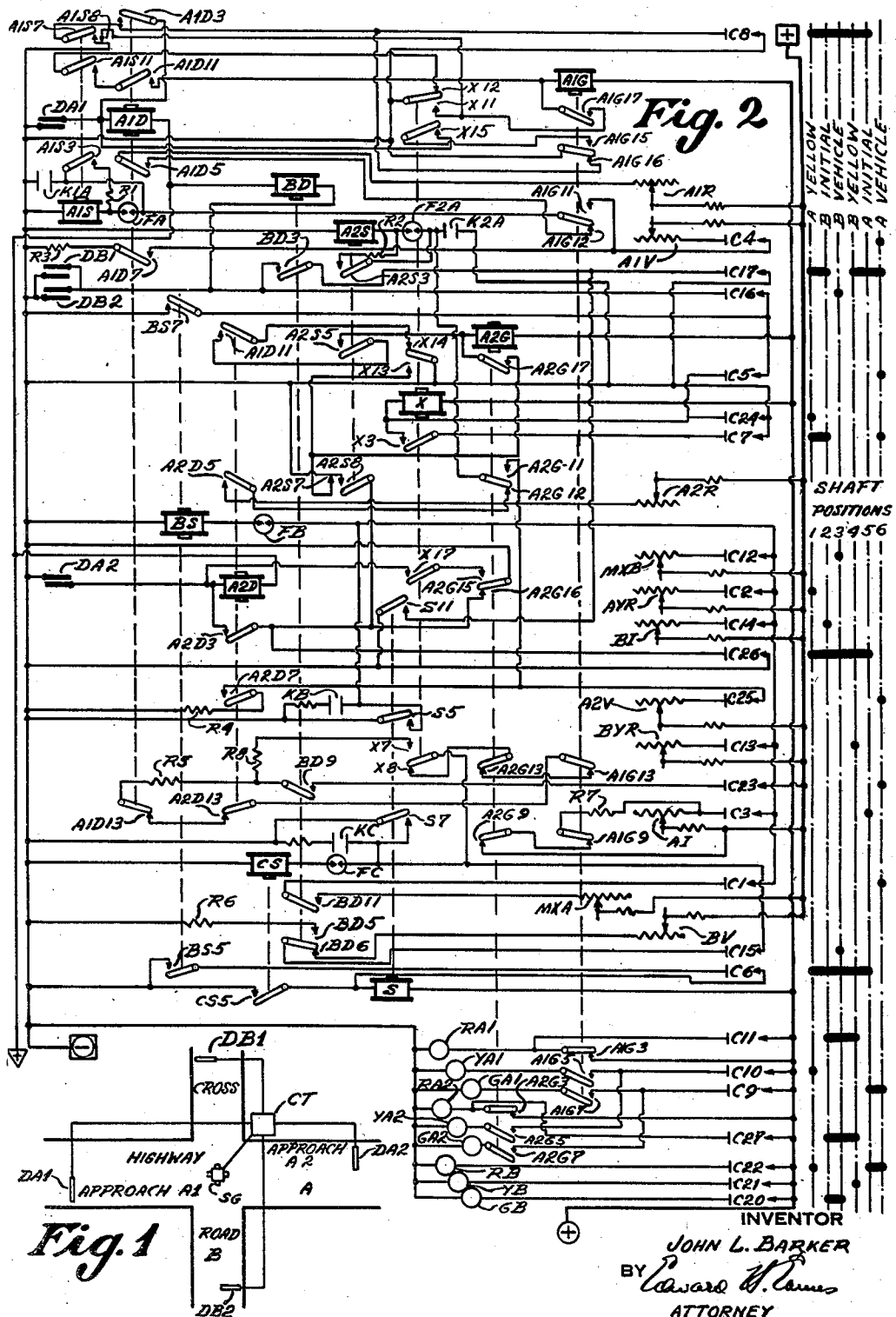


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TRAFFIC ACTUATED CONTROL APPARATUS

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This invention relates to traffic actuated control apparatus for use at road intersections and the like and in which traffic control signals are operated by the traffic on the road.

