May 7, 1940. J. N. PAUL 2,199,573

TRAFFIC SIGNAL

Filed Dec. 2, 1937 3 Sheets-Sheet 1

FIG. 1

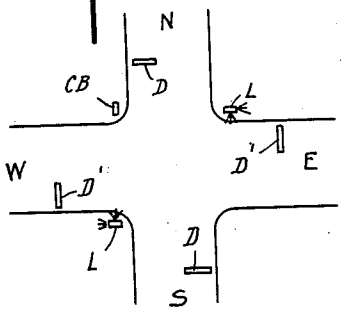


FIG. 2

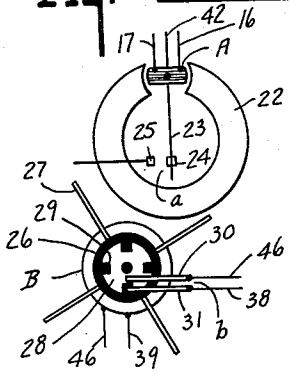


FIG. 3

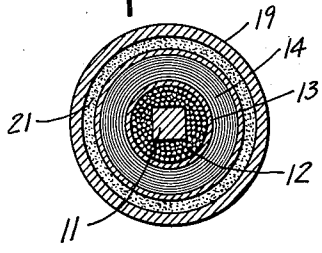


FIG. 4

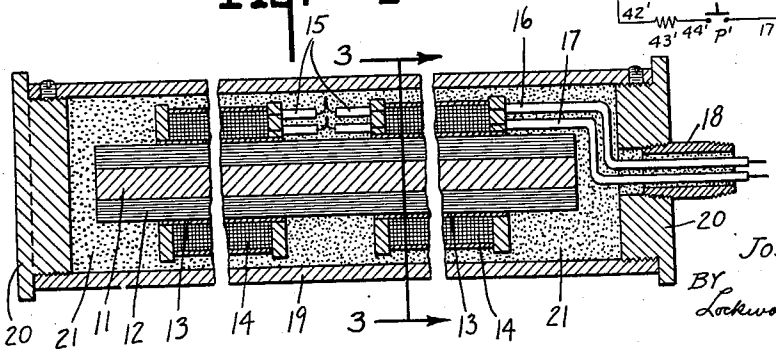


FIG. 7

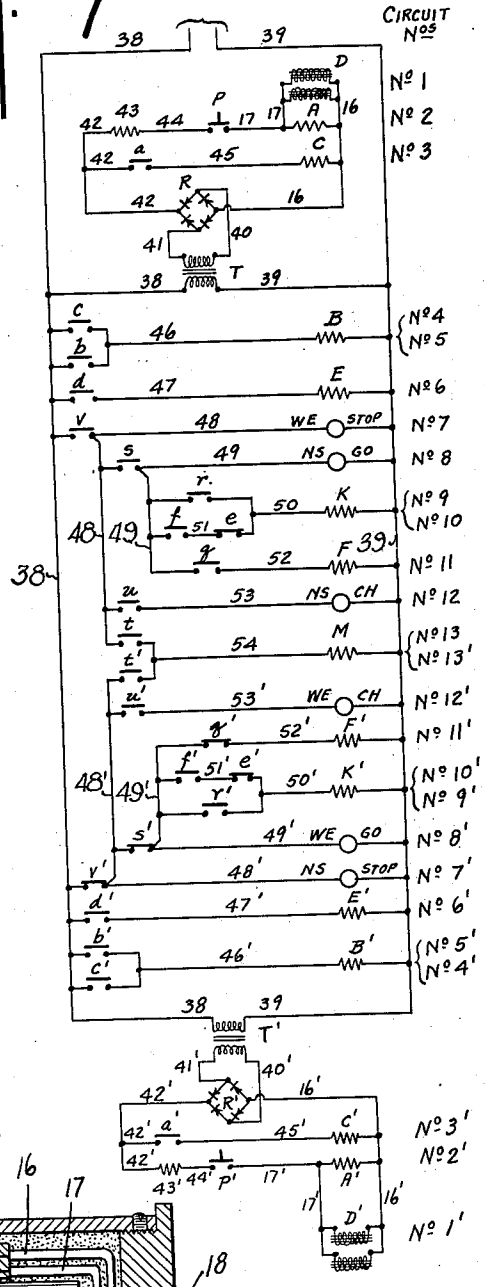


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FIG. 5

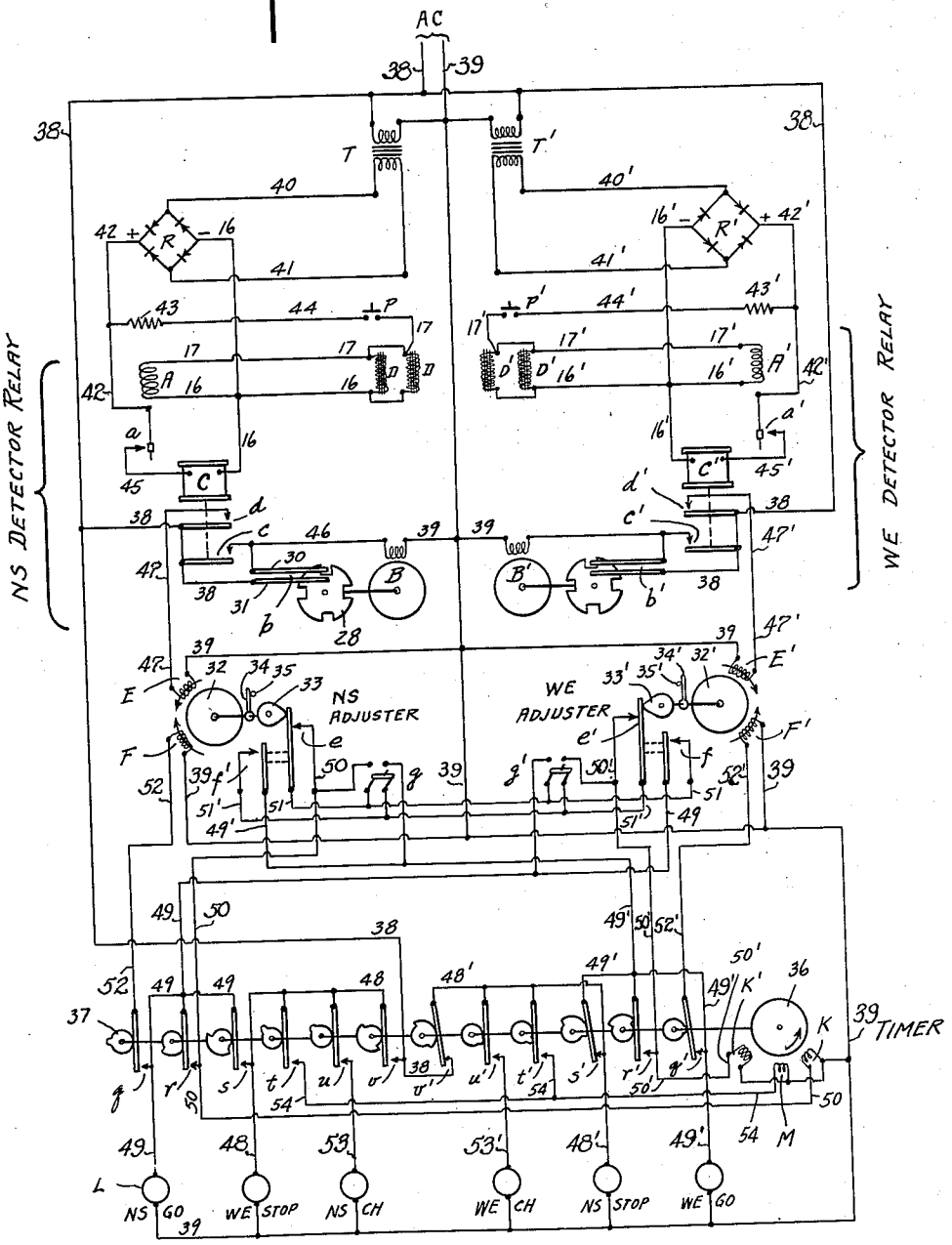


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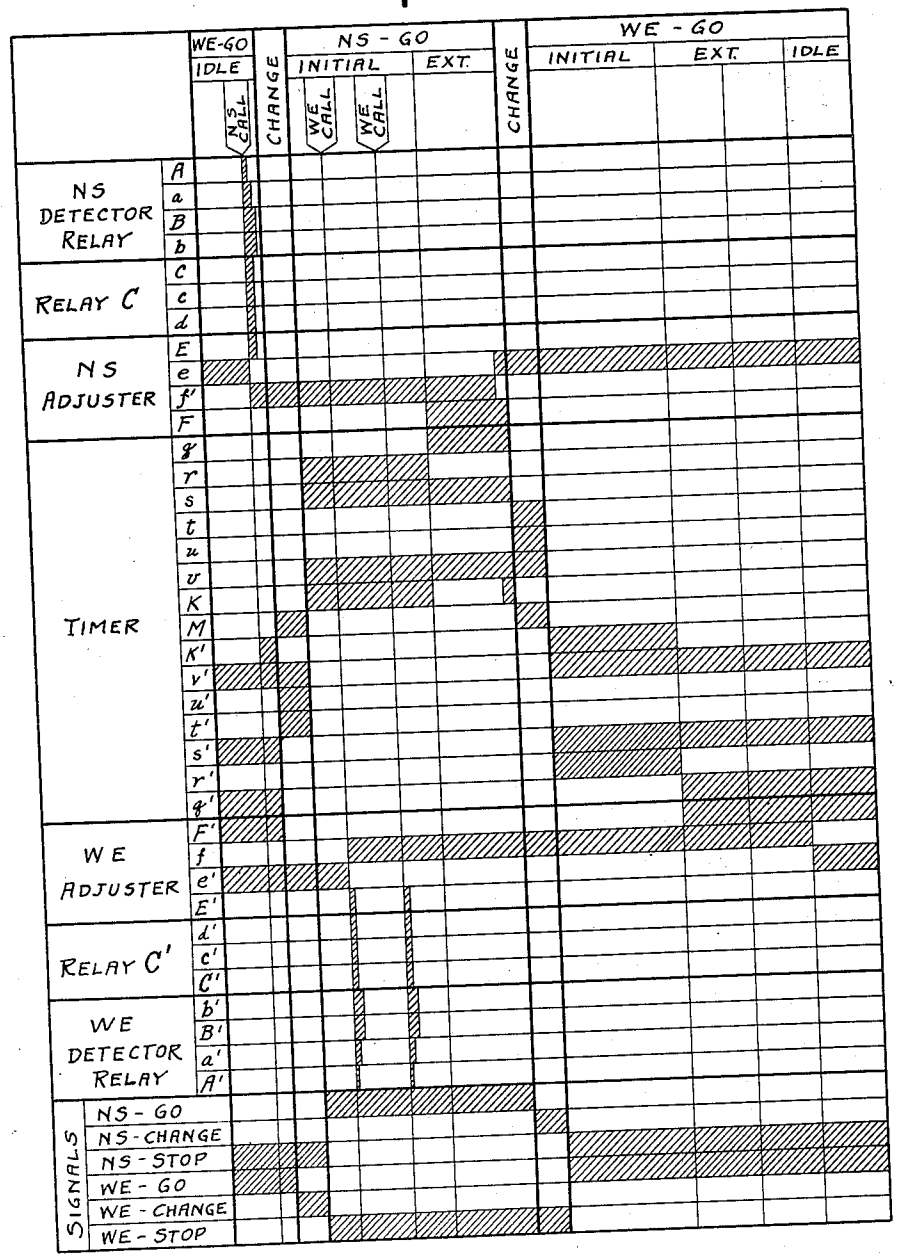
FIG. 6

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Patented May 7, 1940 2,199,573

# UNITED STATES PATENT OFFICE

2,199,573

## TRAFFIC SIGNAL

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Application December 2, 1937, Serial No. 177,763

14 Claims. (Cl. 177—337)

This invention relates to a traffic actuated signal for intersecting traffic lanes. More particularly, it relates to a system in which the duration of right of way periods is proportioned between the intersecting lanes in accordance with the amount of traffic in each lane.

