité de la carte par ledit dispositif embarqué et d'indications. dans ledit dispositif embarqué, de messages qui sont associés aux résultats desdits contrôles et/ou sont envoyés par le dispositif installé au sol.

14. Procédé selon la revendication 12 ou 13, caractérisé en ce que ladite étape de présentation à l'entrée dans un système fermé ou dans un système ouvert comprend la détection de paramètres physiques associés au véhicule automobile par le dispositif installé au sol, la diffusion d'un code cyclique par le dispositif installé au sol, la mémorisation d'une marque de blocage sur la carte, la mémorisation dudit code de la carte et du code cyclique dans le dispositif embarqué, la transmission du code de la carte et du code cyclique au dispositif installé au sol et aux moyens centraux de traitement de données, l'exécution, par les moyens centraux de traitement de données, desdits contrôles formels appliqués à ia carte et la classification du véhicule.

15. Procédé selon la revendication 14, caractérisé en ce que ladite étape de validation à l'entrée d'un système d'autoroute du type fermé comprend la détection du véhicule par le dispositif installé au sol, l'envoi, au dispositif installé au sol, du code cyclique mémorisé par le dispositif embarqué, pendant l'étape de présentation d'entrée et dudit code de la carte, l'application de contrôles formels à ces données. la transmission, par le dispositif installé au sol, de données d'entrée associées à l'entrée de l'autoroute, au dispositif embarqué, l'envoi, au dispositif installé au sol, de la confirmation de la réception de la partie du dispositif embarqué et éventuellement de l'acquisition du numéro minéralogique dans le cas de la détection d'anomalies lors du passage ou dans les transmissions entre le dispositif installé au sol et le dispositif embarqué.

16. Procédé selon la revendication 15, caractérisé en ce que ladite étape de présentation lors de la sortie d'un système d'autoroute fermé comprend la détection d'un véhicule automobile par le dispositif installé au sol, la diffusion d'un code cyclique par le dispositif installé au sol, la mémorisation d'une marque de blocage sur la carte, l'émission, par le dispositif installé au sol, du code de la carte, du code cyclique et des données d'entrée mémorisées antéricurcmcnt au dispositif installé au sol et aux moyens centraux de traitement de données, et l'exécution, par les moyens centraux de traitement de données, de contrôles formels appliqués au code de la carte et aux données reçues et le calcul de la taxe de péage.

17. Procédé selon l'une quelconque des revendications 14 à 16, caractérisé en ce que ladite étape de validation à la sortie d'un système d'autoroute du type fermé ou dans un système d'autoroute du type ouvert

comprend la détection du véhicule par le dispositif installé au sol, l'émission du code cyclique mémorisé par le dispositif embarqué pendant l'étape de présentation de sortie et du code de la carte au dispositif installé au sol, l'exécution de contrôles formels de ces données, l'émission de données associées à la sortie de l'autoroute et au paiement de la taxe de péage au dispositif embarqué, la transmission de la confirmation de réception dans la partie du dispositif embarqué et éventuellement de l'acquisition du numéro minéralogique du véhicule dans le cas de la détection d'anomalies lors du passage ou dans les transmissions entre le dispositif installé au sol et le dispositif embarqué.

18. Procédé selon l'une quelconque des revendications 12 à 17. caractérisé en ce qu'il comprend l'envoi de messages concernant le trafic et les conditions de route du dispositif installé au sol au dispositif embarqué.

