United States Patent

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[54] REVENUE CONTROL SYSTEM FOR TOLL ROADS

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[52] **U.S. Cl.** .....**235/61.8 A,** 235/61.1, 235/61.9 R, 235/61.7 B, 235/92 CP, 235/92 TC, 340/31 R, 340/51

[51] **Int. Cl.** **G08g 1/015,** G06k 17/00

[58] **Field of Search**.....235/61.8 A, 61.9 R, 61.1 R, 235/61.6 R, 61.7 R; 340/31 R, 51 R

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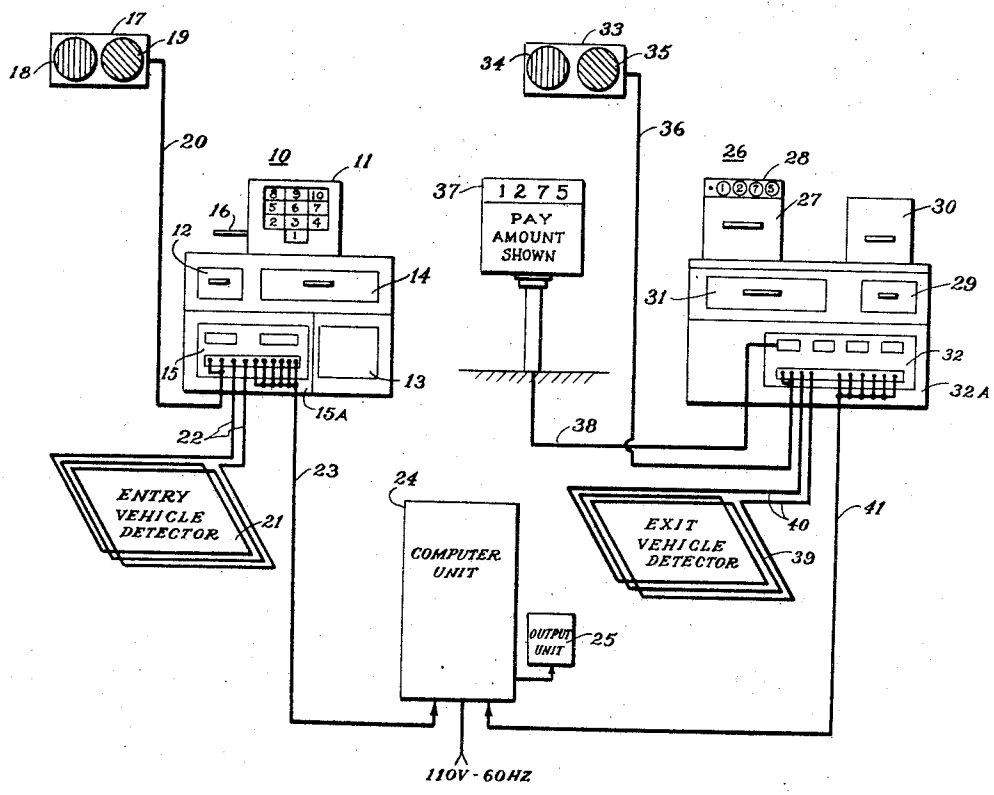
[57] **ABSTRACT**

A system for automatically reconciling the revenues collected, with the vehicle type and distance travelled over a toll road. The system is applicable to a barrier type configuration where the amount collected by the collector is reconciled with the amount automatically determined by the type of vehicle passing the barrier terminal. In the closed loop system information is taken at the entrance to the toll road and is transmitted to a computer. A ticket is encoded at the entering terminal. The tickets are decoded at the exit as well as additional information taken at the exit which is also transmitted to a computer for further reconciliation. The fee is automatically computed and displayed at the exit terminal directly from the tickets. Non-revenue transactions and credit card transactions are accommodated and checked for validity by the computer.