The invention is more particularly concerned with apparatus of this type for the control of right of way traffic at road intersections where it is also desired to control the speed of traffic approaching the intersection by normally displaying a red or stop signal to all of the approaches to the intersection in the absence of approaching traffic and to introduce a brief time delay before switching to a green or go signal in response to traffic approaching a short distance from the intersection but to provide alternate accord of right of way to the intersecting roads when traffic is present on more than one of the conflicting roads.

The invention provides improved apparatus of this type in which a brief time delay is provided before change from red to green for the first car approaching a red signal on either of the roads and provides for the prolonging of the display of the green signal by closely spaced cars approaching the green signal with a maximum time limit to such prolonging of the green signal on either road in case of traffic waiting on the other road, and also providing a cautionary clearance period upon change from green to red at the maximum limit.

In the preferred form of the invention, the usual red, yellow or amber, and green signals are provided for each approach to the intersection and traffic detectors are located for actuation by traffic approaching the intersection some distance in advance in each approach and a control apparatus or controller including timing devices operates the signals under joint control of the timing devices and traffic actuation of the detectors.

This apparatus lends itself most favorably to the control of vehicle traffic at the intersection of a high speed highway and a cross road, with relatively long-distance signal visibility. Each approach of the high speed highway is treated separately during such time as the traffic controller would be normally showing a green light to the highway. By so separating the highway traffic it is possible to control the traffic on each highway approach in such a manner as to accomplish speed control of all highway vehicles. The apparatus, depending upon traffic conditions, also transfers the right of way from the highway to the cross road and in this sense it operates in a manner similar to a normal fully vehicle actuated signal system for two roads.

Summarizing the operation of the apparatus for various traffic conditions, under conditions of no traffic on any of the approaches all of the signal lights will show red. The controller is now resting in the highway right of way extension position. Actuation on one of the highway approaches will, if the vehicle is travelling at the proper speed, cause the signals on that approach to change from red to green by the time the vehicle arrives at the stop line or edge of the intersection. The green light will remain until the vehicle has cleared the intersection at which time the signal will change from green back to red. Another vehicle, on the same approach, crossing the detector during the first vehicle's green will be given another full green interval commencing at the moment of actuation. This feature allows traffic, which is travelling at the proper rate of speed and at close spacing between cars, to extend the green light indefinitely if there have been no vehicles on the cross street.

Vehicles crossing the detector on the other approach of the highway will receive the same treatment on their approach as was discussed for the case in the last paragraph. To summarize, when in an ordinary traffic control system the right of way would be on the highway, the following signal conditions may exist in the present apparatus: (a) both highway signal faces may be displaying red, (b) one red and the other green, or (c) both green, depending upon the presence, speed, and spacing of traffic on the two approaches.

Vehicles crossing the side street detectors will put in a call for the right of way. If neither of the highway approaches is being used the controller will immediately accord the right of way to the side street.

If either one or both of the highway approaches has traffic continuously extending the green signal, the controller begins a highway maximum timing period when a vehicle crosses the side street detectors. This timing period determines the maximum waiting time for the side street traffic at the expiration of which the right of way will automatically be transferred from the artery to the side street. During this side street waiting time the green light may alternate between the two highway approaches or be on both but if during the period both artery approaches are cleared, the right of way will be assigned immediately to the side street.

Either one or both of the highway approaches will have a green light as the above maximum period expires and under these conditions a clear-

ing period will be given to the highway. If both of the highway approaches are showing green as the maximum expires both highway green lights will change to yellow for the clearing period. If only one of the highway approaches is receiving a green light as the maximum expires, only this signal face will change to yellow, the other approach remaining red.

In the case where one of the highway approaches is carrying continuously moving traffic and is extending the green light on its side of the signal a car may cross the detector of the other highway approach, which has previously been red in the absence of traffic, just before the expiration of the highway maximum. Due to the fact that it would not be advisable to show a green light to the vehicle on the second approach momentarily and immediately change this to yellow when the maximum period expires, an additional timing circuit is incorporated in the controller which will add a short period to the highway right of way at the maximum limit. This period assures that if the controller has accorded a green light, after the necessary speed control delay, to the vehicle on the second approach the green will now include the balance of the extendable period plus the minimum period which can be set to any desired value.

The cross road right of way period can be extended by vehicles up to a maximum in the usual manner. The cross road right of way is followed by the customary clearing period in which time the cross road green lights change to yellow.