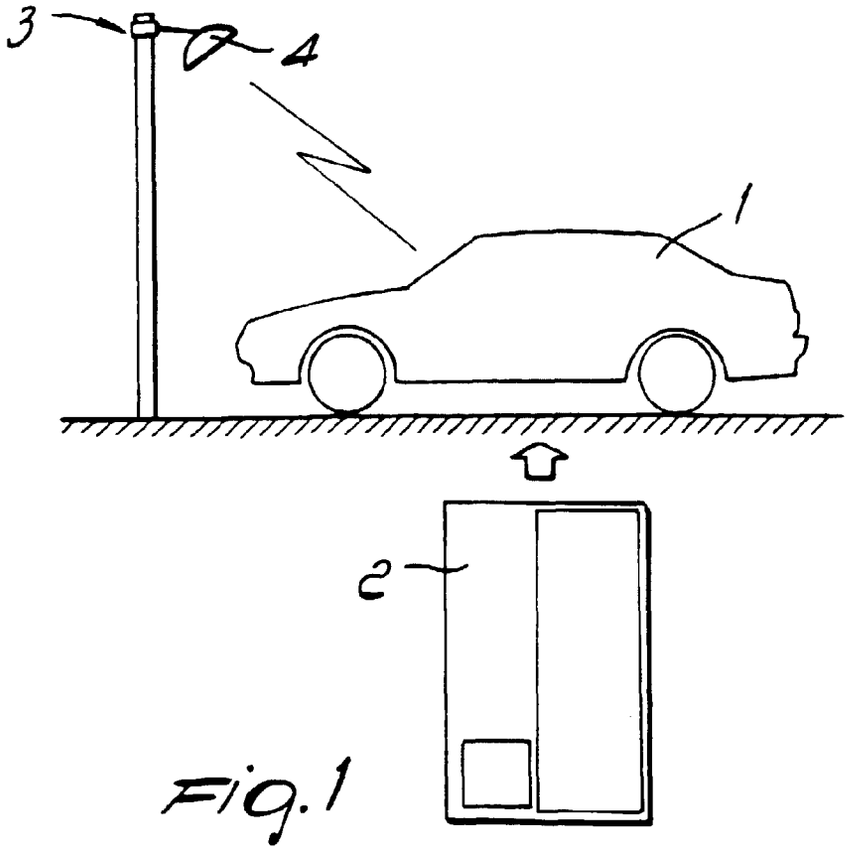
3
4
1
2

Fig.1

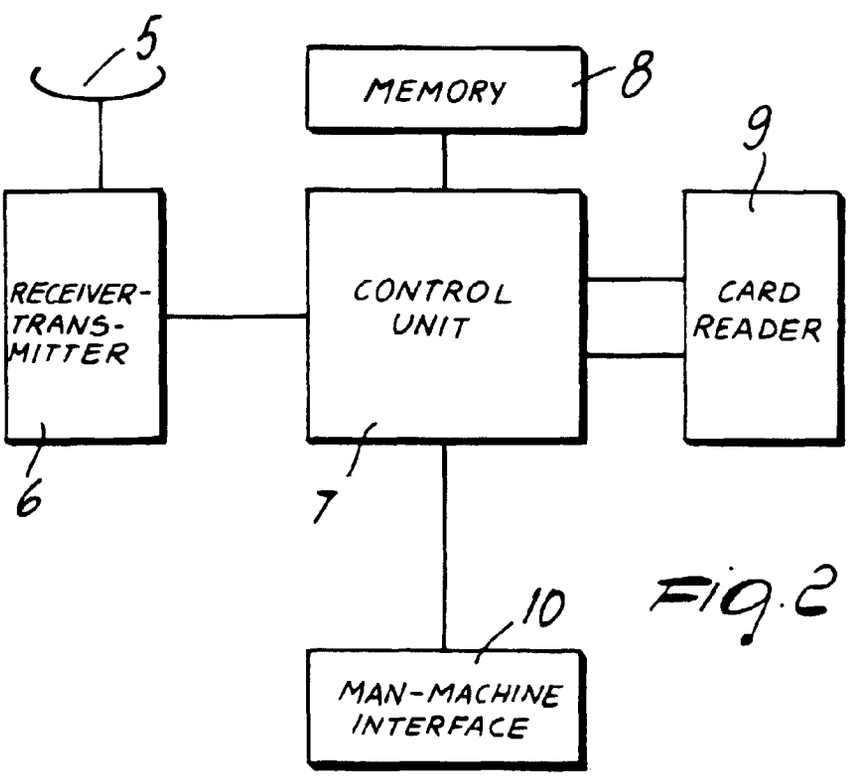
5
MEMORY
8
9
RECEIVER-
TRANS-
MITTER
CONTROL
UNIT
CARD
READER
6
7
10
MAN-MACHINE
INTERFACE

