Oct. 29, 1963 N. A. BOLTON 3,109,157

DIRECTIONAL TRAFFIC CONTROL SYSTEM

Filed June 15, 1959 4 Sheets-Sheet 1

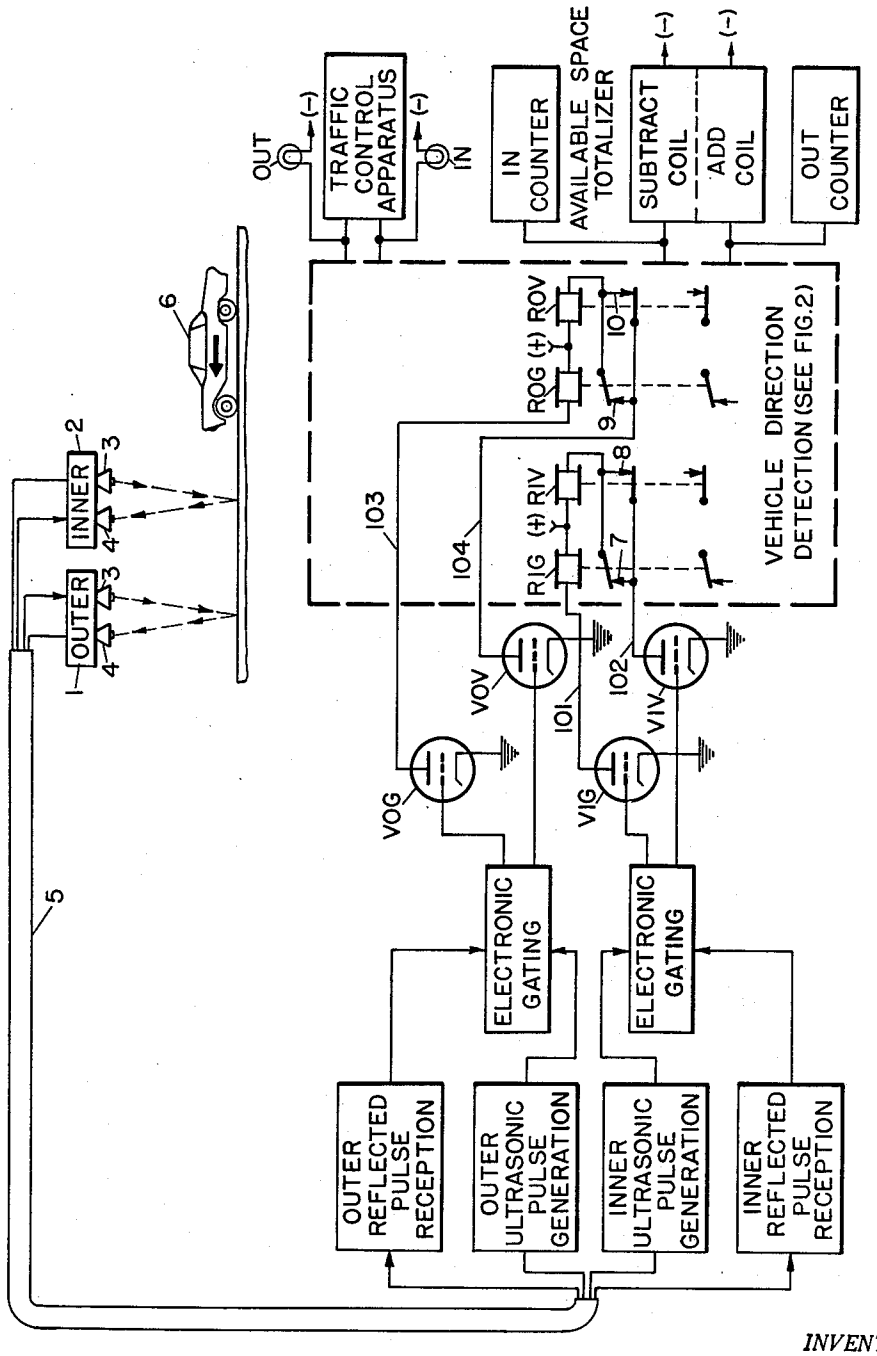


FIG. 1.