30 Claims, 5 Drawing Figures



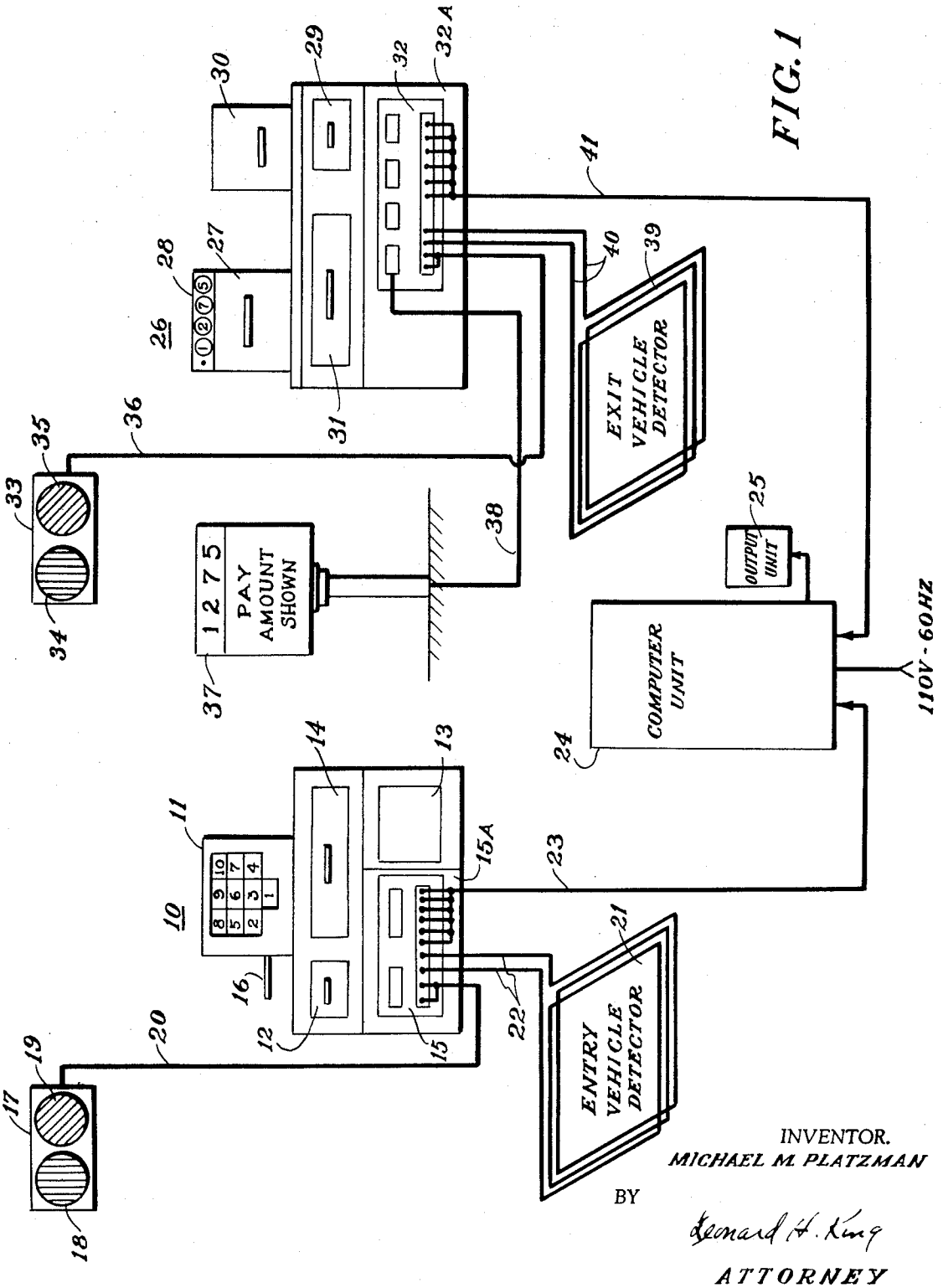


FIG. 1

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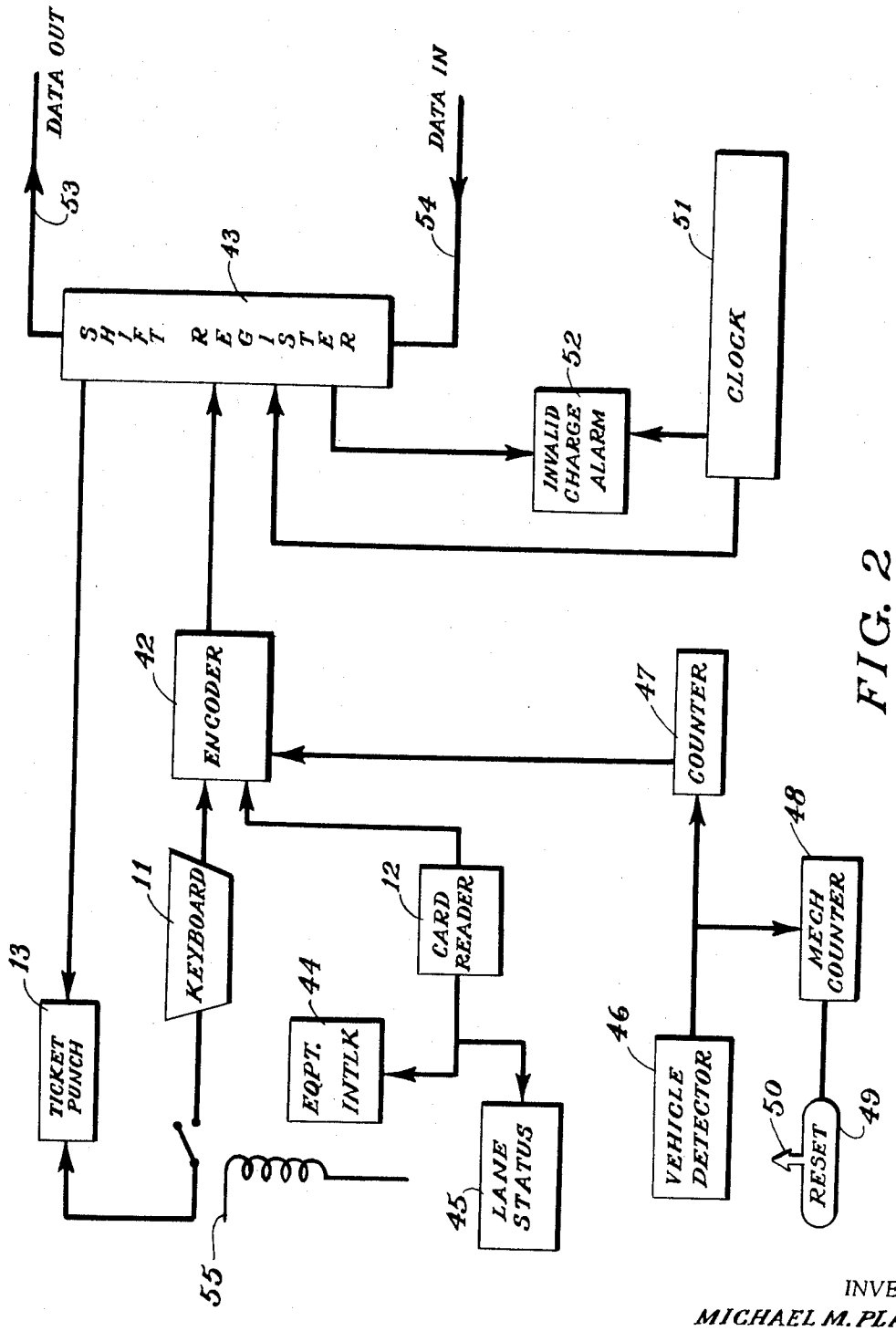

FIG. 2

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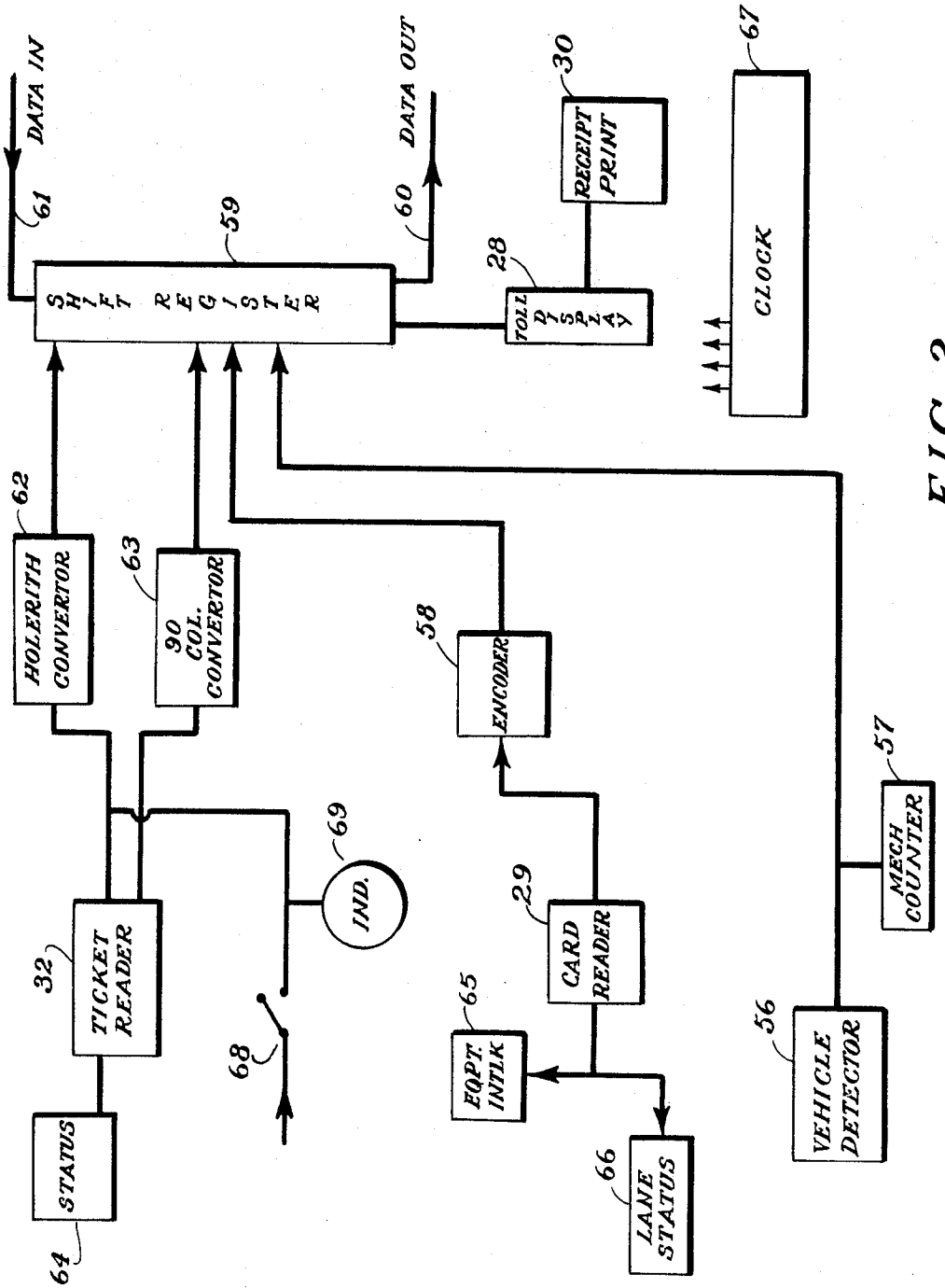