The invention preferably employs a magnetic type of traffic actuated device or detector. In this type of detector, the passage of a vehicle disturbs a magnetic field and said disturbance in turn generates a small electromotive force which may be used to actuate the system.

Certain features of the invention reside in the arrangement of relays and control circuits, by means of which the electromotive force is made to control the display of signals. Other means for translating the detector impulse into signal operations are disclosed in my copending application Serial No. 137,705, filed April 19, 1937. Certain other features of the signal system disclosed herein are disclosed and claimed per se in my aforementioned copending application.

Other objects and features of the invention will be understood from the accompanying drawings and the following description and claims:

Fig. 1 is a diagrammatic representation of a street intersection illustrating the location of certain elements of the control apparatus. Fig. 2 is a diagrammatic view of a portion of a detector relay unit used to receive the detector impulse. Fig. 3 is a lateral sectional view through one of the detector units taken substantially on the line 3—3 of Fig. 4. Fig. 4 is a longitudinal sectional view of the same. Fig. 5 is a diagram of electrical connections in which the electrical elements are conventionally illustrated Fig. 6 is a sequence table showing the sequence of operations of the electrical apparatus through an illustrative cycle of operations. Fig. 7 is an electrical diagram equivalent to Fig. 5 but arranged in "across the line" form for more ready identification of the individual circuits.

In the drawings and the following description, the invention is shown applied to a traffic control system giving the same sequence of signals as that shown in my last mentioned copending application. However, certain features of the invention may be applied equally well to systems giving other operating cycles.

The control system herein illustrated is normally operated as a "full traffic actuated" system in which detector elements are placed in both of a pair of intersecting traffic lanes and in which right of way normally remains with either highway until called to the other by a traffic demand. Manual switches are provided, however, which permit the system to be operated as a "semi-traffic actuated" system in which right of way is automatically returned to a main highway after a traffic call from a cross street has been satisfied.

When used as a full traffic actuated system, the period of right of way in the highway to which the signal is called includes an initial period of predetermined duration, and one or more extension periods, each of predetermined duration. It may also include an idle period of indefinite duration if no calls are received from the intersecting highway prior to the end of the last extension period. The number of extension periods granted to one highway is regulated by the number of vehicles registering calls from that highway during the time that right of way is denied thereto and during at least a part of the right of way period. During the initial period and extension periods, a call from the intersecting highway is registered but is not satisfied until the last of the extension periods expires.

When used as a semi-traffic actuated system, the right of way normally remains with the main highway until called to the cross road by a traffic demand. The period of right of way in the cross road includes an initial period and one or more extension periods but cannot include an idle period since right of way is automatically restored to the main highway at the ends of the last extension period. Right of way remains with the main highway for at least a predetermined minimum period, during which calls from the cross road are registered but not satisfied until the expiration of that period.

In Fig. 1 there is indicated a street intersection in which the two highways are designated WE and NS. Traffic actuated detectors D are placed in the north and south traffic lanes in position to be actuated by vehicles approaching the intersection but not by vehicles leaving the same. Similar detectors D' are similarly placed in the east and west traffic lanes. These detectors are preferably of the form shown in detail in Figs. 3 and 4. Signal lamps L are placed in suitable positions to indicate right of way to the traffic lanes. A control box CB may be mounted at any convenient point adjacent the intersection and may be connected by suitable underground cables to the detectors and lamps. The control box contains the electrical control units illustrated diagrammatically in Fig. 5.

Referring particularly to Fig. 5, there are illustrated therein the detectors D and D' and the

lamps L. One set of lamps is shown for the NS lane, designated "NS GO", "NS CH" (change) and "NS STOP". Another set of lamps for the WE lane is correspondingly designated. Ordinarily two sets of lamps connected in parallel are provided for each lane but the second set is omitted from the diagram for simplicity.

Pedestrian push button switches *p* and *p'* are also shown. These may be mounted on suitable supports adjacent the intersection and are used by pedestrians for calling right of way in the absence of traffic calls. The remainder of the apparatus shown in Fig. 5 is preferably contained within the control box CB. Each of the electrical elements will first be described in detail.

*Detectors*

Each detector (Figs. 3 and 4) includes a core consisting of a bar 11 of permanently magnetized steel surrounded by a group of soft iron rods 12. Surrounding the rods 12, there are provided a plurality of spools 13 upon each of which there is wound a coil 14 of insulated wire. The coils are electrically connected by conductors 15 and the coil at one end is connected to conductors 16 and 17 leading through a suitable conduit 18 to the control box. The core and coils are enclosed in a pipe 19 of non-magnetic material, preferably the material known commercially as "Transite", as marketed by Johns-Manville Sales Corporation for example.. Plugs 20 serve to close the ends of the pipe 19 and one of said plugs receives the conduit 18. The core and coils are held in place within the pipe 19 by a filling 21 of a water-proofing material, such as paraffin.

The detectors are buried beneath the pavement or are cast within the concrete paving slab if put in position simultaneously with the pavement. Each detector is made sufficiently long so that a car approaching the intersection must pass through at least a part of its magnetic field. The magnetic field of each detector extends beyond the ends of the detector about half the length of the detector itself. A detector six feet long placed centrally in a traffic lane 22 feet wide will be actuated by any car passing in that lane. For narrower lanes, shorter detectors may be used. For wider lanes, two or more detectors preferably are used. For a six-foot detector, preferably three of the coils 14 are used, each about 20 inches long. The magnetized bar 11 provides a magnetic field, a part of which extends above the highway surface. The soft iron rods 12 increase the permeability of the core and thus increase the change in lines of magnetic force actually threading the coils 14 which results from the passage of a vehicle containing magnetic material. When the magnetic field is disturbed by the passage of a vehicle, the resulting change in the number of lines of magnetic force threading the coils 14 induces an electromotive force therein which is applied through the conductors 16 and 17 to the electric units in the detector relay.

*Detector relay units*

Within the control box CB there is provided a detector relay unit indicated NS detector relay in Fig. 5 and shown in more detail in Fig. 2. The relay unit includes a coil A pivotally mounted in a gap in the field of a permanent magnet 22 and carrying a needle 23 movable by movement of the coil A in the well known manner of a D'Arsonval galvanometer. The needle 23 carries a small armature 24 adapted to engage a stationary contact member 25. Armature 24 is of magnetic material and member 25 is permanently magnetized and thus attracts and holds said armature when the needle 23 is moved sufficiently to bring the armature into the magnetic field. Armature 24 and contact member 25 together form an electric switch referred to hereinafter as switch *a*.