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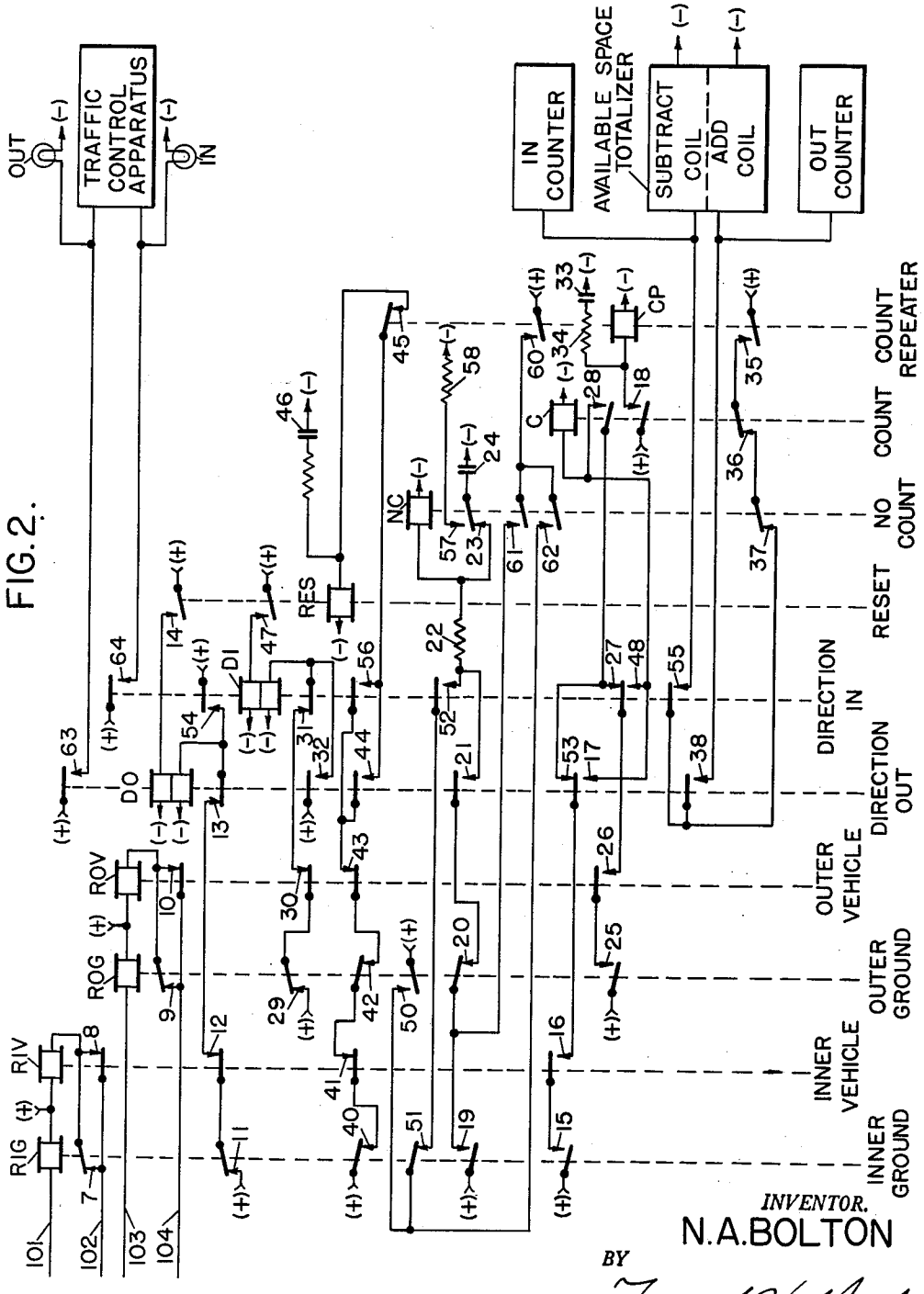
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DIRECTIONAL TRAFFIC CONTROL SYSTEM

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FIG. 2.



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FIG. 3A.

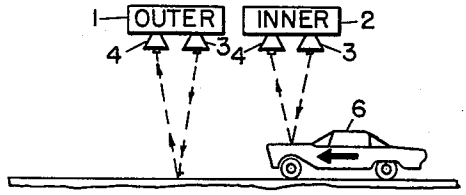


FIG. 4A.

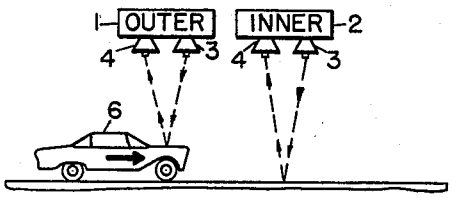


FIG. 3B.

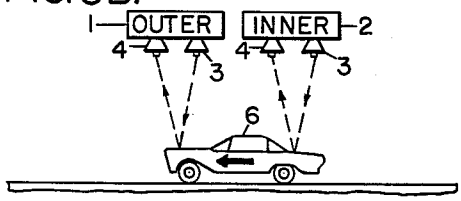


FIG. 4B.

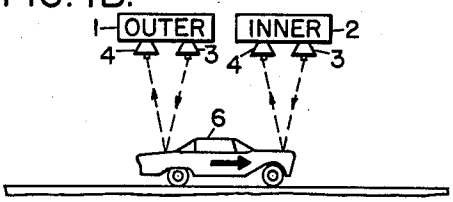


FIG. 3C.

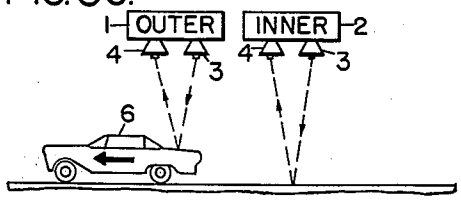


FIG. 4C.

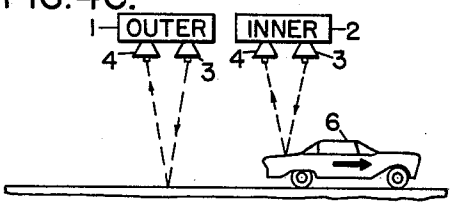
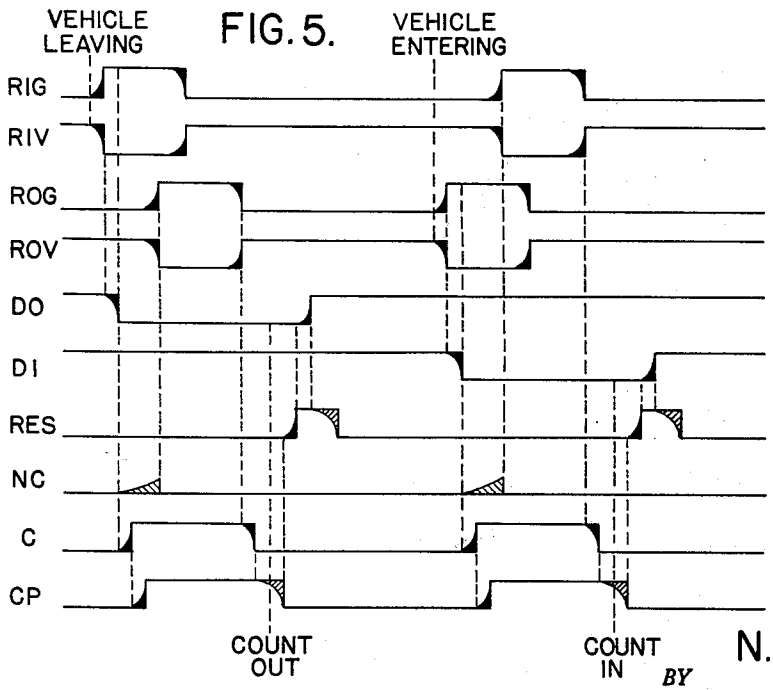


FIG. 5.