FIG. 3

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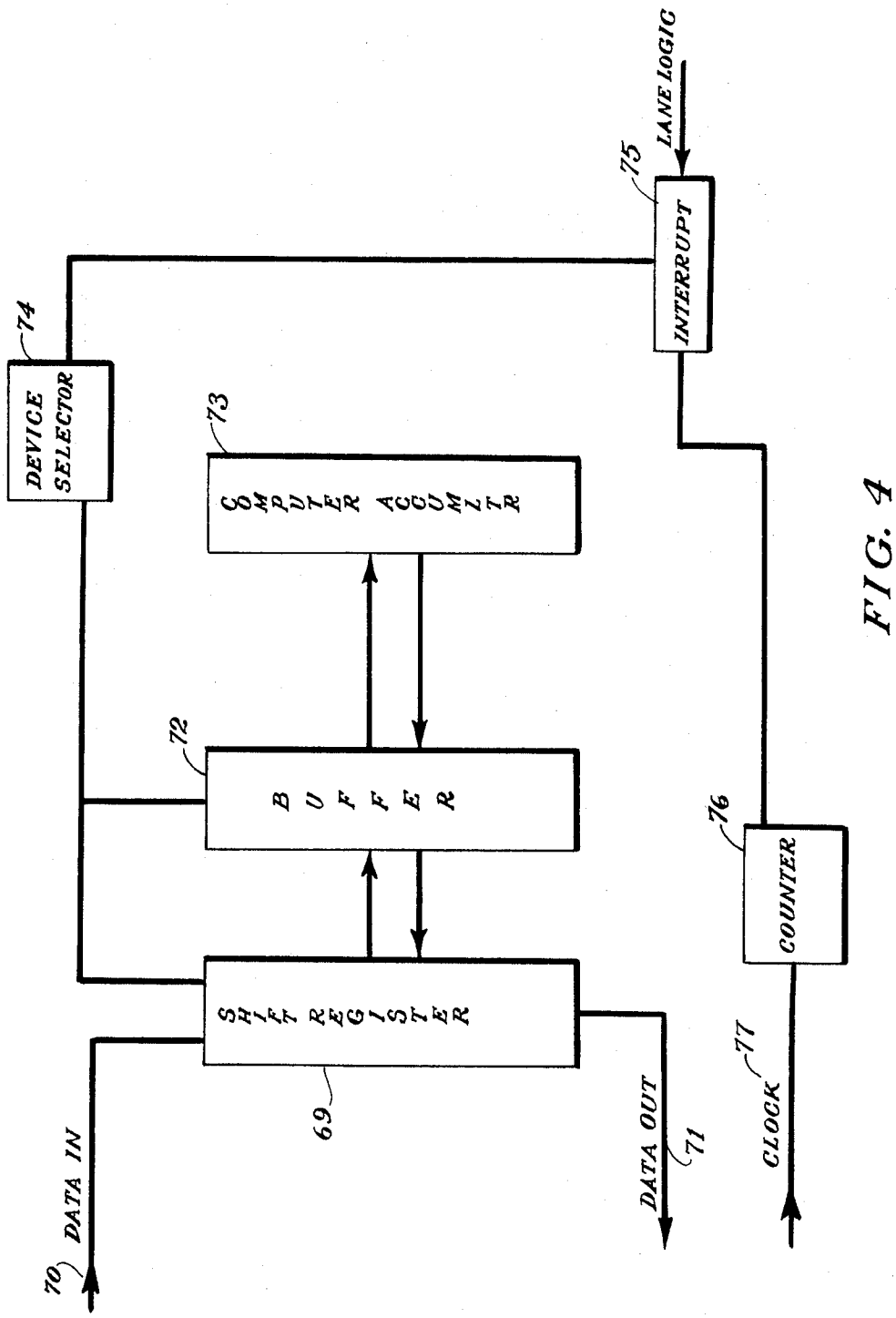

FIG. 4

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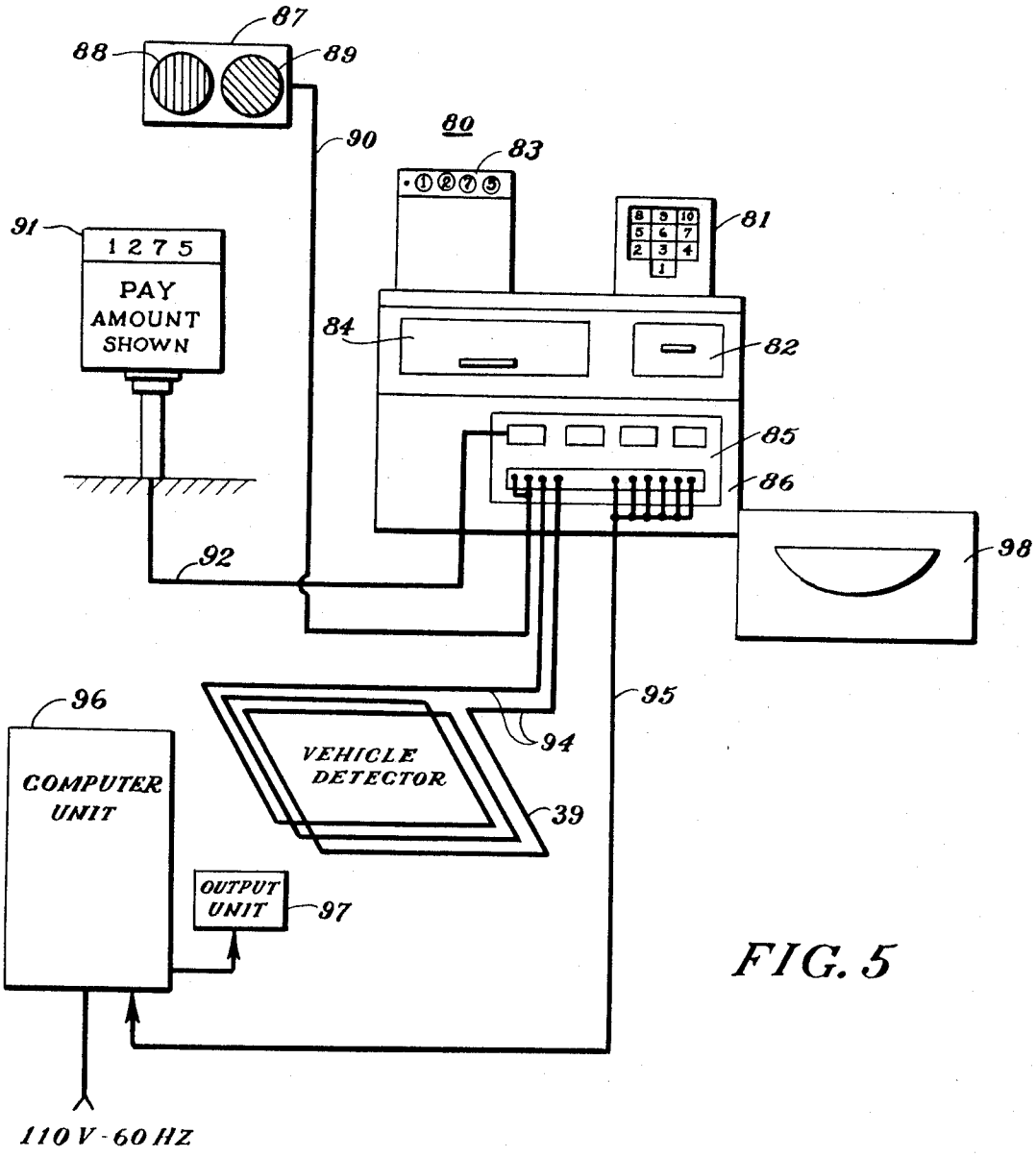