Adjacent the switch *a* there is provided a motor B on the shaft of which there is mounted an insulation block 26 carrying a plurality of strikers 27 each adapted to strike the end of the needle 23 in the rotation of the motor and thus to break the same free from the magnetic contact member 25. The insulation block also carries a metallic contact plate 28 having a plurality of indentations 29 in the periphery thereof and engaged by the tips of a pair of resilient contact fingers 30 and 31. So long as both contact tips engage plate 28 current may flow between them. The contact finger 31 is in the path of travel of the indentations 29 and when one of said identations engages said finger the electrical connection between said fingers is broken. The fingers 30 and 31 and plate 28 constitute an electric switch hereinafter referred to as switch *b*.

Associated with the NS detector relay there is a magnetic relay having a magnet coil C adapted when energized to close a pair of switches *c* and *d* and to open the same when deenergized.

There is also provided a WE detector relay indicated by name in Fig. 5 which is a duplicate of the NS detector relay just described. In the drawings, primed reference characters in this relay indicate parts having the same construction and function as corresponding parts in the NS detector relay.

*Adjusters*

There is provided in the control box CB a motor driven switching unit preferably of the induction disc type indicated NS adjuster in Fig. 5. Said unit includes a "register" motor coil E and an "extension" motor coil F adapted to drive an induction disc 32 in opposite directions as indicated by their respective arrows in Fig. 5. The disc 32 in turn rotates a cam 33 which in the position shown in the drawings maintains a switch *e* in closed position and a switch *f'* in open position. When moved from this position by operation of the register coil E, the cam permits switch *e* to be opened and switch *f'* to be closed. The induction disc 32 also rotates a stop arm 34 engageable with a stop pin 35 to limit the travel of cam 33 in the direction of drive of the extension coil F. The speed of movement of the adjuster under the control of either coil E or F may be adjusted by manual means well known in the art of induction disc motors.

There is also provided a WE adjuster which is a duplicate of the NS adjuster just described, primed reference characters in the one indicating parts having similar construction and function to correspondingly indicated parts in the other.

*Timer*

There is also provided in the control box CB a motor driven switching unit indicated TIMER in Fig. 5. As shown in the drawing, the timer includes an induction disc 36 driven by any one of three motor coils K, M and K' and in turn operating a series of cams 37 to open and close

switches *q*, *r*, *s*, *t*, *u*, *v*, *v'*, *u'*, *t'*, *s'*, *r'* and *q'* in a predetermined sequence which will be described in detail in connection with the operation of the system as a whole.

The motor coils K, M and K' are arranged so that all drive the timer in the same direction and may be arranged so that each drives the timer at a different speed. The speed resulting from the actuation of each coil may be varied by various means, such as shading coils or adjustable pole pieces well known in the art pertaining to induction disc motors. While the timer is shown in the drawing in a conventionalized form in which each switch is provided with an individual cam, preferably a timer unit is used such as that described in Bechtold Patent No. 1,926,833 in which a single cam controls the opening or closing of all switches which operate simultaneously.

*Wiring*

In describing the wiring connections, conductors will be referred to by reference number only in tracing the circuits of which they form a part. Conductors having more than one branch carry the same reference number throughout all branches. Conductors having primed reference numbers are connected to switches and relays having primed reference characters in the same manner that correspondingly numbered conductors are connected to the corresponding switches and relays. Complete circuits are referred to as circuit No. 1, No. 1', No. 2, etc. for convenience of reference and are indicated by number in the simplified diagram Fig. 7. Circuits having primed circuit numbers include conductors and switches having primed reference characters and are analogous to the corresponding circuits having unprimed circuit numbers.

*Power supply*

The main power supply is preferably alternating current of a commercial voltage and frequency supplied by power mains **38** and **39**. Suitable fuse protection and service switches (not shown) may be supplied in either or both power mains. Transformers T and T' have their primary windings connected to said power mains and supply alternating current at a suitable lower voltage to rectifiers R and R' respectively by means of conductors **40** and **41**, **40'** and **41'**. Direct current is supplied by rectifier R to a branch of conductor **16** and to a conductor **42**, which conductors serve as direct current power mains. Rectifier R' similarly supplies direct current power mains **16'** and **42'**.

*Detector relay operation*

The purpose of the detector relays is to amplify and prolong the effect of the electromotive force of the detectors so that relay C will be energized for a predetermined time as a result of each detector actuation. In the normal position of the detector relay, switch *a* is open and circuit No. 1 (D, 16, A, 17 D) is complete but no current flows therein until an electromotive force is generated in one of the detectors D. The conductors **16** and **17** connect the two detectors D in parallel so the actuation of either causes current to flow in the circuit. With the detector relay in this condition, the passage of a vehicle at either detector generates an electromotive force which causes a current to flow in circuit No. 1 in one direction as the vehicle enters the detector magnetic field and in the opposite direction as the vehicle leaves said field. This current deflects coil A and moves needle **23** either directly toward contact member **25** or first away from said member and then toward the same. In either case the armature **24** is caught by the magnetic contact member **25** and held thereby to close switch *a*.

Coil A may also be energized to close switch *a* by the operation of the pedestrian push button switch *p* which completes circuit No. 2 (R, **42**, resistance **43**, **44**, *p*, **17**, A, **16**, R) to supply direct current to coil A. Although only one such push button is shown in the drawings, it is obvious that as many as needed may be connected in parallel.

The closing of switch *a* completes circuit No. 3 (R, **42**, *a*, **45**, C, **16**, R) to supply direct current to energize relay C, closing switches *c* and *d*. The closing of switch *c* completes circuit No. 4 (**38**, *c*, **46**, B, **39**) to energize motor B, the movement of which brings the plate **28** into engagement with finger **31** closing switch *b*. The closing of switch *b* completes circuit No. 5 (**38**, *b*, **46**, A, **39**) which will continue the operation of motor B after circuit No. 4 is opened. The operation of motor B brings one of the strikers **27** into engagement with the needle **23** to open switch *a*, opening circuit No. 3 and deenergizing relay C. The position of the strikers **27** with relation to the indentations **29** is such that switch *a* is opened at a predetermined interval of time after motor B is started. This interval is preferably of the order of one second or less but is appreciably longer than the duration of the electromotive impulse from the detector D. The relay C is thus energized for a predetermined brief period after each detector impulse.