Vehicles which have approached on the highway during the cross road right of way period will be given a green light immediately at the expiration of the cross road clearing interval. If cars are on both approaches of the highway both signals will change to green at the expiration of the cross road clearing interval. If traffic is waiting on one of the highway approaches only, that approach will receive a green light and the other highway approach will remain red. An initial green interval will be provided for standing traffic to get in motion, and then an extendable green or "vehicle interval," without interruption of the green signal. Traffic which approaches on the highway during the latter part of the cross road right of way interval or the cross road clearing interval will, however, have to be travelling at the proper rate of speed in order to receive the green light at the beginning of the right of way period for the highway. As an example of this, a vehicle may approach the highway red signal at a high rate of speed during the cross-road yellow clearing interval and the yellow clearing interval may expire but the red light should still be maintained in order to slow the highway vehicle. The signal lights will then change from yellow to red on the cross road and will continue red on the highway for the regular delay time so that the vehicle speed has been reduced to a proper value at which time the highway signal light will change from red to green. This condition may exist on one or both of the approaches of the highway.

The controller is so arranged that it automatically returns to its position of potential highway right of way in the absence of traffic on the cross road. In light traffic conditions there may be no vehicles present on either of the highway approaches when the controller returns to the highway position, in which case the highway signals will be red and the normal starting time which the controller accords for vehicles which

have been stopped will be cut out of the controller cycle. The controller under this condition will step rapidly through the initial interval and come to rest in the extendable portion of the highway right of way period.

The controller can yield to the cross road immediately if both highway approach signals are red and there is no traffic on either of the highway approaches, and the controller can also step rapidly through the highway initial interval and vehicle interval if there have been no cars on the highway, so it is possible for the controller to return the right of way to further cross road traffic immediately after a red delay interval serving to control the speed of such cross road traffic. Under conditions where the controller is showing the green light to the cross road and it changes to the customary cross road clearing interval with no cars on the highway, another vehicle approaching on the cross road will now cause the controller to go from the cross road yellow to red for only a short delay interval and then immediately back to cross road green again. This process can be repeated until such time as the dispatcher moves to cross road yellow and there is traffic waiting or arriving on the highway in which case it resumes its functions as a normal traffic controller assigning the right of way alternately to the highway and cross road in accordance with traffic demands on both roads.

It is an object of the invention to provide improved apparatus to combine speed control and right of way control for traffic at a road intersection to include holding a stop signal for a brief delay before changing to a go signal for widely spaced vehicles approaching the stop signal and to prolong the go signal by closely spaced vehicles approaching the go signal.

It is a further object of the invention to provide traffic control apparatus of this character including provision for independent speed control on each approach of one of the intersecting roads with facilities for separate timing adjustment for the two approaches and for assurance of a minimum go signal period responsive to traffic actuation.

Reference may be had to the accompanying drawing illustrating the preferred embodiment of the invention and in which:

Fig. 1 shows a layout of apparatus such as may be employed at an intersection in accordance with the invention.

Fig. 2 shows a schematic wiring diagram of one form of the traffic actuated control apparatus in accordance with the invention.

Referring now to Fig. 1 there is illustrated an intersection of a highway A and a cross road B. A traffic signal SG is shown in position to display signals to both roads, and will preferably include the usual red, yellow and green signals for each of the roads A and B. Traffic detectors DA1 and DA2 are located on approaches A1 and A2 respectively of a highway A at some distance from the intersection to be actuated by approaching traffic and detectors DB1 and DB2 are similarly located on the approaches of the cross road B. The detectors and signal are connected to the controller CT as indicated schematically.

Referring now to Fig. 2 the apparatus is indicated schematically including the controller with its internal wiring and its connections to the signals and detectors. The controller includes a step-by-step cyclic switching unit which is preferably but not necessarily of the camshaft

type. In the present embodiment this cyclic switch unit has a cycle of six camshaft positions indicated schematically in the camshaft position diagram at the right of the figure and includes the cam operated contacts C1 to C27 inclusive arranged along the right side of the figure. The respective cam contacts are closed in the positions indicated by the black bar or dot in the camshaft position diagram opposite the contacts.

The camshaft is stepped from one position to another by a solenoid or magnet S in accordance with familiar practice through a ratchet mechanism not shown. The camshaft remains at rest in one position until the solenoid is operated to step it immediately to the next position in the cycle.