FIG. 5

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REVENUE CONTROL SYSTEM FOR TOLL ROADS

This invention relates to revenue control systems and more specifically to a toll collecting system for use with either a closed loop system or barrier type system whereby revenue reconciliation is automatically accomplished.

BACKGROUND OF THE INVENTION

This system comprises various control means, which, in combination, are designed to overcome the inadequacies of present toll collecting systems utilized on many of today's super highways. Most systems in use today use open-ended systems; that is, no immediate check is made between the amount deposited by the collector and the money that should have been turned in. Any accounting system devised with a closed loop system would be faced with the horrendous task of compiling the information available on millions of cancelled or receipted tickets. Even with the barrier type systems, reconciliation generally requires constant monitoring by supervisory personnel.

Closed loop systems in use today require pre-printed punch cards which are distributed to each vehicle entering the toll road. The pre-printed punch cards contain information relating to the entry point, generally by interchange number; and the time of entry. The pre-printed cards are classified by the type of vehicles using the toll road, generally by the number of axles which the vehicle contains. A distributor at the entry lane selects the proper pre-printed card and presents it to the vehicle driver. At the point of exit, a collector retrieves the punch card and reads the fee either directly from the pre-printed card, or from a table look-up.

The systems presently in use require the cumbersome task of distribution and collection of the pre-printed cards. Furthermore, although there is generally an automatic axle counter provided at points of entry and points of exit, there is little, if any, accurate reconciliation between the total axle count and the fees collected at the interchanges. As a result of this lack of reconciliation, toll collectors acting in collusion with the vehicle driver can select a card for a lesser number of axles then the vehicle actually has. To check on the entrance toll collector, it would be necessary to take all the tickets for a fixed period of time from each exit and manually sort them for a given entrance and a given toll collector's tour of duty. A comparison could then be made between the axle count determined by the treadle counter at the selected entrance, and the axle count by totaling the punch cards.

A limited reconciliation is made in present systems at each exit point since tickets which are collected by the cashier are forwarded to a central data processing center where they are tabulated to determine the amount of money the toll collector is responsible for and the total number of axles that have passed through his lane. However, since certain routine maintenance vehicles are given non-revenue tickets at an entrance and terminate at a maintenance building, this ticket may be passed to and substituted by an unscrupulous toll collector for the ticket of a vehicle that has paid the toll, thereby having the axle count on the treadle match the ticket axle count and the money collected being in the excess of that required. The excess funds are generally not turned in. At the present time, an audit of the funds for which the toll collector is responsible would take a day or more, with the problem of scanning every ticket by machinery and evaluating the cash value of these tickets for the distance traveled.

In the barrier type system, no tickets are issued but instead a fixed fee is paid at each barrier terminal. However, the schedule of fees depends upon the type of vehicle passing the barrier terminal. An unscrupulous collector could record a fee for a smaller type of vehicle while actually collecting a greater amount. Also many non-revenue vehicles could be registered at the terminal while the collector could personally retain the monies collected.

BRIEF DESCRIPTION OF THE INVENTION

Briefly, this invention describes a system having a number of terminals each in communication with a central computer. In the barrier type configuration the terminals contain a keyboard on which to register the fee to be collected and a display on which the amount can be seen by the driver. A vehicle detector counts the number of axles on the vehicle and determines the type of vehicle passing the barrier terminal. The information from the detector and the keyboard is sent to the computer for corroboration.

In the closed loop type configuration there are separate entry lanes and exit lanes, each of which is in communication with a central computer. Tickets are individually perforated or printed at each entry lane bearing the classification of vehicle type or axle number, the interchange number, the entry lane number, the identification number of the collector, the time and day of entry and a consecutive serial number. This information is simultaneously transmitted to a computer. At each exit lane there is provided a ticket reader which automatically reads the ticket retrieved from the vehicle driver and automatically displays the fee on a display device.

Each terminal is opened by a collector inserting a card bearing his individual identification number. At the opening of a terminal, the computer records the time and day of opening, the interchange number, the lane number and tabulates the transactions previously completed prior to the present opening of the terminal. At a close of a tour of duty, the identification card is similarly entered into a card reader and the computer automatically closes the terminal recording information similar to that at the time of the opening. Should a collector neglect to close a lane, a new collector subsequently opening his tour of duty would automatically close out the previous tour before the opening procedure is initiated. Non-revenue cards can be recognized at the terminals and automatically verified by the computer. A receipt, when requested, is automatically printed for the availability of the vehicle driver.

It is, therefore, an object of this invention to provide an improved computer controlled, revenue control system for toll roads.

Another object is to provide a revenue control system for vehicle toll roads having a plurality of terminals each in communication with a central computer providing revenue reconciliation with vehicle type.

A further object is to provide a revenue control system for vehicle toll roads which can be used with

either a barrier type configuration or a closed loop type configuration.

A further object of this invention is to eliminate problems of maintenance and audit control, simplify handling of tickets and reduce ticket data processing at a central office on toll road revenue systems.

A still further object of this invention is to provide a system which improves the supervision of toll collectors at toll plazas in revenue control systems.

Yet another object of this invention is to provide an automatic record of the transactions at points of entry and exit in a closed loop revenue control system which can be automatically transmitted to a central office by radio or wire.

A further object of this invention is to provide a closed loop toll revenue system wherein computer cards are automatically punched at each point of entry.

Yet another object of this invention is to provide a toll revenue system which reconciles the number of vehicles using the toll roads with the total fees collected.

Yet another object of this invention is to provide a toll revenue system which can be used by non-revenue paying vehicles or in conjunction with a credit card system.