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DIRECTIONAL TRAFFIC CONTROL SYSTEM

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FIG. 6.

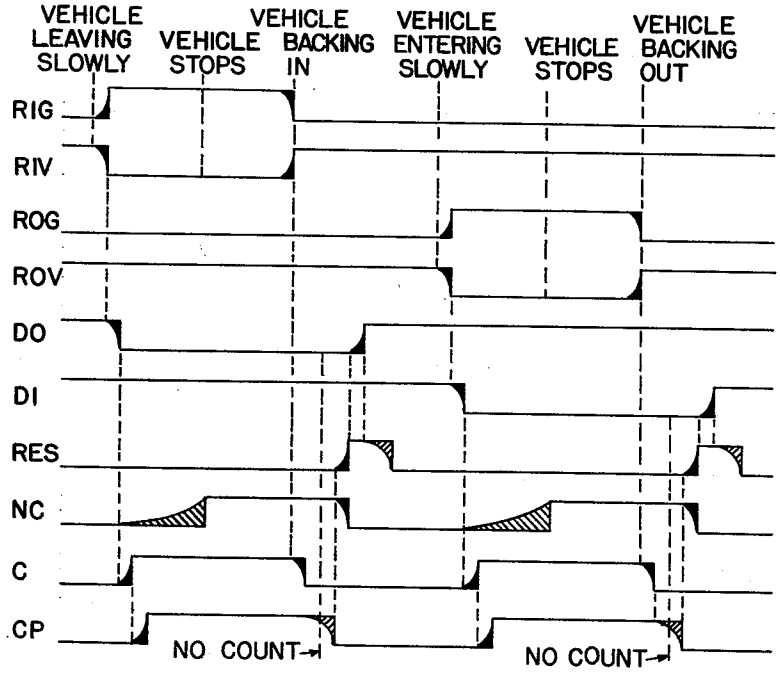
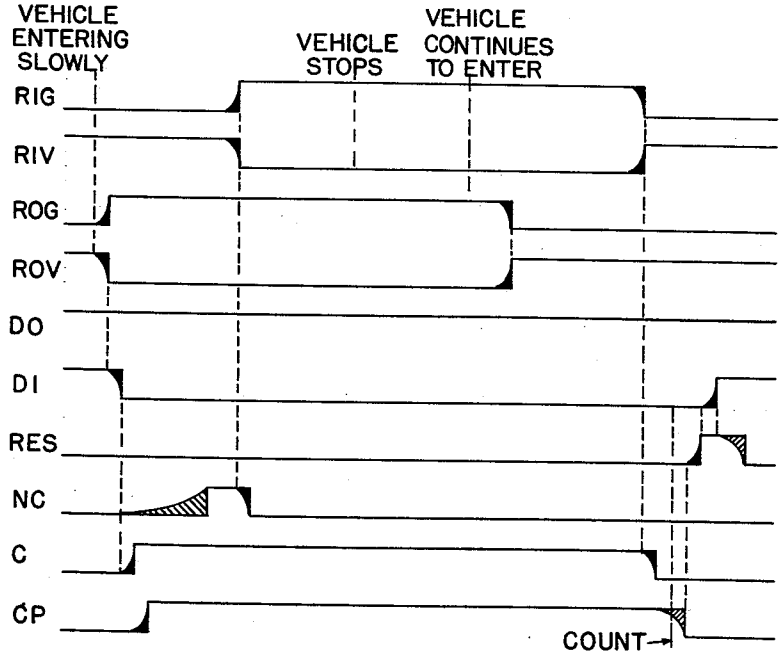


FIG. 7.



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United States Patent Office 3,109,157
Patented Oct. 29, 1963

3,109,157

DIRECTIONAL TRAFFIC CONTROL SYSTEM

Norman A. Bolton, Scottsville, N.Y., assignor to General Signal Corporation, a corporation of New York

Filed June 15, 1959, Ser. No. 820,225
4 Claims. (Cl. 340—39)

This invention relates to the selective detection of objects passing a fixed point in accordance with their direction of travel, and, more particularly, it relates to the selective detection, counting and control of automotive traffic traveling past a particular point in more than one direction.

One of the problems facing highway engineers is the necessity to provide adequate traffic control systems which can readily handle the ever increasing loads of automotive traffic. Vital to the solution of this problem is the need for continuous accurate information concerning the number of vehicles passing over a particular stretch of highway. Often, in order to provide maximum utilization of given highway facilities, it is necessary to use a particular single traffic lane for vehicles moving in both directions, such as the center lane of a three-lane highway, or multi-lane highways using all but one lane for traffic in a particular direction during rush hours.