The apparatus is ordinarily supplied from alternating current power supply wires including the power wire indicated by plus in a circle and extending along the right side of the figure and the grounded return wire indicated by minus in a circle and square and extending along the left side of the figure. The apparatus also employs alternating current of a lower voltage for the detector circuits and the low voltage supply line is indicated by a plus in a triangle and extends along the left side of the figure.

Several timing elements are employed in the controller to time the various signal periods subject to control by the traffic detectors in certain camshaft positions, and in the present preferred embodiment these timing elements are of the type employing the charging of a condenser through a resistance to the threshold breakdown or conduction voltage of a gaseous discharge tube, the condenser then immediately discharging through the tube to operate a relay indicating the termination of the time period.

Four such condenser discharge tube and relay groups are used as timing units in the present apparatus with various adjustable resistances connected to the several timing circuits by the camshaft contacts in different positions of the camshaft and also by relay contacts in different relay combinations as will be subsequently described. Thus the four condenser timing units are employed for a much larger number of different time periods.

The four timing units can be identified by their discharge tubes F1A, F2A, FB and FC in the figure. Tube F1A has an associated condenser K1A and a relay A1S. Tube F2A has an associated condenser K2A and relay A2S. Tube FB has an associated condenser KB and relay BS. Tube FC has an associated condenser KC and relay CS.

The several resistances are shown schematically near the right side of the figure.

Direct current power supply is provided for the timing units, employing a common negative line at the left side of the figure and employing a separate positive line indicated by a plus in a square and extending along the right side of the figure. This direct current supply may be obtained by a transformer and rectifier arrangement from the AC line for example.

The two approaches of the highway A1 and A2 are served independently by the red, yellow and green signals RA1, YA1, GA1, and RA2, YA2, GA2, respectively; and the cross road is served by the red, yellow and green signals RB, YB, GB.

The cross road signals are operated directly by the cam contacts C22, C21, C20 respectively, and the highway signals are operated under joint

control of the cam contacts C9, C10, C11, C21 and contacts of the relays A1G and A2G.

The traffic detectors DA1 and DA2 for approaches A1 and A2 respectively of the highway and the detectors DB1 and DB2 for the two approaches of the cross road are indicated schematically in the figure as switches, although it will be appreciated that these detectors may take any of a number of well known forms. In the present illustration the switches are closed momentarily by passage of a vehicle over the respective detectors.

Considering now the cycle of operation of the controller it will be noted that the camshaft has a cycle of six positions as indicated in the camshaft diagram at the right of the figure, including the three positions for the initial, vehicle and yellow intervals for the cross road B in camshaft positions 2, 3 and 4 respectively, and the three positions for the corresponding initial, vehicle, and yellow intervals for the highway in position 5, 6 and 1 respectively. The A initial and A vehicle interval positions 5 and 6 are in reality potential right of way or go signal positions for the highway, the actual display of the go signal to each approach of the highway being made only responsive to actuation of the respective detectors in the highway approaches and consequent operation of the relays A1D and A1G for the A1 approach and relays A2D and A2G for the A2 approach respectively. The display of the go signal is controlled by these relays only in these two camshaft positions 5 and 6, and in these two positions the display of the red or green signal alternatively is controlled independently for these two approaches. In the cross road positions of the camshaft positions 2, 3 and 4, the signals for both approaches of the highway are maintained red by the cam contacts C11 and C21, the circuit of the green signals of both approaches of the highway being interrupted by the cam contact C9 at this time and the yellow signals for the highway also being interrupted by the cam contact C10.

Thus the camshaft provides the usual signal cycle responsive to cross road actuation but the green and the yellow signal periods for the highway are only potential signal periods as far as the camshaft is concerned and are converted to actual green and yellow periods for the highway only in accordance with traffic actuation as will be more fully described later in the specification, the red signals being displayed to both approaches of the highway in absence of traffic actuation there, in the highway potential right of way positions of the camshaft, and the red signals also being maintained to the highway approaches in the potential highway yellow position 1 of the camshaft unless the green signal has just previously been accorded responsive to actuation, in which case the yellow signal is actually displayed to the approach in which such actuation occurred, during the potential A yellow position of the highway.