A still further object of this invention is to provide a toll revenue system which will provide reliable statistical information on revenues collected at each exit which can then be tabulated and reconciled with the number and type of vehicles using the exits and correlated to their point of entry, without further processing of the tickets.

Yet another object of this invention is to provide an improved revenue control system of the barrier type which can be used with either automatic toll lanes or with collectors.

These and other objects of this invention will become more apparent from the following description of embodiments of this invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a first embodiment of the revenue system in accordance with this invention.

FIG. **2** is a block diagram of the entry lane in accordance with the first embodiment of this invention.

FIG. **3** is a block diagram of an exit lane in accordance with the first embodiment of this invention.

FIG. **4** is a block diagram of the interface control between an entry or exit lane and the computer, in accordance with the first embodiment of this invention.

FIG. **5** is a block diagram of a second embodiment of the revenue system in accordance with this invention.

DESCRIPTION OF THE INVENTION

Referring now to FIG. **1** there is shown the system of this invention used in a closed loop type configuration wherein an entry validator **10** is placed at the entry lane. The validator **10** is a unit containing a keyboard **11**, a card reader **12**, a ticket punch **13** and a storage drawer for unpunched tickets **14**. Electrical connections are made to the unit **10** through the connector terminals on connector board **15**. In a locked electrical compartment **15A** tickets which are punched are ejected at **16**. A lane signal **17** having red light **18** and green light **19** is electrically connected through line **20** to the connector board **15**. A vehicle detection system **21** containing single or multi contact treadle type axle counters or electronic vehicle detection device is electrically connected by line **22** to the connector board **15**. The validator unit **10** is electrically connected by means of line **23** to a central computer unit **24** contained in a room generally placed at the maintenance office at the plaza terminal. The computer unit **24** feeds an output peripheral unit **25** typically shown as a punch tape unit.

The exit lane has an exit validator **26** which is comprised of a ticket reader **27**, a fee display device **28**, a card reader **29**, a receipt printer **30** and a cash drawer **31**. Electrical connections are made to the exit validator **26** by means of connector board **32** in a locked electrical compartment **32A**. Lane signal **33** comprising red light **34** and green light **35** are electrically connected by means of line **36** to the exit validator terminal connector board **32**. A separate fee display unit **37** is electrically connected through line **38** to the terminal connector board **32**. An exit vehicle detector system **39** containing detecting and counting means similar to that of entry detector system **21**, is shown at **39** and electrically connected through line **40** to the terminal connector board **32**. The exit validator **26** is electrically connected by means of line **41** to the computer unit **24** contained at the exit terminal maintenance office.

The operation of the system shown in FIG. **1** will now be described:

Initially a lane is closed and the lane signal **17** indicates the closed lane by means of the red signal light **18**. Upon the beginning of a tour of duty by a collector, the collector inserts his identification card bearing his identification number into the card reader **12**. The identification number contains a predetermined number of digits. In this embodiment, four digits were used for the collector identification number. Upon insertion of the identification card into the card reader **12**, the computer unit **24** records the interchange and lane designation numbers, the collector identification number, the time and day of the opening of the tour of duty and the traffic direction. A signal is sent to the computer programmer to change the lane signal identification to green light **19** indicating the lane is now open. The computer also sends a signal back to the card reader to eject the identification card. The computer also records the totals of the prior transaction count. This assures that there has been no tampering of either the audit tape or the validator terminal from the time that the lane had been previously closed. The information recorded by the computer unit is printed out on the punch tape unit **25**. This information could also be printed on sheets of paper by an output keyboard printer.

After the lane has been opened, it is ready for entering vehicles. When a vehicle enters the lane, the collector sets the keyboard **11** for the proper class of vehicle. Generally, vehicles are classified by the number of axles. For convenience, the keyboard is normally set for a Class 1 vehicle of the general automobile type. For vehicles of other types and those with more axles than regular automobiles, the number must be set on the keyboard. The validator unit will punch the ticket

with the vehicle class as set on the keyboard and also the day and time of entry, the interchange and entry lane numbers and the identification number of the collector.

As the vehicle passes the entry lane, the entry vehicle detector **21** will count the total number of axles passing through the lane, and transmit the information to the computer unit **24**. The vehicle detector **21** contains a plurality of treadle contacts encased in a closed unit which close with the passage of the vehicle. In addition to counting the number of axles, the treadles also determine whether the vehicle is proceeding through the entry lane in a normal manner or whether it is backing up. In the event the vehicle backs out of the lane, the sequence of the closing of treadle contacts will be in a reverse direction and a signal will be sent to the computer unit **24** to subtract the number of axles determined from the total.

A vehicle which is used for maintenance would be provided with a card bearing a specific identification number whose digits differ in number from that of the collector code identification number. In this embodiment, nine digits were used to identify the non-revenue paying vehicles. Similarly, credit cards can be issued to drivers with a similar number of digits. When a non-revenue paying vehicle or credit card vehicle approaches the entry lane, the collector inserts the card into the card reader **12**. The card reader recognizes the number of digits representing a non-revenue identification number and transmits the number to the computer unit **24**. The computer unit checks the number and verifies it as a current valid number. If the number is a valid one, the validator unit **10** will automatically punch a ticket indicating the same information as for a normal cash paying transaction, however, bearing an additional indication representing the non-revenue paying code or a credit charge code. Should the computer recognize the identification number as an invalid number, an alarm will be sounded whereby the collector will be able to apprehend the violator. Should he desire, the collector can then issue a regular cash paying ticket in the normal manner.

At the completion of a tour of duty, the collector again inserts his own identification card into the card reader. The computer will recognize the collector identification number and record that number together with the interchange number, the lane number, the time and the total transactions completed during the collector's tour of duty.

Should a collector neglect to close his lane, when he completes his own tour of duty, at the beginning of the next tour of duty, when the new collector inserts his card the computer will recognize this by the dissimilar collector identification numbers and will first close out the previous totals and then reopen the lane with the new collector number.

The computer tabulates information for each lane at every hour in addition to the opening and closing of the tour of duty. The information tabulated includes the total axles as counted by the vehicle detector system, the total indicated axles as computed from the classifications registered by the entry validator, and any variance between these numbers. It also computes the number of tickets validated by class of vehicle for each particular lane. In addition, the computer can be set to tabulate information on the unauthorized passage of a vehicle through a closed lane. The vehicle detector would sense the passage of such a vehicle and if the lane is closed this could be set to trigger a printout from the computer.

At the exit lane, the lane is opened in a similar manner to that described for the entry lane. The toll collector inserts his identification card into the card reader **29** and the computer records information similar to that recorded at the opening of the entry lane. The lane signal **33** will change from red **34** to green **35**, indicating to motorists that the exit lane is now open.

To process a normal transaction at the exit lane, the collector retrieves from the driver the toll ticket and inserts it into the ticket reader **27**. The ticket reader automatically senses the point of entry and the class of vehicle and transmits this information to the computer unit **24**. The computer, using table look-up methods, computes the toll, which is transmitted back to the exit validator unit and displayed on the fee display unit **37** for the motorist. The ticket is then automatically passed directly into a ticket storage unit. The computer records for each transaction the collector's identification number, the lane and interchange designation number, the exit time and day of the recording, the computed fee, the entry interchange and lane numbers, the entry time and date, and the classification of the vehicle.