Fig.2

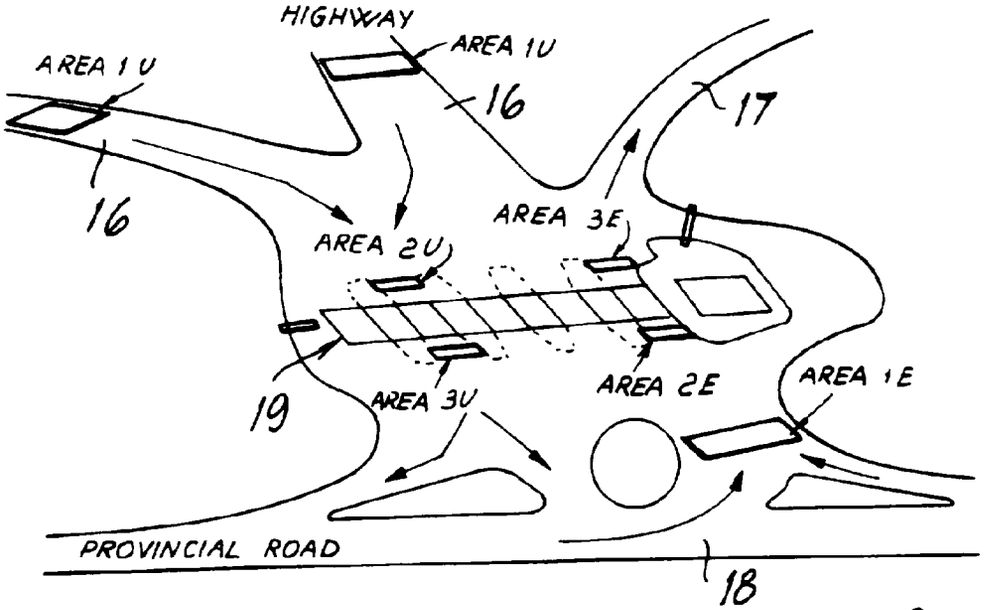
HIGHWAY
AREA 1U
AREA 1U
16
17
16
AREA 3E
AREA 2U
19
AREA 3U
AREA 2E
AREA 1E
PROVINCIAL ROAD
18

Fig.3

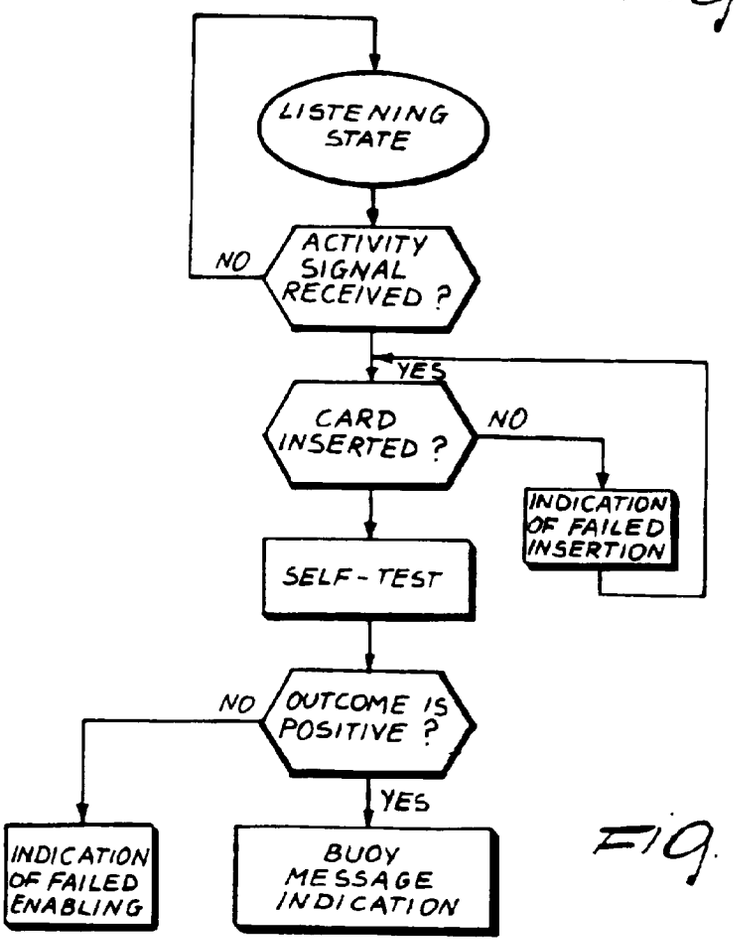
LISTENING STATE
NO
ACTIVITY SIGNAL RECEIVED ?
YES
CARD INSERTED ?
NO
INDICATION OF FAILED INSERTION
SELF-TEST
NO
OUTCOME IS POSITIVE ?
YES
INDICATION OF FAILED ENABLING
BUOY MESSAGE INDICATION