Let it now be assumed that the camshaft is resting in the A vehicle position 6 in absence of any traffic actuation on either approach of the highway or cross road. The cross road red signal RB will be energized by cam contacts C22 across the normal A. C. power wires, and the cross road green and yellow signals BG and BY will be maintained deenergized by the open cam contacts C20 and C21. The red signal RA1 will be energized from the normal A. C. power line via back contact A1G3 of relay A1G to the negative power

line. The red signal RA2 of approach A2 is energized from the normal A. C. power line via back contact A2G3. The green signals GA1 and GA2 and the yellow signals YA1 and YA2 are maintained deenergized by the open front contacts A1G7 and A2G7, and A1G5 and A2G5 respectively.

The relays A1G and A2G are deenergized under the assumed condition since their energizing circuits are maintained interrupted at the front contacts A1D11 and A2D11 of the relays A1D and A2D respectively. The relays A1D and A2D are in deenergized position because their energizing circuits are open at detectors DA1 and DA2 respectively in the absence of traffic actuation.

Under the assumed conditions all of the timing circuits are inactive.

Let it now be assumed that a vehicle arrives on approach A1 of the highway actuating the detector DA1 which may be located from 100 to 250 feet from the intersection, for example, depending upon the speed of traffic with the greater distance for a higher speed. Actuation of detector DA1 closes the detector switch DA1 thus connecting the negative power line through relay A1D to the low voltage positive power line indicated by the plus in a triangle thus energizing relay A1D. The relay A1D locks up over its own make contact A1D3 and the back contact A1G15 of relay A1G to negative power.

Energization of relay A1D also closes contacts A1D5 to start one of the timing units by closing the charging circuit for condenser K1A from the positive DC line marked plus in a square at the right side of the figure via the resistor A1R, relay contact A1D5, back contact A1G12 of relay A1G through the condenser to negative power. This charging of condenser K1A starts timing a brief red delay interval for controlling the speed of the vehicle on approach A1, the red delay interval being timed by adjustment of the resistance A1R so that if the vehicle is travelling faster than a desired speed the vehicle will arrive at the stop line at the edge of the intersection while the signal is still red and will therefore be forced to stop to avoid violating a signal, but if the vehicle is traveling at not more than the desired speed it will receive a green signal before arriving at the stop line.

When condenser K1A becomes charged to the threshold voltage of the discharge tube F1A this tube becomes conducting and condenser K1A discharges through the tube and the relay A1S to energize relay A1S to complete the red delay timing interval. Relay A1S closes its contact A1S3 to shunt tube F1A with a low resistance R1 to assure the full discharge of the condenser K1A.

Energization of relay A1S also energizes relay A1G from negative power via back contact X12 of relay X, front contact A1D11, previously closed, and front contact A1S5, now closed, of relay A1S, to relay A1G and power.

Relay A1S remains energized only momentarily until condenser K1A becomes discharged through the low resistance R1 and relay A1S then becomes deenergized again. Relay A1G locks up over its own contact A1G17 and the make before break contact A1S9 of relay A1S to negative power. Energization of relay A1G also interrupts one branch of the lockin circuit of relay A1D at contact A1G15, and as soon as the other branch of the lockin circuit closed momentarily by relay contact A1S7 released upon deenergization of relay A1S the relay A1D is deenergized.

We now have relay A1G energized and relay A1D deenergized and the red signal RA1 deenergized by interruption of relay contact A1G3 and the green signal GA1 energized by the closure of relay contact A1G7, the remaining signals displaying red as before.

A new charging circuit is now completed for condenser K1A via the adjusting resistance A1V, cam contact C4, relay contact A1G11. Condenser K1A is thus charged to time the A1 vehicle interval for display of the green signal GA1 for brief time period of a few seconds for example.

If another vehicle actuates the detector on approach A1 during this green period the relay A1D will be energized as before and will discharge condenser K1A to reset its time interval and prolong the green signal by closure of relay contact A1D7 to connect the positive side of condenser K1A via relay contact A1G11 and resistor R3 to negative power. Successive traffic actuations of detector DA1 can continue to reset condenser K1A but as soon as a sufficient time gap appears between vehicles on approach A1 the condenser K1A will become sufficiently charged to break down the discharge tube F1A and energize the relay A1S again momentarily as before. With the cessation of traffic actuation on approach A1 as described the relay A1D will remain deenergized but the energization of relay A1S will interrupt the lockin circuit of relay A1G at relay contact A1S8 and thus deenergize relay A1G which restores the relays to their original positions and restores the A1 signals to their original positions with the red signal RA1 energized and the green signal GA1 deenergized.