Also, the problems created by the steady increase of automotive traffic are not limited to highways, and all metropolitan areas are faced with the necessity of providing their commercial districts with adequate parking facilities which can readily and efficiently handle large traffic loads. Vital to the solution of this parking problem is the need for continuous, accurate information concerning the space available at any given time in each particular parking facility, or portion thereof. Often, it is necessary to utilize a single traffic lane for both ingress and egress to a particular parking area, and any efficient and accurate system for maintaining a running count of the spaces available within such an area must differentiate the traffic traversing in each direction and also must properly compensate for cars partially entering or leaving the area and then backing out or in again due to traffic congestion, etc.

This invention provides an efficient and accurate system for monitoring a single traffic lane used by vehicles traveling in more than one direction. The system set forth herein distinguishes, by means of interlocking relay circuits, the direction of travel of vehicles passing through the single lane and provides means at a remote central office for indicating the direction of travel of each passing vehicle as well as the number of vehicles going in each direction.

When adapted to monitor a parking area, the system herein provides an accurate running count of the parking spaces available at any given time in the area and provides means for operating other traffic control devices in accordance with the presence of a vehicle and its direction of travel in the traffic lane serving the area. The system herein will also maintain accurate vehicle counts in spite of the fact that some vehicles may partially enter or leave the area and then back out or in once again.

It is an object of this invention to provide a system that will monitor objects passing a fixed point, indicating their direction of travel and maintaining an accurate count of the objects traveling in each direction.

It is a further object of this invention to provide a system which can be used to monitor vehicles using a single highway traffic lane for travel in more than one direction.

It is a further object of this invention to provide a system for monitoring traffic entering and leaving a designatd parking area by way of a single traffic lane, maintaining an accurate running count of parking spaces available within the area at any given time.

It is a further object of this invention to provide a system for monitoring the traffic entering and leaving a designated area and maintaining an accurate count of the traffic traveling in each direction even where vehicles begin to enter or leave the area but reverse direction and back out or in again.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

For the purpose of simplifying the illustration and facilitating in the explanation, the various parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain elements have been left in block form, the drawings having been made more with the purpose of making it easy to understand the principles and mode of operation than with the idea of illustrating the specific construction and arrangement that would be employed in practice. Thus, the various relays and their contacts are illustrated in a conventional manner, and symbols are used to indicate connections to the terminals of batteries, or other sources of electric current, instead of showing all of the wiring connections to these terminals.

In describing the invention in detail, reference will be made to the accompanying drawings, in which like reference characters designate corresponding parts throughout the several views, and in which:

FIG. 1 is a block diagram and schematic of an overall vehicle detection system of which the invention herein is an integral part;

FIG. 2 is a schematic diagram illustrating the vehicle direction detection circuit with output circuits to counters, indicators, and traffic control apparatus;

FIGS. 3A, 3B and 3C illustrate a vehicle passing through the detection zones of the system herein while leaving a parking area by way of the single traffic lane;

FIGS. 4A, 4B, and 4C illustrate a vehicle passing through the detection zones of the system herein while entering a parking area by way of the single traffic lane;

FIG. 5 is a composite sequence chart showing the operation of the relays in the circuit illustrated in FIG. 2 under the normal conditions of a vehicle entering and leaving the designated parking area;

FIG. 6 is a composite sequence chart showing the operation of the relays in the circuit illustrated in FIG. 2 where a vehicle starts to leave, or enter, but stops in the position illustrated in FIG. 3A, or FIG. 4A, and backs in, or out, again; and,

FIG. 7 is a composite sequence chart showing the operation of the relays in the circuit illustrated in FIG. 2 where a vehicle begins to enter the designated area as shown in FIG. 4A, stops in the position illustrated in FIG. 4B, and then proceeds into the area as shown in FIG. 4C.

The adaptation of the invention herein for monitoring

a parking area contains all of the features necessary to its adaptation for highway traffic monitoring, and so, for purposes of simplifying this disclosure, the following specification assumes that the invention herein is integrated into a general vehicle detection system which is being utilized to monitor a single traffic lane serving for both ingress and egress from a designated parking area. The use of ultrasonic object detection apparatus in the system illustrated is arbitrary and not essential to the invention herein, and the operation of this ultrasonic apparatus will only be explained sufficiently to assure the understanding of the interlocking relay circuits which comprise the novel Vehicle Direction Detection portion of the system. If a more complete disclosure of the ultrasonic detection apparatus referred to herein is desired, reference can be made to the pending application of H. C. Kendall et al., Ser. No. 808,736, filed April 24, 1959.

INITIAL DETECTION

Referring now to FIG. 1, two adjacent ultrasonic transducer units 1 and 2 are mounted over the single traffic lane. Both outer unit 1 and inner unit 2 have transmitting transducers 3 and receiving transducers 4 which are connected by means of cable 5 to apparatus located at a central office. Transmitting transducers 3 are connected to ultrasonic pulse generators and beam intermittent pulsse of ultrasonic energy toward the ground. The pulses of ultrasonic energy are reflected from the ground, or from the surface of any vehicle passing through the detection zones beneath transducer units 1 and 2, and are received by receiving transducers 4.

Each receiving transducer 4 is connected to a reflected pulse reception circuit which amplifies and filters the reflected pulses and feeds them to an electronic gating circuit which differentiates the pulses in accordance with their time of reception, the pulses reflected from the ground having a greater transit time than the pulses reflected from the surface of a passing vehicle. A succession of pulses received during the "ground" gate cuts off ground triodes VIG and VOG, while a succession of pulses received during the "vehicle" gate cuts off vehicle triodes VIV and VOV. Thus, with no vehicles passing through the detection zone, pulses are reflected from the ground only, and ground triodes VIG and VOG are normally cut-off, whlie vehicle triodes VIV and VOV are normally conducting.