Fig.5

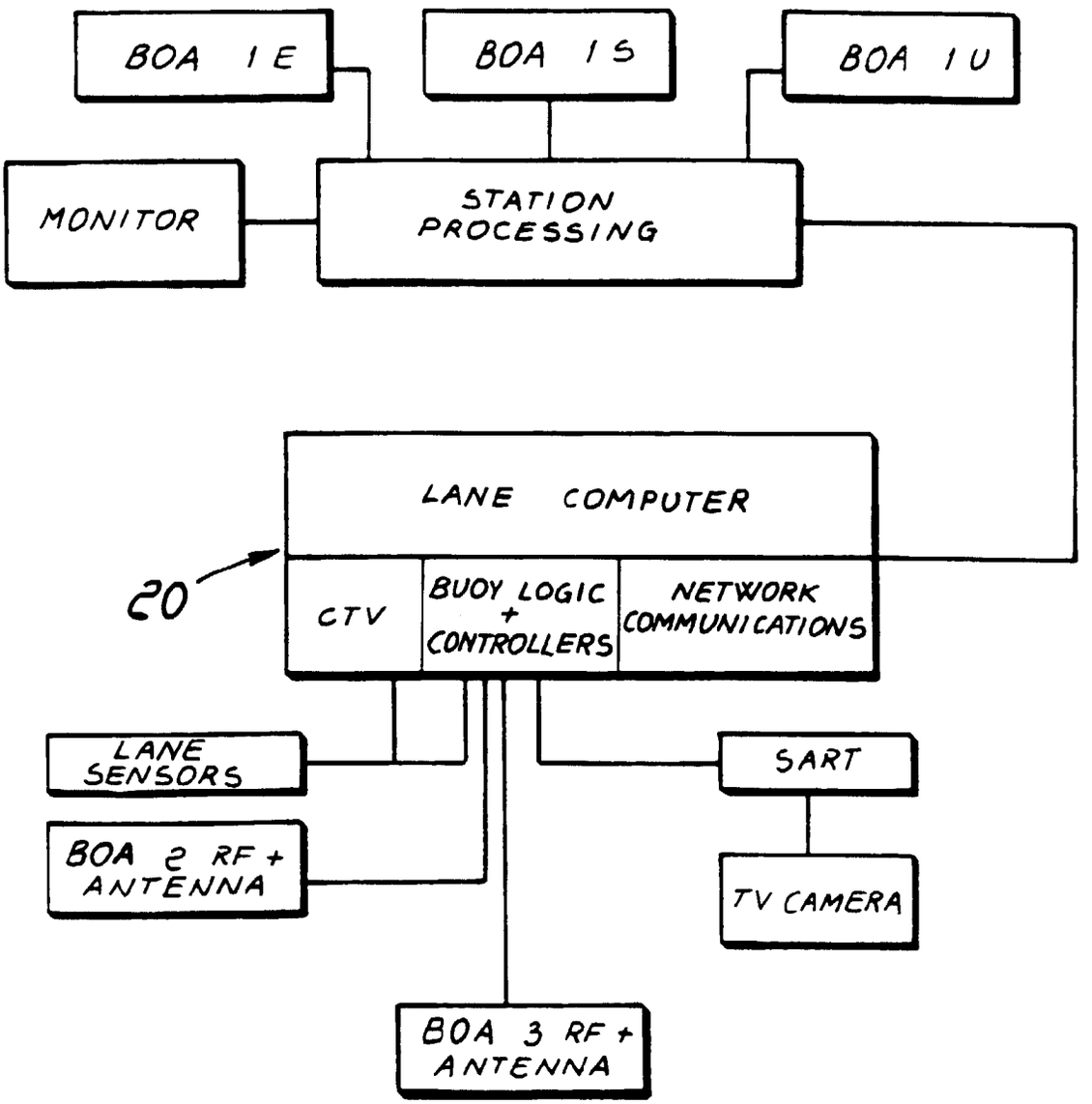
BOA 1E
BOA 1S
BOA 1U
MONITOR
STATION PROCESSING
LANE COMPUTER
20
CTV
BUOY LOGIC + CONTROLLERS
NETWORK COMMUNICATIONS
LANE SENSORS
SART
BOA 2 RF + ANTENNA
TV CAMERA
BOA 3 RF + ANTENNA