The deenergizing of relay C opens switch *c* breaking circuit No. 4 but the operation of motor B continues through circuit No. 5 until the next of the indentations **29** reaches finger **31**, whereupon switch *b* is opened, circuit No. 5 is broken, and the apparatus is in condition to receive another impulse from the detectors. The single detector actuation has resulted in the energizing of relay C and the closing of switch *d* for a predetermined period of time. The closing of switch *d* may initiate signal changes which will be described in connection with an illustrative sequence of operations.

*Illustrative sequence of operations*

The sequence of operation of the switches included in the various circuits is shown in Fig. 6 for an illustrative cycle of operation. In this figure the cross hatched areas indicate the portion of the cycle in which each switch is closed while the blank areas indicate the portion in which the switch is open. The time during which each relay, motor coil and signal lamp is energized is also indicated by cross hatched areas. The duration of the various time periods is not shown to scale, certain periods being exaggerated for clearness and all periods being manually adjustable within wide limits.

The alternating current circuits referred to by circuit number in describing the sequence of operation of the illustrative cycle of Fig. 6 and indicated by number in Fig. 7 are as follows:

Circuit No. 6 (38, *d*, 47, E, 39) energizes the register coil E of the NS adjuster.

Circuit No. 6' (38, *d'*, 47', E', 39) energizes the register coil E' of the WE adjuster.

Circuit No. 7 (38, *v*, 48, WE STOP, 39) displays stop signal for the WE highway.

Circuit No. 7' (38, *v'*, 48', NS STOP, 39) displays stop signal for the NS highway.

Circuit No. 8 (38, *v*, 48, *s*, 49, NS GO, 39) displays go signal for the NS highway.

Circuit No. 8' (38, *v'*, 48', *s'*, 49', WE GO, 39) displays go signal for the WE highway.

Circuit No. 9 (38, *v*, 48, *s*, 49, *r*, 50, K, 39) energizes the timer motor coil K.

Circuit No. 9' (38, *v'*, 48', *s'*, 49', *r'*, 50', K', 39) energizes the timer motor coil K'.

Circuit No. 10 (38, *v*, 48, *s*, 49, *f*, 51, *e*, 50, K, 39) also energizes the timer motor coil K.

Circuit No. 10' (38, *v'*, 48', *s'*, 49', *f'*, 51', *e'*, 50', K', 39) also energizes the timer motor coil K'.

Circuit No. 11 (38, *v*, 48, *s*, 49, *q*, 52, F, 39) energizes the extension coil F of the NS adjuster.

Circuit No. 11' (38, *v'*, 48', *s'*, 49', *q'*, 52', F', 39) energizes the extension coil F' of the WE adjuster.

Circuit No. 12 (38, *v*, 48, *u*, 53, NS CH, 39) displays a cautionary signal to the NS highway.

Circuit No. 12' (38, *v'*, 48', *u'*, 53', WE CH, 39) displays a cautionary signal to the WE highway.

Circuit No. 13 (38, *v*, 48, *t*, 54, M, 39) energizes the timer motor coil M.

Circuit No. 13' (38, *v'*, 48', *t'*, 54, M, 39) likewise energizes the timer motor coil M.

*Starting conditions—WE GO idle period*

In the illustrative cycle of operations of Fig. 6 it is assumed that the cycle begins in the idle portion of the WE right of way period. The condition of the various switches during this period is shown in the wiring diagrams Figs. 5 and 7 and is indicated in the column of Fig. 6 headed WE GO IDLE. The following circuits are complete:

Circuit No. 7' displays the stop signal for the NS highway.

Circuit No. 8' displays the go signal for the WE highway.

Circuit No. 11' energizes the extension coil F' of the WE adjuster, holding the stop arm 34' against the stop 35' to maintain the adjuster in the position shown in Fig. 5. As long as coil F' is energized, coil E' will not have sufficient torque to move the adjuster from this position.

*Traffic call from the NS highway*

With the apparatus in the idle position just described, it is assumed that one of the NS detectors D is actuated by a vehicle approaching the intersection at the point indicated by the notation NS CALL in Fig. 6. The consequent operation of the NS detector relay has been previously described and is indicated in Fig. 6. It will be remembered that this action results in the closing of switch *d* for a predetermined period of time. The closing of switch *d* completes circuit No. 6 to energize the register coil E of the NS adjuster. The coil E being energized during this predetermined period turns the NS adjuster from its initial position a predetermined distance. This distance is preferably a small fraction of a revolution but is sufficient to permit switch *e* to be opened and switch *f'* to be closed, as indicated in Fig. 6. The opening of switch *e* has no immediate effect. The closing of switch *f'* however completes circuit No. 10' to energize the timer motor coil K'. The operation of motor coil K' runs the timer out of its idle position into a zone corresponding to the first change period indicated in Fig. 6.

*Change period*

The entry of the timer into the first change zone opens switches *s'* and *q'* and closes switches *t'* and *u'*.

The opening of switch *s'* breaks circuit No. 8' to extinguish the WE GO signal, breaks circuit No. 11' to deenergize the extension coil F' of the WE adjuster, thus placing said adjuster in position to receive a WE traffic call, and also breaks circuit No. 10' to deenergize the timer motor coil K'. The closing of switch *u'* completes circuit No. 12' to display the cautionary signal for the WE lane. The closing of switch *t'* completes circuit No. 13' to energize the timer motor coil M which runs the timer through the change zone. The duration of the cautionary period depends upon the speed at which the coil M is permitted to run the timer and this speed may be manually adjusted.

*NS GO initial period*

At the end of the change period, the timer enters a zone corresponding to the period designated "NS GO initial" in Fig. 6. The entry of the timer into this zone opens switches *v'*, *t'* and *u'* and closes switches *v*, *s* and *r*.