As car 6 moves forward from its position as illustrated in FIG. 1 and enters the detection zone under inner unit 2 (see FIG. 3A), the pulses normally reflected to receiving transducer 4 of in unit 2 from the ground are cut-off. In their stead, pulses are reflected from the surface of car 6 and are received during the "vehicle" gate. This results in the cutting off of inner vehicle triode VIV, while the loss of ground reflected pulses during the "ground" gate allows inner ground triode VIG to conduct. When triode VIG conducts, it closes a circuit from ground, through triode VIG, line 101 and the windings of inner ground relay RIG to (+), causing inner ground relay RIG to pick-up, opening back contact 7. At the same time a circuit from (+), through the windings of inner vehicle relay RIV, front contact 8, line 102 and inner vehicle triode VIV is opened by the cutting off of triode VIV, and inner vehicle relay RIV drops away, opening front contact 8.

At this instant, that is, when car 6 has just entered the detection zone and is under inner unit 2 but not yet under outer unit 1 (see FIG. 3A), receiving transducer 4 of outer unit 1 is still receiving pulses reflected from the ground. These pulses are received during the "ground" gate and, as explained above, outer ground triode VOG is still in its normally cut-off state, while outer vehicle triode VOV is still normally conducting. In this normal state, the circuit from (+), through the windings of outer ground relay ROG, line 103 and triode VOG to ground is open (triode VOG being cut-off), and outer ground relay ROG remains dropped away, closing back contact 9. At the same time, the circuit from (+), through the windings of outer vehicle relay ROV, back contact 9, line 104 and triode VOV to ground is closed, and outer vehicle relay ROV is normally picked up, closing front contact 10.

It should be obvious that moments later, when car 6 passes under outer unit 1 (see FIG. 3B), that outer ground relay ROG picks up, while outer vehicle relay ROV drops away. As car 6 continues through the detection zone, it first passes out from under inner unit 2 (FIG. 3C), allowing inner detection relays RIG and RIV to return to their normal states (as illustrated in FIG. 1, and then, after a brief time lapse depending upon its speed, car 6 leaves the detection zone, allowing outer detection relays ROG and ROV to return to their normal states.

It should be noted that when a convertible passes through the detection zone, its fabric top will adsorb rather than reflect the ultrasonic energy beamed from transmitting transducers 3, and reflected pulses of ultrasonic energy will be received only from the hood and trunk portions of the convertible. Also, slanted windshields and rear windows of cars will not reflect the transmitted pulses back to receiving transducers 4, thus causing a momentary loss of vehicle pulse reflections. This loss of reflected vehicle pulses allows vehicle triodes VIV and VOV to conduct momentarily. However, once vehicle relays RIV and ROV drop away in response to vehicle pulse reflections, they cannot pick up again in response to the momentary conduction of vehicle triodes VIV and VOV as long as ground relays RIG and ROG remain picked up and back contacts 7 and 9 remain open. Since no ground pulse reflections can be received while a vehicle is present in the detection zone, ground relays RIG and ROG will remain picked up and vehicle relays RIV and ROV will remain dropped away throughout the passage of a vehicle.

It is the operation of inner and outer detection relays RIG, RIV, ROG and ROV in response to the passing of a vehicle that triggers the interlocking relay circuits comprising the vehicle direction detection portions of the system herein.

NORMAL OPERATION OF DIRECTION DETECTION CIRCUITS

A. *Car Leaving Designated Area*

The interlocking relay circuits for vehicle direction detection shown in schematic detail in FIG. 2 can best be described from the standpoint of their operation. It will be assumed at first that car 6, as illustrated in FIG. 3A, is leaving the designated parking area at normal speed, first passing into the detection zone under inner unit 2.

This causes inner ground relay RIG to pick up and inner vehicle relay RIV to drop away, opening back contact 11 and front contact 12, respectively. This opens the circuit from (+), back contact 11, front contacts 12 and 13 through the lower windings of direction out relay DO to (−), causing relay DO to drop away. At this time, front contact 14 of relay RES is also open and the upper winding of direction out relay DO is deenergized. It should be noted that relay DO is designed so that it will pick up upon the energization of its upper winding only, and once picked up, the energization of only its lower winding is sufficient to retain it in its picked up position.

In order to help clarify the sequence of relay operations which shall be described next, it is suggested that reference be made to the left hand portion of the sequence chart set forth in FIG. 5 which should be read from left to right, beginning with the operation of inner relays RIG and RIV in response to the leaving of car 6 as just explained above.

With inner ground relay RIG picked up, inner vehicle relay RIV dropped away and direction out relay DO dropped away, count relay C picks up due to the completion of the circuit from (+) through front contact 15 (of relay RIG), back contacts 16 and 17 and the windings of count relay C to (—). This closes front contact 18, allowing count repeater relay CP to pick up, and also charging capacitor 33.

At the same time, a circuit is closed to the windings of no-count relay NC from (+), front contact 19 (of relay RIG), back contacts 20 and 21, through resistor 22 and through the windings of relay NC to (—). However, the windings of relay NC are in parallel with a circuit including its own back contact 23 and capacitor 24 which must be charged up to an appreciable portion of its very large capacity before the windings of no-count relay NC receive enough current to cause that relay to pick up. The effect of very large capacitor 24 is to cause no-count relay NC to pick up very slowly.

Before no-count relay NC can pick up, car 6 moves under outer unit 1 as shown in FIG. 3B, and outer ground relay ROG picks up while outer vehicle relay ROV drops away. This opens the pick-up circuit of no-count relay NC by opening back contact 20 (of relay ROG), and, at the same time, closes the stick circuit for count relay C from (+), front contact 25 (of relay ROG) back contact 26 and front contacts 27 and 28 through the windings of relay C to (—). Thus, when the back end of car 6 passes out from under in unit 2 as shown in FIG. 3C, inner detection relays RIG and RIV return to their normal positions opening front contact 15 and back contact 16, but relay C is maintained picked up by the above recited stick circuit.