Fig. 4

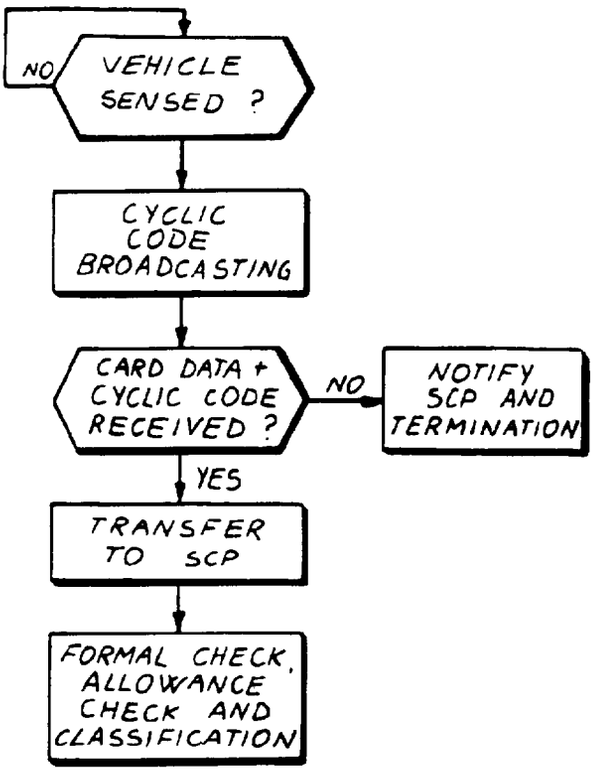
NO
VEHICLE SENSED ?
CYCLIC CODE BROADCASTING
CARD DATA + CYCLIC CODE RECEIVED ?
NO
NOTIFY SCP AND TERMINATION
YES
TRANSFER TO SCP
FORMAL CHECK, ALLOWANCE CHECK AND CLASSIFICATION

Fig. 6

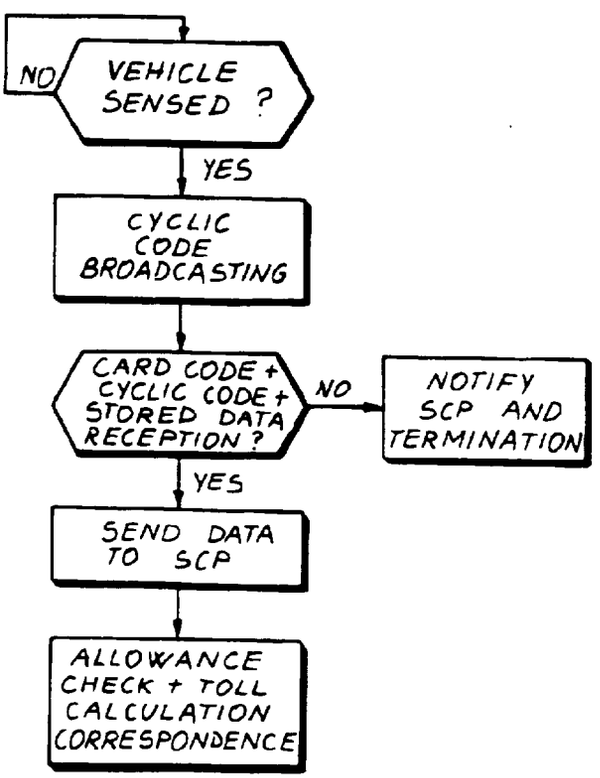
NO
VEHICLE SENSED ?
YES
CYCLIC CODE BROADCASTING
CARD CODE + CYCLIC CODE + STORED DATA RECEPTION ?
NO
NOTIFY SCP AND TERMINATION
YES
SEND DATA TO SCP
ALLOWANCE CHECK + TOLL CALCULATION CORRESPONDENCE