The opening of switch *v'* opens circuit No. 7' to extinguish the NS STOP signal, open circuit No. 12' to extinguish the WE CH signal and opens circuit No. 13' to deenergize motor coil M. The opening of switches *t'* and *u'* insure that only circuit No. 7' of these three will be completed when switch *v'* is again closed.

The closing of switch *v* completes circuit No. 7 to display the WE STOP signal. The closing of switch *s* completes circuit No. 8 to display the NS GO signal. The closing of switch *r* completes circuit No. 9 to energize the motor coil K which runs the timer through the initial portion of the NS right of way period. The duration of this period may be varied by adjustment of the speed at which motor coil K is permitted to operate the timer.

*Receipt of a plurality of WE traffic calls*

In the illustrative sequence of operations, the next assumed event is the actuation of one of the detectors D' in the WE lane, taking place before the completion of the initial period of NS right of way, as indicated in Fig. 6 by the first notation WE CALL. Upon receipt of this call, the WE detector relay acts as previously described to close switch *d'* to complete circuit No. 6' for a predetermined brief period of time. Circuit No. 6 actuates the register coil E' to offset the WE adjuster from its initial position a predetermined distance, at the same time opening switch *e'* and closing switch *f*. No immediate result ensues from the operation of these switches.

The next assumed event is a second call from the WE highway indicated in Fig. 6 by the second notation WE call. This call results in a second closing of switch *d'* and consequent actuation of register coil E' for a second predetermined time. The second actuation of the register E' results in offsetting the WE adjuster a greater distance from its initial position. Subsequent calls would have the same effect so that the angular position of the adjuster indicates the number of traffic calls which have been received.

*End of NS GO initial period*

When the timer has traversed the zone corresponding to the NS GO initial period, switch *r* is opened and switch *q* is closed.

The opening of switch *r* opens circuit No. 9 to the timer motor coil K and brings the timer to rest in an idle position.

*NS extension period*

The closing of switch *q* completes circuit No. 11 to the extension coil F of the NS adjuster. The actuation of coil F turns the adjuster toward its initial position and the speed of its movement is adjusted to occupy the period of time indicated by the first notation EXT in Fig. 6. A certain definite period is thereby added to the NS right of way period. At the completion of this movement of the adjuster, arm **34** comes to rest against stop **35** and switch *e* is closed and switch *f'* is opened. If at this time no traffic call had been received from the WE lane, no circuits would be completed by this switch movement. The apparatus would then remain in an idle condition indicating NS right of way until at least one such call is received.

In the present example, however, it is assumed that WE calls have been received. The WE adjuster is, therefore, standing with switch *f* closed. The closing of switch *e*, therefore, completes circuit No. 10 to energize motor coil K to move the timer from its idle position into a zone corresponding to the second change period indicated in Fig. 6.

*Second change period*

The entrance of the timer into the zone corresponding to the second change period results in a change of signals analogous to that described for the first change period. In this operation, primed circuits take the place of unprimed circuits, and vice versa.

*WE GO initial period*

The change of signals at the start of the WE GO initial period is accomplished by circuits similar to those described for the NS GO initial period, primed circuits taking the place of unprimed circuits, and vice versa. At the end of this period, switch *r'* is opened and switch *q'* is closed. The coming of switch *r'* opens circuit No. 9' to the timer motor coil K' and stops the timer in its idle position.

*WE GO extension periods*

The closing of switch *q'* at the end of the WE GO initial period completes circuit No. 11' to the extension coil F' of the WE adjuster. The actuation of this coil returns the adjuster to its initial position. Since it was assumed that two WE traffic calls had been received, the distance to be traversed is twice what it would have been if only one such call had been received. The extension period timed by the movement of the adjuster is, therefore, approximately twice the period for a single call and may be considered as made up of two extension periods of equal length. A larger number of calls would, of course, result in a larger number of extension periods. At the end of the WE GO extension periods, switch *e'* is closed and switch *f* is opened. Unless traffic calls have been received from the NS highway, the apparatus remains in an idle position indicating WE right of way until such a call is received. This idle position is the same as that from which the illustrative sequence of operations began.

*Summary—Full traffic actuated system*

Briefly summarized, the full traffic actuated system just described provides for retention of right of way on one highway until called to the other by a traffic demand. The period of right of way includes an initial period timed by the timer and an extension period timed by the adjuster during which right of way can not be transferred to the other highway. During this period, traffic calls from the other highway are registered and counted by the adjuster for that highway. The length of the extension period is in proportion to the number of traffic calls received during the time that right of way was denied to the highway in question and during the initial portion of the right of way period for that highway. In practice the initial period and extension period for a single traffic call are timed to permit a vehicle to start from a standing position, enter and clear the intersection. The additional extension time for an additional traffic call is the additional time necessary for a second vehicle stopped behind the first, to start, enter and clear the intersection. Thus, a change of signals is denied only as long as necessary for waiting vehicles to pass the intersection. The movement of the adjuster required to register each call is sufficiently small to register in less than one turn of cam **33** as many calls as are necessary for the number of vehicles which may be stopped between the detector and the intersection. This number may of course be varied to suit the traffic requirements at any given intersection.

It is to be noted that traffic calls received from one highway during an idle right of way period for that highway will not be registered since the corresponding extension coil F or F' is energized. Traffic calls received from one highway during an extension period for that highway result in the simultaneous actuation of the register coil E and extension coil F of the corresponding adjuster. Since coil F preferably has a greater torque than coil E, the return movement of the adjuster is not stopped but is slowed down during the brief period that coil E is energized as a result of the call. The slowing of the adjuster results in the addition to the extension period of an amount of time which is less than the time added by a traffic call received during the preceding periods. Since a vehicle actuating the detector during an extension period ordinarily will not be required to come to a stop before entering the intersection, the smaller additional time is sufficient.