It should be noted that when outer detection relays ROG and ROV pick up and drop away, respectively, in response to the presence of car 6, this opens the circuit from (+) back contact 29 (of relay ROG) and front contacts 30 and 31 through the lower windings of direction in relay DI to (—). (Relay DI is designed similar to relay DO as explained above, being picked up by its upper winding and being maintained by its lower winding.) However, direction in relay DI does not drop away due to the stick circuit from (+) and back contact 32 (of relay DO) through the lower windings of relay DI to (—).

When car 6 completes its passage through the detection zones, outer detection relays ROG and ROV also return to their normal positions opening front contact 25 and back contact 26, allowing count relay C to drop away, and opening front contact 18. This opens the circuit maintaining energy on count repeater relay CP, but relay CP does not drop away immediately due to the discharge of capacitor 33 through resistor 34 and the windings of relay CP to (—).

During the instant before the charge on capacitor 33 dissipates sufficiently to allow relay CP to drop away, the counting circuit is closed from (+), front contact 35 (of relay CP), back contacts 36, 37 and 38 through the windings of the add coil of the "available space" totalizer and the out counter to (—). This results in an impulse which causes one unit to be added to each of these counters, showing that a vehicle has passed out of the designated parking area, and showing the availability of another parking space in the area.

When count repeater relay CP drops away, reset relay RES is energized by the closing of the circuit from (+), contacts 40, 41, 42 and 43 of the inner and outer detection relays, back contacts 44 and 45 through the windings of relay RES to (—), closing front contact 14 and picking up direction out relay DO. The closing of the pick up circuit for reset relay RES also charges up capacitor 46 which assures that relay RES will remain picked up until direction out relay DO is fully picked up, opening front contact 44 and allowing reset relay RES to drop away once again following the discharge of capacitor 46.

This restores the various interlocking relay circuits to their normal position as shown in FIG. 2.

B. *Car Entering Designated Area*

Assuming now that car 6 in FIG. 4A, traveling at normal speed, is entering the designated parking area by way of the single lane monitored by the invention herein. Car 6 first passes under outer unit 1, picking up and dropping away outer detection relays ROG and ROV, respectively. This opens the circuit including back contact 29 (of relay ROG), front contacts 30 and 31 and the lower windings of direction in relay DI which drops away, since its upper winding is also deenergized at this time, front contact 47 (of relay RES) being open.

This starts the sequence of relay operations shown in the right-hand portion of the FIG. 5 sequence chart.

With outer detection relays ROG and ROV picked up and dropped away, respectively, and direction in relay DI dropped away, a circuit is closed from (+), front contact 25 (of relay ROG) and back contacts 26 and 48 through the windings of count relay C to (—). This picks up relay C, closing its front contact 18 and picking up count repeater relay CP and charging capacitor 33 as explained above.

Also, a pick-up circuit for no-count relay NC is closed from (+), front contact 50 of relay ROG, back contacts 51 and 52, and resistor 22 through the windings of relay NC to (—). However, as explained above, relay NC has a very slow pick up due to the effect of capacitor 24 which is in parallel with it by means of the circuit including its own back contact 23. Begore no-count relay NC can pick up car 6 passes into the detection zone of inner unit 2 as shown in FIG. 4B, causing inner detection relays RIG and RIV to pick up and drop away, respectively. This opens the above described pick-up circuit for relay NC at back contact 51 (of relay RIG).

At the same time, the operation of inner detection relays RIG and RIV closes their respective contacts 15 and 16, thereby closing a stick circuit for count relay C including front contact 53 of relay DO and front contact 28 of relay C.

It should be noted that the operation of inner detection relays RIG and RIV also opens their respective contacts 11 and 12 opening the circuit including front contact 13 and the lower windings of direction out relay DO. However, relay DO remains stuck in its energized position due to the fact that direction in relay DI is dropped away closing its back contact 54, completing the circuit from (+) through front contact 54 and the lower windings of relay DO to (—).

As the rear end of car 6 passes out of the detection zone of outer unit 1 as shown in FIG. 4C, outer detection relays ROG and ROV return to their normal position, but this has no effect at this time due to the stick circuits mentioned above. Moments later, when car 6 completely clears the detection zone of inner unit 2, inner detection relays RIG and RIV also return to their normal positions opening, respectively, contacts 15 and 16 and allowing count relay C to drop away. This opens front contact 18 of relay C and the energization circuit for count repeater relay CP. However, as explained above, relay CP does not drop away immediately due to the discharge of capacitor 33 through its windings.

During the short interval in which capacitor 33 discharges sufficiently to allow count repeater relay CP to drop away, the counting circuit is closed from (+), front contact 35 (of relay CP), back contacts 36, 37 and 55 through the subtract coil of the "available space" totalizer and through the coil of the in counter to (—). This results in an impulse which causes one unit to be added to the in counter and one unit to be subtracted from the "available space" totalizer, indicating that a vehicle has entered the designating parking area, and showing one less parking space available within the area. When count repeater relay CP finally drops away, reset relay RES is

energized by the closing of a circuit from (+), contacts 40, 41, 42 and 43 of the inner and outer detection relays, back contacts 56 and 45 through the windings of relay RES to (—), closing front contact 47 and picking up direction in relay DI. Reset relay RES is held picked up due to the discharge of capacitor 46 until relay DI is fully picked up, opening front contact 56 and allowing Reset relay RES to drop away once again following the discharge of capacitor 46. This restores the relay circuits to their normal positions as shown in FIG. 2.