Simultaneously, the computer sets the type wheels on receipt printer **30**. The receipt printer contains preprinted paper bearing the exit interchange and lane designation numbers, and under control of the computer, prints the amount of toll, the day, time, entry point and classification of vehicle. The receipt is made available for a driver of the vehicle upon request.

Upon the vehicle leaving the exit lane, the displayed amount on the fee display units **28**, **37** is blanked out and the fee display units are ready for the next vehicle.

To process a non-revenue or credit authorized transaction, the collector inserts the ticket into the ticket reader **27** in a normal manner. The ticket reader senses the information from the ticket and transmits it to the computer. Should it be a non-revenue ticket, the fee display will indicate by a predetermined code that it represents no fee. Should it be a credit transaction, the fee display **28**, **37** will display the amount of the toll which will be charged to the driver's account.

The computer unit will record for the opening and closing of each tour of duty as well as hourly, the lane and interchange designation numbers, the total number of tickets read, the transaction totals for each class of vehicles, the total axles counted by the detectors in the vehicle detector system **39**, the total axles computed from the information on the tickets and any variance between these last two numbers. Any variance will indicate that the amount of revenues collected do not correspond with the total number of classes of vehicles which have passed through the lane, thereby providing an immediate check on the activities of the collector.

The computer unit indicated at **24** can be placed at each interchange whereby the computer will be able to handle the operations of each of the lanes at that particular interchange. The individual computers would then transmit the totals accumulated to a central com-

puting station at the central data processing center. Alternatively, instead of the individual computers located at each interchange, the terminals can be connected directly to communicate with a large computer at the data processing center which would receive the information from each individual entry and exit lane directly. The amounts charged on the credit cards would be transmitted to the central data processing center to a billing department and bills could automatically be sent out to each credit card holder.

Although a particular embodiment of the closed-loop type configuration has been shown and described in FIG. 1, it is understood that variations could be effected without departing from the system approach. For example, the tickets encoded at the entry lane need not be of the punch card type: Other types of encoding schemes could be substituted. For example, magnetic encoding of the tickets could be easily arranged at the entry lane, and the exit lane would be provided with a magnetic reader instead of the punch ticket reader.

The embodiment as described requires the insertion of the collector's identification card to open the lane. The card is then removed, and a second insertion is required to close the lane. However, the system can be arranged such that the card would remain inserted throughout the tour of duty and only removed at the completion of the tour of duty. Other variations could similarly be made to accommodate for particular requirements.

The exit lane can be arranged to work automatically wherein a customer inserts his ticket by himself and the amount to be paid is automatically computed and displayed. A toll collection machine placed adjacent to the terminal and connected thereto will permit passage of the car after the correct amount has been deposited.

Referring to FIG. 2, there is shown the specific equipment and connections required for the entry lane **10**. Items which are the same as in FIG. 1 have like identification numbers. The output signals from keyboard **11** pass through encoder **42** into the shift register **43**. Card reader **12** has one output which is fed through the encoder **42** to the shift register **43** and a second output which controls the equipment interlock device **44**, and the lane status device **45**. Vehicle detector unit **46** feeds automatic counter **47** as well as mechanical counter **48**. The count from automatic counter **47** passes through the encoder **42** into the shift register **43**. A reset mechanism **49** is connected to the mechanical counter **48** as well as to the entire entry lane system through line **50**, as will hereinafter be explained. A clock **51** provides signals to the shift register **43** as well as to the alarm **52**. The data from the shift register **43** goes to the computer unit through the data output **53**. Data from the computer unit comes in to the entry lane system through the data input **54** into the shift register **43**. The information passing through the shift register **43** controls the ticket punch **13** as well as the alarm **52**. A manual switch interlock **55** also controls the ticket punch **13**.

At the beginning of a tour of duty, the collector inserts his identification card into card reader **12**, which sends signals through the encoder **42** and shift register **43** into the computer unit. The insertion of the card will also enable the lane status **45** to indicate it is now open and will enable the equipment interlock **44** to open the lane equipment.

When a vehicle enters the lane, the vehicle detector **46** sends signals to the automatic counter **47** which is transmitted through the encoder **42** and shift register **43** to the computer. The mechanical counter **48** will also directly count the number of axles. The collector will enter the classification of the vehicle on keyboard **11**. This information is passed into the computer through the encoder **42** and shift register **43**. The computer will then return signals to the unit through shift register **43** to ticket punch **13** which will punch the ticket for the particular vehicle. Upon the presentation of a non-revenue or credit card, the card is inserted into the card reader **12** which reads the number and transmits the information to the computer. If the computer recognizes the number as an invalid number, the computer will send a signal to the invalid charge alarm **52** which will sound the alarm signal whereby the collector will be able to apprehend the violator. If the computer recognizes the non-revenue identification number as a valid number, it sends signals through the shift register **43** to the ticket punch **13** to punch the ticket in the usual manner but also includes the identification number of the non-revenue or credit card as well as a code indicating it as a non cash paying transaction.

Clock **51** provides the timing to the system as well as providing pulses for the shift register operation. The reset mechanism **49** is used to reset the mechanical counter as well as the other system logic upon the occurrence of a power failure. The manual switch interlock **55** is used for direct control of the ticket punch from the keyboard. This can be used for maintenance operation on the ticket punch and in the event of a computer failure, the manual switch interlock can be engaged whereby the ticket punch is operated manually and tickets can still be prepared.

FIG. 3 shows the system logic for the exit lane. Ticket reader **32** has two outputs; one for a standard Hollerith card through the Hollerith converter **62** and the second for a **90** column card through the **90** column converter **63**. Both signals go through shift register **59** and into the computer unit through line **60**. Ticket reader **32** also sends signals to card status unit **64**. A switch **68** is used to control the two outputs **62** and **63** and the position of the switch is shown on indicator **69**.

Card reader **29** sends signals through encoder **58** and shift register **59** through data out **60** to the computer. It also controls the equipment interlock **65** and the lane status **66**. Vehicle detector **56** controls the mechanical counter **57** and also sends inputs to the computer unit through shift register **59**. Data from the computer unit comes into the shift register on line **61** and is used to control the toll display unit **28** and the receipt printer **30**. Timing for the system comes from clock **67**.

The operation of the exit lane will now be explained:

The exit lane is opened at the beginning of a tour of duty in a similar manner to that shown for the entry lane. The card reader **29** senses the presence of a four digit identification code representing the collector's number. It then sends signals through the encoder **58** and shift register **59** to the computer unit to record the appropriate information at the beginning of a tour of duty. It also signals to the lane status unit **66** to open the lane and enables the equipment interlock **65** whereby the exit lane equipment can now be functional.