*Semi-traffic actuated operation*

For semi-traffic actuation, manual switches *g* and *g'* are provided, herein illustrated as double pole knife switches (not shown in Fig. 7). Switch *g* is arranged to short circuit switches *e* and *f'* and thus to render the NS adjuster ineffective. Switch *g'* similarly short circuits switches *e'* and *f*. When it is desired to operate the system by semi-traffic actuation with the right of way automatically returning to the WE highway after each NS right of way period, switch *g'* is closed, switch *g* remaining open. Starting from a WE GO idle period an NS traffic call then operates the system as previously described up to the end of the NS GO extension period. Since switch *f* is short circuited, the closing of switch *e* at the end of said period immediately completes circuit No. 10 to timer motor coil K to run the timer from its normally idle position into the succeeding change period irrespective of the fact that no WE traffic calls may have been received. The system then operates through the change and WE GO initial period as previously described. Since switch *e'* is short circuited, the apparatus at the end of said pe-

riod is in condition to be again operated by an NS traffic call irrespective of the fact that the WE adjuster may have been offset by one or more WE traffic calls. WE extension periods are thus omitted and the WE initial period may be adjusted to give sufficient time for any desired volume of traffic to pass on the WE highway before the signal may again be called to the NS highway.

By closing switch *g*, leaving switch *g'* open, the system may be operated by semi-traffic actuation with automatic return to the NS highway.

*Non-traffic actuation*

By closing both switches *g* and *g'*, the system becomes a fully pre-timed, non-traffic actuated system since both NS and WE idle periods and NS and WE extension periods are eliminated. The timer speed developed by motor coils K and K' may then be adjusted to give to each highway any desired length of right of way period.

The foregoing specification describes a preferred form of the invention, the details of which may be varied within wide limits without departing from the scope of the invention as defined by the appended claims. For example, other types of traffic actuated detectors may be used, the duration of the period during which calls may be registered may be limited and the so-called "extension" periods may precede instead of follow the fixed right of way period shown herein as an "initial" period, all by simple changes in wiring or by changes in the operation of the timer switches.

The invention claimed is:

1. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled means for returning said member to its initial position, cyclic switching means operating said signal apparatus and operable at a predetermined point in its cycle to initiate said return movement, electric circuits controlled by movement of said movable member to interrupt the operation of said cyclic switching means and to maintain a right of way signal for the lane of said controller during said return, electrically actuated means for moving said movable member from its initial position, and time controlled apparatus for actuating said last mentioned means for a predetermined brief period of time in response to each of a plurality of traffic actuations of said detector occurring prior to the initiation of and during said return movement.

2. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled means for returning said member to its initial position, cyclic switching means operating said signal apparatus and operable at a predetermined point in its cycle to initiate said return movement, electric circuits controlled by movement of said movable member to interrupt the operation of said cyclic switching means and to maintain a right of way signal for the lane of said controller during said return, electrically actuated means for moving said movable member from its initial position, and time controlled apparatus for actuating said last mentioned means for a predetermined brief period of time in response to each of a plurality of traffic actuations of said detector occurring during a registry period prior to the initiation of said return movement and during said return movement and in at least a part of which registry period right of way is denied to the lane of said detector.

3. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled forward driving means for returning said member to its initial position, electric circuits controlled by movement of said movable member to display a right of way signal for the lane of said detector during said return movement, electrically actuated reverse driving means for moving said movable member from its initial position, said reverse driving means having a weaker driving effect than said forward driving means so that operation of both driving means concurrently will retard but not overcome the return movement, and time controlled apparatus for actuating said reverse driving means for a predetermined brief period of time in response to each of a plurality of traffic actuations of said detector occurring during said return movement to prolong such display of right of way during return movement.

4. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled forward driving means for returning said member to its initial position, electric circuits controlled by movement of said movable member to display a right of way signal for the lane of said detector during said return movement, electrically actuated reverse driving means for moving said movable member from its initial position, said reverse driving means having a weaker driving effect than said forward driving means so that operation of both driving means concurrently will retard but not overcome the return movement, and time controlled apparatus for actuating said reverse driving means for a predetermined brief period of time in response to each of a plurality of traffic actuations of said detector occurring during said return movement and during a registry period prior to the initiation of said return movement and in at least a part of which registry period right of way is denied to the lane of said detector.

5. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled means for returning said member to its initial position, cyclic switching means operating said signal apparatus and operable at a predetermined point in its cycle to initiate said return movement, electric circuits controlled by movement of said movable member to interrupt the operation of said cyclic switching means and to maintain a right of way signal for the lane of said controller during said return, electrically actuated means for moving said movable member from its initial position, an electric switch and associated circuit means for actuating said elec-

trically actuated means, relay apparatus connected with said detector to move said switch to actuated position in response to traffic actuation of said detector, and time controlled means maintaining said switch in said actuated position for a predetermined brief period of time after each actuation thereof and at the end of each of such brief period moving said switch from actuated position, whereby said movable member will be moved farther from its initial position as a result of a plurality of traffic actuations occurring before the return movement thereof than as a result of one such actuation.

6. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled means for returning said member to its initial position, electric circuits controlled by movement of said movable member to display a right of way signal for the lane of said detector during said return movement, electrically actuated means for moving said movable member from its initial position, an electric switch and associated circuit means for actuating said electrically actuated means, relay apparatus connected with said detector to move said switch to actuated position in response to traffic actuation of said detector, an electric motor, circuits associated with said switch for operating said motor when said switch is actuated, magnetic means maintaining said switch in actuated position, and mechanical means operated by said motor and opposing said magnetic means after the lapse of a predetermined brief period of time to move said switch from its actuated position.

7. In a traffic control system for intersecting traffic lanes having right of way signal apparatus and a traffic actuated detector in one lane, the combination of an electrical switching unit having a member movable a variable distance from an initial position, time controlled means for returning said member to its initial position, electric circuits controlled by movement of said movable member to display a right of way signal for the lane of said detector during said return movement, electrically actuated means for moving said movable member from its initial position, an electric switch and associated circuit means for actuating said electrically actuated means, relay apparatus connected with said detector to move said switch to actuated position in response to traffic actuation of said detector, an electric motor, circuits associated with said switch for operating said motor when said switch is actuated, magnetic means maintaining said switch in actuated position, and a striker rotated by said motor and adapted to strike said switch after the lapse of a predetermined brief period of time and to move the same from its actuated position.