It should be obvious that the invention as just described would operate in a similar fashion if adapted for highway use. For instance, if the detection units were placed over the center lane of a three-lane highway, the circuits just described would similarly provide a separate and distinct count of the traffic moving in each direction through the monitored center lane.

NO COUNT RESPONSE UNDER SPECIAL CIRCUMSTANCES

A. *Vehicles Changing Direction While Within Detection Zones*

As stated earlier, one of the problems encountered by a system for monitoring the traffic entering and leaving a designated parking area by way of a single traffic lane results from the fact that, due to traffic congestion, a vehicle may enter the detection zones but not pass through them completely, stopping within the detection zones and then backing out again. It should be obvious that such vehicle operation might normally result in a count being made in accordance with the direction from which the vehicle originally entered the detection zones.

For purposes of explaining the "no count" feature of the invention herein, it will be assumed first that car 6 begins to leave the designated parking area but stops under inner unit 2 as shown in FIG. 3A, and then backs into the designated area again. The sequence of relay operations resulting under this set of assumed circumstances is illustrated in the left-hand portion of FIG. 6.

As car 6 enters the detection zone of inner unit 2, inner detection relays RIG and RIV pick up and drop away, respectively. This results, in turn, in the operation of direction out relay DO, count relay C, and count repeater relay CP, as explained above. Also, with relay RIG picked up and relay DO dropped away, a pick-up circuit for no count relay NC is closed, this circuit including front contact 19 (of relay RIG), and back contacts 20 and 21. Due to the fact that car 6 is traveling very slowly and stops while still under inner unit 2, this pick-up circuit for no count relay NC remains closed and capacitor 24 charges sufficiently to allow the necessary build up of current in the windings of relay NC to pick it up. It should be noted that the picking up of no count relay NC closes front contact 57, allowing capacitor 24 to discharge through resistor 58.

When car 6 backs into the parking area once again and passes from under inner unit 2, inner detection relays RIG and RIV return to their normal positions, opening their respective contacts 15 and 16, and thereby deenergizing count relay C. The dropping away of count relay C opens front contact 18 and the circuit maintaining energy on the windings of count repeater relay CP, however, as explained above, relay CP does not drop away immediately due to the fact that capacitor 33 discharges through its windings.

During the interval before count repeater relay CP drops away, the normally closed counting circuit including contacts 35, 36, 37 and 38 is now open at back contact 37 of no count relay NC. Relay NC has remained picked up after the dropping away of detection relay RIG (opening front contact 19) by virtue of the stick circuit from (+), front contacts 60 and 61 (of relays CP and NC, respectively), back contacts 20 and 21 through resistor 22 and the windings of relay NC, to (—). Thus, the normally expected "count" impulse is not received by the counters, the count remaining undisturbed by the unusual action of car 6.

When count repeater relay CP finally drops away following the discharge of capacitor 33, it opens front contact 60 and closes back contact 45. Thus, the stick circuit holding no count relay NC is opened, and relay NC drops away, the other relays being restored to their normal positions as explained above.

The right-hand portion of FIG. 6 shows the sequence of relay operations based upon the assumption that car 6 begins to enter the designated area but stops under outer unit 1 (in the position illustrated in FIG. 4A) and then backs out once again.

Under these newly assumed facts, outer detection relays ROG and ROV pick up and drop away, respectively, resulting in the operation of direction in relay DI, count relay C, and count repeater relay CP as explained above. No count relay NC is then picked up by the closing of the circuit including front contact 50 of relay ROG, back contact 51 of relay RIG, and back contact 52 of relay DI, capacitor 24 having time to charge up sufficiently to allow relay NC to pick up due to the fact that car 6 remains in the detection zone for a relatively protracted period.

Once picked up, no count relay NC is stuck up by the circuit from (+), front contact 60 (of relay CP), front contact 62, back contacts 51 and 52 through resistor 22 and the windings of relay NC, to (—). When car 6 backs out once again, allowing outer detection relays ROG and ROV to return to their normal positions, count relay C drops away due to the opening of the circuit including contacts 15 and 16. This opens front contact 18 of relay C, resulting in the setting up of the counting circuit as explained above. However, the counting circuit, including contacts 35, 36, 37 and 55, which would normally be closed at this time, is now open at front contact 37 of relay NC, and the detection of car 6 does not result in the normal count impulse.

When count repeater relay CP finally drops away, the various circuits are restored to their normal positions as described above.

B. *Vehicle Passing Slowly Through, or Stopping Within, Detection Zones*

Although a vehicle may move slowly through or stop within the detection zones, thereby causing the picking up of no count relay NC as explained above, this will not prevent the normal counting of the vehicle as long as it continues in its initial direction of travel. To illustrate this point, it is assumed that car 6 begins to enter the designated area slowly, as shown in FIG. 4A, that due to traffic congestion it stops within the detection zones in the position shown in FIG. 4B, and then, finally, that it continues on into the area as shown in FIG. 4C.

The sequence of relay operations resulting from this set of assumed circumstances is illustrated in FIG. 7. As car 6 first enters the detection zones under outer unit 1, the outer detection relays ROG and ROV respond, causing the operation of direction in relay DI, count relay C, and count repeater relay CP, and, due to its relatively long time under outer unit 1, causing the pick up of no count relay NC as explained above.