Fig. 8

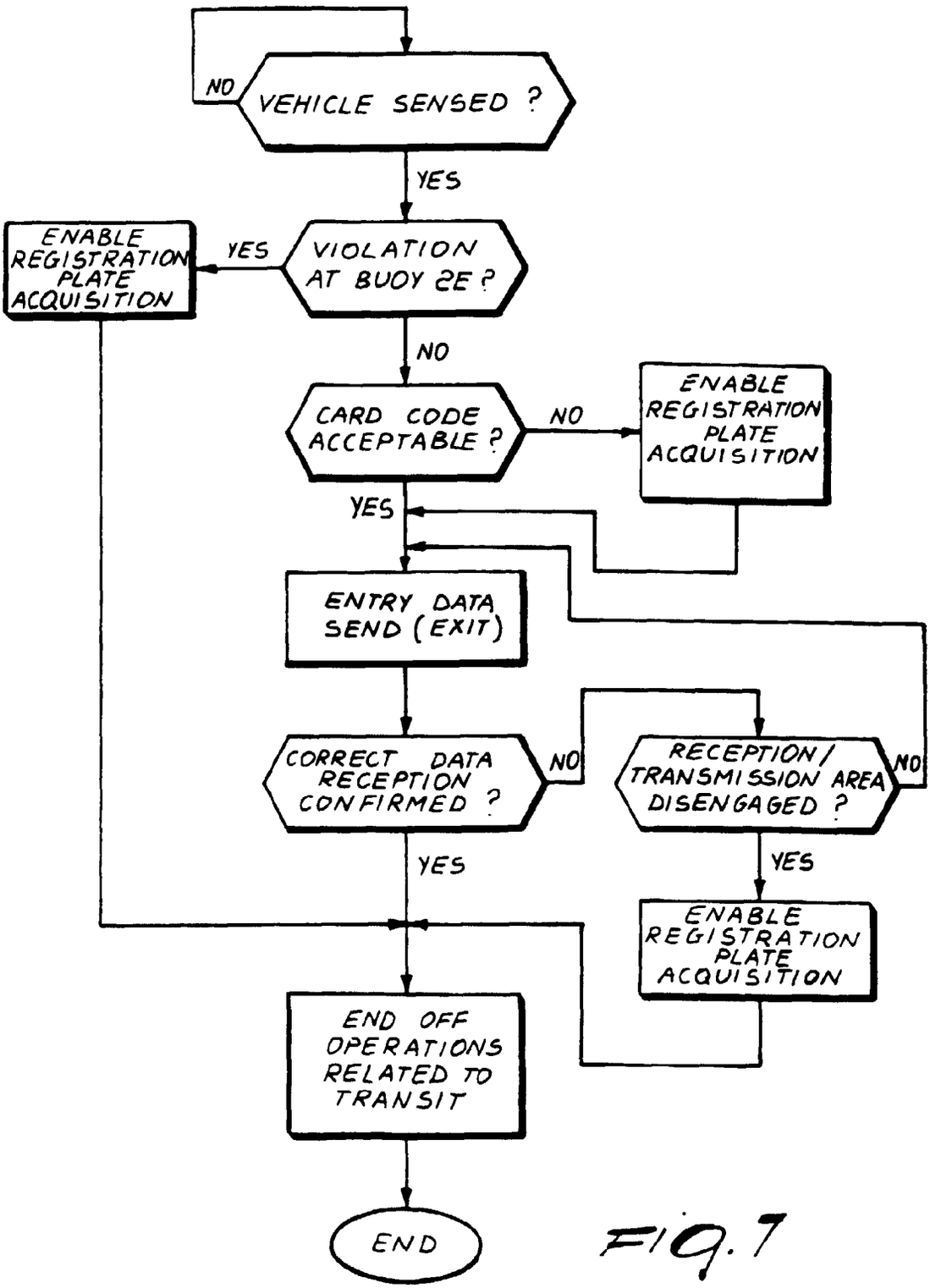
NO
VEHICLE SENSED ?
YES
ENABLE REGISTRATION PLATE ACQUISITION
YES
VIOLATION AT BUOY 2E ?
NO
CARD CODE ACCEPTABLE ?
NO
ENABLE REGISTRATION PLATE ACQUISITION
YES
ENTRY DATA SEND (EXIT)
CORRECT DATA RECEPTION CONFIRMED ?
NO
RECEPTION / TRANSMISSION AREA DISENGAGED ?
NO
YES
YES
ENABLE REGISTRATION PLATE ACQUISITION
END OFF OPERATIONS RELATED TO TRANSIT
END

FIG. 7