For a normal transaction, the ticket is taken from the driver of the vehicle and inserted in ticket reader **32**. In this embodiment the exit lane can be used with both standard Hollerith encoded tickets or 90 column code tickets. The reader will automatically sense which card is inserted. Normally the system is engaged to receive 90 column code tickets. Should it sense the presence of a Hollerith code, it automatically closes switch **68** and indicates the presence of the Hollerith code on indicator **69**. The Hollerith converter **62** is then enabled and the information is read and sent to the shift register **59**. The status unit **64** will record the status of the ticket as read by the reader **32**. The information from the shift register goes to the computer on line **60**. The computer will calculate the proper fee and signal back on line **61** through the shift register to the toll display unit **28** which will display the toll to be paid. The amount will also be sent to receipt printer **30** which will engage the appropriate type to print a receipt which will be available for the driver upon request. When a non-revenue or credit ticket is presented, it is inserted in the ticket reader in the usual fashion and the computer will sense the non cash paying code whereby the toll display unit **28** will either register a no fee amount, or will register a fee and the computer will automatically charge the credit account of the vehicle driver. The vehicle detector unit **56** and mechanical counter **57** are similar to those shown for the entry lane. Mechanical switching is not shown; however, it is understood that it can be included on the exit lane similar to that shown for the entry lane.

FIG. **4** shows the interface control between the entry or exit lane and the computer unit. The shift register indicated at **69** can be either the shift register from the exit or entry logic device. The output from the shift register is passed to an intermediary buffer **72** which then transfers the information to the computer accumulator **73**. An interrupt device **75** receives an interrupt signal from the exit or entry lane which passes through a device selector **74** to control the shift register **69**. The interrupt **75** also receives inputs from a clock **77** which passes through a counter **76**. The input from the entry or exit lane comes into the shift register at **70** and the information from the computer through the shift register **69** to the entry or exit lane leaves through line **71**.

The information from the entry or exit lane enters the shift register serially under the control of clock pulses. When an entry or exit lane has information to transmit to the computer, it sends a signal to the interrupt **75**. The computer will then use the interrupt signal to determine the address of the lane and will enable the device selector **74** so that when the shift register is full, there will be parallel transmission of the information to the buffer and to the computer accumulator. The computer will then await a further interrupt signal indicating that the entry of exit terminal is ready to receive information from the computer and the computer will then transmit information through the shift register back to the entry or exit lane terminal.

Referring to FIG. **5**, there is shown a second embodiment of the invention for use with a barrier type configuration. In the barrier type system there are no tickets issued but instead toll booths are placed at preset control points along the toll road. The revenues collected at each booth are fixed for each class of vehicle.

The terminal **80** contains a keyboard **81**, a card reader **82**, a fee display device **83** and a receipt printer **84**. Electrical connections are made to the terminal by means of connector board **85** in a locked electrical compartment **86**. Lane signal **87** comprising red light **88** and green light **89** are electrically connected by means of line **90** to the terminal connector board **85**. A separate fee display unit **91** is electrically connected through line **92** to the terminal connector board **85**. A vehicle detector system containing detecting and counting means is shown at **93** and electrically connected through line **94** to the terminal connector board **85**. The terminal is electrically connected by means of line **95** to the computer unit **96**. The output of the computer is recorded onto output unit **97** which may be typically a punch tape unit. Connected to the terminal is an automatic toll collection device **98**.

The operation of the terminal is similar to that heretofore described with respect to the closed-loop system. Initially the lane is closed and the lane indicator **87** has the red light **88** in operation. To open the terminal, the collector inserts his identification card into card reader **82**. This causes the computer to record the previous cumulative totals. The interchange and lane numbers, the collector identification number and the time and date. The computer also opens the lane equipment and causes the green light **89** to be operative.

For each transaction, the collector presses the appropriate class button on the keyboard. The amount of revenue to be collected is displayed both on the terminal display **83** and the customer display **91**. The information is also transmitted to the computer unit **96** for tabulation. As the vehicle passes through the terminal, the vehicle detector will count the number of axles and the direction of passage and transmit this information to the computer. The computer will tabulate the axle count from the vehicle detector unit and the axle count from the information encoded onto the keyboard and calculator any variance between these values.

For each transaction, the computer sets the type on the receipt printer so that a receipt will be issued upon request as heretofore described.

To close the lane the collector identification card is again inserted into the card reader whereupon the computer totals the transactions and records the time and date, the collector identification number, and the lane and interchange numbers. The computer will also provide an hourly tally and also a printout each time a vehicle passes through a closed lane.

Non-revenue cards and credit cards are inserted into the card reader for the computer to check their validity. An invalid card will cause the computer to trigger an alarm. If the number should be a valid one, the collector still presses the appropriate class button on the keyboard. However, for the non-revenue card the display will indicate a no-fee amount and for the credit card the display will indicate the fee and the computer will automatically charge the account.

Since the revenues are fixed in the barrier type configuration, it is possible to have automatic toll booths for a fixed class of vehicles. The automatic toll collector **98** is used for that purpose. To change the lane into an automatic lane, the collector must open the lane in the normal manner. He then inserts a safe into the collecting machine **98**. The keyboard is set for one par-

ticular class of vehicles, usually automobiles. Each time a vehicle passes the detector, the fee display will automatically display the fixed fee to be collected. The display can be arranged to have a red light which will be turned on together with the amount to be paid. After the money is deposited into the collection machine the light can be arranged to change to green.

The computer keeps a tally of vehicles passing through the automatic lane without paying the appropriate fee. Each time such a vehicle passes in violation, the computer will cause an alarm to sound.

It will therefore be appreciated that the invention as described provides a toll revenue system with prompt reconciliation of all pertinent collector data. In the closed-loop configuration it provides an accumulated count of the number of vehicles for which transit tickets have been issued at each entry point, and a further accumulation of the number of vehicles and tickets issued for each class of vehicle. A variance, if any, between the actual vehicle count and the number of vehicles for which total tickets have been issued at each lane is automatically computed. All the data can be directly processed by a central office without requiring additional keypunching operation or transporting of encoded tickets. In the barrier type configuration it provides a check on the accuracy of revenues collected and permits the use of automatic toll booths which are also mentioned. The system further provides the availability of offering charge accounts to patrons and permitting a check of valid credit and non-revenue cards. Repairmen will also be issued identification cards which must be inserted into the card reader before repairs commence. This will present any manipulation of the terminals by unscrupulous repair personnel.

It will be further appreciated by those skilled in the art that the data which is available at the computer unit can be further classified to provide an accurate financial record and accounting of each terminal according to each collector's tour of duty. The data can be further used to determine the number and class of vehicles entering and exiting a toll road or passing a particular barrier, to determine which lanes are most heavily used; where the traffic goes to; and all other traffic patterns necessary for a complete road study analysis.

There has been disclosed heretofore the best embodiment of the invention presently contemplated. However, it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What I claim as new and desire to secure by Letters Patent is:

1. An automatic revenue reconciliation system for vehicle toll roads having a plurality of terminals each located at vehicle crossing points and control computer means, each said terminals being in communication with said computer means, each of said terminals comprising, in combination:

a. card reader means capable of reading indicia information encoded on a card means when inserted into said card reader means;

b. keyboard means for entering information identifying the class of the vehicle passing through the terminal;

c. vehicle detection means for sensing the number of axles on the vehicle and the direction of passage of the vehicle through the terminal;

d. fee display means for displaying the fee to be collected; and

e. transmitting means for transmitting the information from said card reader means, keyboard means and vehicle detection means to said computer means, means,

said computer means comprising:

a. control means responsive to the information from said card reader means for controlling the operation of the terminal transmitting the indicia information;

b. reconciliation means to immediately compare the information from said keyboard means and said vehicle detection means; and

c. calculating means responsive to the information from said keyboard means for determining the fee to be collected and causing said fee display means to display said fee.