However, no count relay NC does not remain picked up. When the front of car 6 passes under inner unit 2, causing the operation of inner detection relays RIG and RIV, back contacts 20 and 51 (of relays ROG and RIG, respectively) are both open, opening the pick-up circuits for relay NC and also opening the above described stick circuits including front contact 60 (of relay CP), and front contacts 61 and 62, and no count relay NC drops away.

As can be seen from FIG. 7, as long as car 6 remains stopped within the detection zone, the condition of the direction detection interlocking relay circuits remains as just described. When car 6 next continues to enter the designated area, it first passes from under outer unit 1,

allowing outer detection relays ROG and ROV to return to their normal positions, but direction in relay DI remains dropped away and count relay C and count repeater relay CP remain picked up as explained above.

Although car 6 continues to move relatively slowly under inner unit 2 (FIG. 4C), no count relay NC does not pick up again since its pick-up circuit, including front contact 19 (of relay RIG) and back contact 20 (of relay ROG), is open at back contact 21, direction out relay DO being stuck in its normally picked up position by the stick circuit including back contact 54 of direction in relay DI.

Thus, when car 6 finally leaves the detection zone, passing from under inner unit 2 and allowing inner detection relays RIG and RIV to return to their normal positions, the normal counting impulse is fed to the out counter and to the subtract coil of the "available space" counter as explained above, and then the entire circuit is restored to its normal condition.

OTHER DIRECTIONAL INDICATIONS

As described in detail above, whenever a vehicle is traveling in such a direction that it passes under inner unit 2 first, direction out relay DO is caused to drop away. Similarly, a vehicle traveling in the opposite direction passes first under outer unit 1, and this results in the dropping away of direction in relay DI.

By utilizing circuits such as those illustrated in FIG. 2 including back contacts 63 and 64 of relays DO and DI, respectively, it should be obvious that lights, bells, or other indications or traffic control devices can be operated in accordance with the direction of travel of each vehicle passing through the monitored traffic lane. For instance, assuming that the invention is adapted to monitor a parking area, whenever direction out relay DO drops away, closing back contact 63, a circuit could be closed to a relay controlling the operation of a yellow caution light over the highway adjacent to the parking area, thus warning passing vehicles of the imminence of a vehicle leaving the parking area.

While the above discussion of the invention herein deals specifically with its adaptation to a system monitoring traffic entering and leaving a designated parking area by way of a single traffic lane, it should be understood that this particular form of the invention has been selected to facilitate the disclosure of the invention rather than to limit the number of forms which it may assume and the various uses to which it can be adapted. Also, it is to be further understood that various modifications, adaptations, and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention.

What I claim is:

1. In a system for selectively registering vehicles according to their direction of travel as they move along a roadway and pass through a detection area comprising at least two successive detection zones the combination comprising, a plurality of vehicle responsive means each defining a respective one of said detection zones and each being operated to a distinctive condition by the passage of a vehicle through the respective detection zone, direction detection means, means governed by said vehicle responsive means for the respective zones for operating said direction detection means to a distinctive condition indicative of the passage of a vehicle in one particular direction along said roadway only for a particular corresponding sequence of vehicle detections by said two vehicle responsive means, vehicle registering means, control means for said vehicle registering means governed jointly by said vehicle responsive means for the respective detection zones and by said direction detection means for registering the passage of said vehicle moving in said one particular direction only when said direction responsive means has been controlled to said distinctive condition and the second-operated of said vehicle detection means for said particular direction of vehicle travel has been restored to its normal condition, registration prevention means for preventing when operated from its normal condition the registration of a count by said vehicle registration means, and means for operating said registration prevention means only when the interval between the successive operations of said two vehicle detection means in response to a single vehicle is substantially in excess of that normally expected for a vehicle passing through said detection, said last-named operating means restoring said registration prevention means when said vehicle is detected by said second-operated vehicle detection means.

2. In a system for selectively registering the passage of vehicles according to their direction of travel through a detection area including at least two detection zones through which each vehicle must successively pass, the combination comprising,

A. vehicle detection means for each detection zone each including:

(1) means for transmitting a beam of pulsed energy across the path of said vehicle to define said detection zone and with said energy impinging upon a fixed reflecting surface only in the absence of said vehicle but impinging instead upon said vehicle when it occupies said detection zone,

(2) receiving means for receiving reflections of the transmitted energy both from said vehicle and from said fixed reflecting surface,

(3) gating means controlled by said transmitting means for selectively passing output signals from said receiving means to produce a first output signal in response to reflected energy received from said vehicle and a second different output signal in response to reflected energy received from said fixed reflecting surface,

B. direction detection means operated by said gating means output signals for the respective zones and being controlled to one distinctive condition only for a vehicle proceeding in one particular direction through said detection area,

C. vehicle registering means,

D. control means for said vehicle registering means governed jointly by said vehicle detection means for the respective detection zones and also by said direction detection means for registering the passage of said vehicle in said one particular direction only when both vehicle detection means corresponding respectively to the first and second-traversed of said two vehicle detection zones have in order each produced said first output signal while concurrently not producing said second output signal and have both thereafter been restored to their normal conditions in which each produces said second output signal but not said first output signal,

E. whereby the passage of any extraneous object through the respective detection zones capable only of providing a reflection signal from its reflecting surface but not capable of substantially fully cutting off the reflection from said first reflecting surface will not be registered by said vehicle registering means.

3. The system of claim 2 wherein said transmitting means transmits said energy in the form of discrete sound pulses.

4. The system of claim 3 wherein said transmitted sound pulses are directed downwardly toward the pavement which constitutes said fixed reflecting surface and said gating means passes said first output signal for each reflection pulse received during a first predetermined interval following the transmission of each sound pulse and passes said second output signal for each reflection

pulse received during a second predetermined time interval following said first predetermined interval.

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