8. In a right of way signal system for intersecting traffic lanes including an electrical switching and timing unit for timing a variable period of right of way for at least one of the said traffic lanes, traffic actuated detector means to control the variation of such period, the said electrical switching and timing unit having a normal position at the end of its timing period and having a shaft and two driving members associated therewith, the first member adapted to be actuated to drive said shaft away from said normal position and the second member adapted to be actuated to drive said shaft toward normal position at a predetermined time rate and having a stronger driving effect than said first member so that concurrent actuation of both members will reduce such time rate but will not prevent return to normal position, means actuating said second member during such right of way period to time such period, and means connecting said first member with said detector to actuate said first member in response to traffic actuations of said detector to prolong such right of way period.

9. In a right of way signal system for intersecting traffic lanes including an electrical switching and timing unit for timing a variable period of right of way for at least one of the said lanes, traffic actuated detector means to control the variation of such period, the said electrical switching and timing unit having a normal position at the end of its timing period and having a shaft and two driving members associated therewith, the first member adapted to be actuated to drive said shaft away from said normal position and the second member adapted to be actuated to drive said shaft toward normal position at a predetermined time rate and having a stronger driving effect than said first member so that concurrent actuation of both members will reduce such time rate but will not prevent return to normal position, means actuating said second member during such right of way period to time such period, and time controlled apparatus connected with said detector to actuate said first member for a brief time period in response to each of a plurality of traffic actuations of said detector to prolong such right of way period.

10. A traffic control system for intersecting traffic lanes comprising right of way signalling mechanism, traffic actuated detector means in one lane, an electrical switching and timing unit movable a variable distance from a normal position, a forward driving member for returning the said unit to its normal position at a predetermined time rate, electric circuits controlled by movement of the said unit to display through said mechanism a right of way signal for the lane of the said detector means during the return movement, an electrically actuated reverse driving member for moving the said unit from its normal position, and time controlled apparatus for actuating the said reverse driving member for a predetermined brief period of time in response to each of a plurality of traffic actuations of the said detector occurring prior to and during such return movement, said driving members being adjusted for the forward driving member to have a stronger driving effect than the reverse driving member whereby when both members are actuated concurrently the time rate of return movement will be reduced to prolong display of right of way but return movement will not be prevented.

11. A traffic control system for intersecting traffic lanes comprising electric right of way signalling mechanism including a time controlled cyclic switch device having a cycle of operation including alternate right of way signal periods for the respective lanes, traffic actuated detector means in one of said lanes, an electrical time switch unit having a normal position and movable a variable distance from said normal position, a forward driving member for said unit and adapted to be operated to return said unit at a predetermined time rate to its normal position, a reverse driving member for said unit connected to be actuated by said detector to move said unit away from normal position for each of a plurality

of such actuations, switch devices forming a part of said cyclic switch to interrupt the cyclic operation of said cyclic switch and actuate said forward driving member in a predetermined part of its cycle in the right of way period for said one lane, and switch means actuated by said switch unit only in its normal position to operate said cyclic switch through said predetermined part of its cycle to continue its cyclic operation, said driving members being adjusted for the forward driving member to have a stronger driving effect than the reverse driving member whereby when both members are actuated concurrently the time rate of return movement will be reduced to prolong right of way but return movement will not be prevented.

12. A traffic control system for two intersecting lanes comprising electric right of way signalling mechanism including a time controlled cyclic switch device having a cycle of operation including alternate right of way signal periods for the respective lanes, traffic actuated detector means in each of said lanes, a pair of electrical time switch units one for each lane and each having a normal position and movable a variable distance from said normal position, a forward driving member for each said unit and adapted to be operated to return its unit at a predetermined time rate to said normal position, a reverse driving member for each said unit connected to be actuated by the said detector of its associated lane to move said unit away from said normal position, switch devices forming a part of said cyclic switch to interrupt said cyclic operation of the latter in a part of each right of way position and to energize the cyclic switch for operation through the remainder of its cycle, an energizing circuit for operation of said cyclic switch through the first lane right of way position including a switch closed by one of said switch units only in its normal position and a switch closed by the second switch unit only when the latter is off normal position, an energizing circuit for operation of said cyclic switch through the second lane right of way position including a switch closed by the second said unit only in its normal position and a switch closed by the first said switch unit when the latter is off normal position, and additional switch devices forming a part of said cyclic switch to energize the forward driving member of said one unit when cyclic operation of the cyclic switch is interrupted in said first right of way position and to energize the forward driving member of said second unit when cyclic operation is interrupted in said second right of way position.

13. A traffic control system for two intersecting lanes comprising electric right of way signalling mechanism including a time controlled cyclic switch device having a cycle of operation including alternate right of way signal periods for the respective lanes, traffic actuated detector means in each of said lanes, a pair of electrical time switch units one for each lane and each having a normal position and movable a variable distance from said normal position, a forward driving member for each said unit and adapted to be operated to return its unit at a predetermined time rate to said normal position, a reverse driving member for each said unit connected to be actuated by the said detector of its associated lane to move said unit away from said normal position, switch devices forming a part of said cyclic switch to interrupt said cyclic operation of the latter in a part of each right of way position and to energize the cyclic switch for operation through the remainder of its cycle, an energizing circuit for operation of said cyclic switch through the first lane right of way position including a switch closed by one of said switch units only in its normal position and a switch closed by the second switch unit only when the latter is off normal position, an energizing circuit for operation of said cyclic switch through the second lane right of way position including a switch closed by the second said unit only in its normal position and a switch closed by the first said switch unit when the latter is off normal position, and additional switch devices forming a part of said cyclic switch to energize the forward driving member of said one unit when cyclic operation of the cyclic switch is interrupted in said first right of way position and to energize the forward driving member of said second unit when cyclic operation is interrupted in said second right of way position, said driving members being adjusted for the forward driving member to have a stronger driving effect than the reverse driving member whereby when both members are actuated concurrently the time rate of return movement will be reduced to prolong right of way but return movement will not be prevented.

14. A traffic control system as in claim 13 and including time controlled apparatus connected between each said detector and its associated said reverse driving member to maintain the latter actuated for a predetermined brief time period in response to each of a plurality of traffic actuations whereby each said unit will be moved a variable distance from normal prior to its return movement corresponding to the number of traffic actuations occurring in the opposite lane since its last previous return movement actuated by the cyclic switch.

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