2. A system as in claim 1 wherein each of said terminals has a normally closed state and an open state and wherein said computer control means controls the operation of said terminals by changing its state.

3. A system as in claim 2 wherein the indicia encoded on the card means represents an identification number and wherein upon a first insertion of said card means into said card reader means, said computer control means causes said terminal to change from its normally closed state to an open state.

4. A system as in claim 3 where, upon a subsequent insertion of said card means into said reader means, the computer means will cause the terminal to revert to its normally closed state.

5. A system as in claim 2 wherein said terminals further include lane status means which display the state of the terminal.

6. A system as in claim 4 wherein said computer means further comprises counting means for respectively totaling all the information from said keyboard means and all the information from said vehicle detection means for the total period of the open state of the terminals.

7. A system as in claim 1, wherein said terminals further include automatic toll collection means.

8. A system as in claim 6 wherein said computer means further comprises output means for printing out the totals from said counting means and printing out the occurrence of a lack of comparison from said reconciliation means.

9. An automatic revenue control system for vehicle toll road including at least one entering terminal, at least one exit terminal and computer means in communication with said terminals, comprising in combination:

a. card reader means associated with each terminal capable of reading indicia information encoded on a card means inserted into said reader means, and transmitting said indicia information to said computer means;

b. computer control means responsive to said indicia information for controlling the operation of the terminal transmitting said indicia information;

c. vehicle detecting means associated with each terminal for sensing the number of axles on the vehicles and the direction of passage of the vehicles passing through the terminals, and transmitting said vehicle information to said computer means;

d. keyboard means controlled by said computer control means and associated with each of said entering terminals for entering information identifying the class of the vehicle passing through the terminal and transmitting said class information to said computer means;

e. ticket encoding means, associated with each entering terminal for dispensing under control of said computer means a ticket having identification indicia encoded thereon including the class information from the keyboard means of that terminal and entering terminal identification information;

f. ticket decoding means associated with each said exit terminals for reading the identification indicia encoded on a ticket when inserted into said decoding means, and transmitting said identification indicia to said computer means;

g. computer calculating means responsive to said ticket decoding means for determining the fee to be paid based upon the identification indicia including said class information and said entering terminal identification information;

h. fee display means associated with the exit terminal, controlled by said computer calculating means, for indicating the fee determined; and

i. computer reconciliation means for immediately comparing the vehicle information from the vehicle detecting means of each entering terminal with the class information from the keyboard means from the same entering terminal and comparing the vehicle information from the vehicle detecting means of each exit terminal with the decoded information indicia from the ticket decoding means from the same exit terminal and determining any discrepancies in said respective comparisons.

10. A system as in claim **9** wherein said card reader means recognizes the presence of a first type of identification card which causes said terminals to open and close, and a second type of identification card representing a non-revenue transaction.

11. A system as in claim **9** wherein said vehicle detecting means further comprise a plurality of detecting elements which sense the number of axles on a vehicle and the direction of passage of said vehicle across said detecting means and counting means which total the number of axles crossing said detecting means in a given direction.

12. A system as in claim **9** wherein each of said entering and exit terminals have a normally closed state and an open state and wherein said computer control means controls the operation of said terminals by changing its state.

13. A system as in claim **12** wherein upon a first insertion of a card means into the card reader means said computer control means changes the state of the terminal from its normally closed state to an open state and upon a subsequent insertion of the same card means into the card reader means said computer control means returns the state of the terminal to its normally closed state.

14. A system as in claim **13** wherein when said terminals are in an open state, insertion of a different card means bearing different indicia information into said card reader means causes said computer control means to first put said terminals into said normally closed state and then back into said open state.

15. A system as in claim **11** wherein said ticket encoding means includes means, under control of said computer means, for encoding on the ticket the time of passage of the vehicle and the indicia information from the card reader means associated with the same terminal of said ticket encoding means.

16. A system as in claim **13** further including printout means associated with said computer means, and wherein said computer means includes means responsive to the opening of a terminal to cause said printout means to record the terminal identification information, the time of the opening, the indicia information from the card means causing the opening and the information recorded at the preceding closing of that terminal.

17. A system as in claim **16** wherein said computer means further includes means responsive to the closing of a terminal to cause said printout means to record the terminal identification information, the time of closing, the indicia information from the card means causing the closing, and the information compared by said computer reconciliation means.

18. A system as in claim **16** wherein said computer means further includes means responsive to the passage of a vehicle through a closed terminal to cause said printout means to record information concerning said passage.

19. A system as in claim **9** wherein said card reader means comprises keyhole means and said card means is in the form of an identification key.

20. A system as in claim **9** wherein said ticket encoding means includes means for consecutively numbering successive tickets dispensed therefrom.

21. The system as in claim **10** wherein said entering terminal further includes alarm means where, upon insertion of said second type of identification card, said computer means checks the validity of said card and upon its being found invalid, activates said alarm means.

22. The system as in claim **10** where, upon insertion of said second type of identification card, said computer causes said ticket encoding means to encode a ticket with a predetermined code symbol.

23. The system as in claim **22** where, upon insertion of said second type of ticket into said ticket decoding means at said exit terminal, said computer means causes said fee display means to display a predetermined figure.

24. The system as in claim **9** wherein said ticket decoding means includes detection means for recognizing the presence of a Hollerith type ticket and a 90 column type ticket.

25. A system as in claim **9** wherein said ticket encoding means and ticket decoding means are of the magnetic type.

26. A system as in claim **1** wherein said ticket encoding means and ticket decoding means are of the Hollerith card type.

27. A method for revenue control for toll roads having an entering terminal, an exit terminal and computer means comprising the steps of:

a. encoding a ticket at said entering terminal for each vehicle entering related to the number of axles on said vehicle and the time and place of entry;

b. counting the axles on said vehicles entering;

c. computing the variance between the axle number counter and the axle number encoded on said tickets;

d. automatically computing the toll at said exit terminal directly from said encoded tickets;

e. displaying the toll at said exit terminal;

f. counting the axles on said vehicles leaving said exit terminal;

g. computing the number of axles leaving said exit terminal from said tickets; and

h. computing the variance between the axles counted at said exit terminals and the axles determined from said tickets at said exit terminal.

28. A method as in claim **27** further including the steps of:

i. inserting an identification card into a card reader at said entering or exit terminal to activate said terminals; and

j. inserting said identification card a second time into said card reader to deactivate said terminals.

29. A method as in claim **27** further including the steps of:

k. inserting a non-revenue card into the card reader at said entering terminal;

l. encoding a unique non-revenue ticket;

m. reading said non-revenue ticket at said exit terminal; and

n. recording a non-revenue transaction.

30. A method as in claim **27** further including the steps of:

o. inserting an identification card into a card reader at said entering or exit terminal to open said terminals; and

p. inserting a different identification card into said card reader to first close and then reopen said terminal.

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