Widely spaced vehicles on approach A1 can repeat this sub-cycle of operation of the A1 signals, providing each vehicle with a brief red delay interval and a green vehicle interval and then restoring to red, in absence of vehicle actuation on the cross road B.

In a similar manner any vehicle approaching on approach A2 will actuate detector DA2 energizing relay A2D and after a red delay interval timed by charging condenser K2A via the control resistance A2R the relay A2S will be operated via discharge tube F2A and energize relay A2G to change from a red signal to a green signal on approach A2 independently of approach A1, when the camshaft is in the A vehicle position 6. The green signal on approach A2 will be timed for a vehicle interval by condenser K2A charging via control resistance A2V, cam contact C25 and relay contacts A2G11 and operating relay A2S momentarily to deenergize the relay A2G again to restore the A2 red signal. The A1 and A2 relay and timing circuits are symmetrical, the A2G relay controlling the signals RA2 and GA2 in a manner similar to the control of the signals RA1 and GA1 via relay A1G, and the A2 group circuit can be traced in more detail if desired by comparison with the A1 group circuit.

If it is now assumed that the controller is in its resting condition in the A vehicle position 6 and with all of the red signals energized, it will also be assumed that a vehicle approaches on either approach of the cross road B in absence of any vehicles on either approach of the highway. The cross road vehicle will actuate the detector in the cross road at a distance from the intersection and will close either detector switch DB1 or DB2 as the case may be. In either case closure of the switch will energize the B detector relay BD between negative power and the low voltage A. C.

power and this relay will lock up over its contacts BD3 and cam contact C17 to negative power. Energization of relay BD also closes a short period charging circuit for condenser KC in another of the timing units from the positive D. C. power via cam contacts C23, relay contact BD9, resistance R5, relay contact A1D13, A2D13, A1G13 and A2G13 with all the last four relays deenergized and via relay contact X8 with the latter relay deenergized to condenser KC to negative power. Condenser KC is charged quickly in a fraction of a second to the threshold voltage of the discharge tube FC so as to discharge through the tube to energize relay CS which in turn at its contact CS5 energizes the solenoid S to step the camshaft from position 6 to position 1.

The relays A1D, A1G, A2D, A2G have remained deenergized due to absence of traffic on the highway and the highway red signals are maintained energized over the back contacts A1G3 and A2G3 as previously described, with the highway yellow signal maintained deenergized by the open front contact A1G5 and A2G5, while the cam shaft is in the A yellow position 1. In this position a charging circuit is completed via control resistance AYR and the cam contact C2 to condenser KB of the four timing units to charge condenser KB to the threshold voltage of tube FB which then discharges condenser KB through relay BS to energize the relay BS momentarily, thus energizing the solenoid S again, but via relay contact BS5 and cam contact C6 to step the camshaft to the B initial position 2. Each energization of the solenoid S closes its contacts S5 and S7 to complete a momentary discharge circuit for condensers KB and KC respectively to assure complete discharge.

In the B initial position the cam contacts C11 and C27 maintain the red signals RA1 and RA2 on the highway and the cam contacts C9 and C10 are open to maintain the green and yellow signals of the highway interrupted. The cam contacts C22 deenergize the cross road red signal BR and cam contact C20 energizes the cross road green signal BG.

In the B initial position a charging circuit is completed via control resistance BI, cam contact C14 to charge condenser KB to time the initial interval and after this short period of a few seconds condenser KB reaches the discharge voltage of tube FB and energizes relay BS to energize the solenoid S again as before and to stop the camshaft into the B vehicle position 3.

In this position the cam contact C17 opens to interrupt the lockin circuit of relay BD and release this relay. In this position also a charging circuit is completed from positive power DC via control resistance BV, back relay contact BD6, cam contact C15 to charge condenser KC over a short time period providing display vehicle interval during a display of the green signal to the cross road, the signals remaining the same in this position as in the preceding B initial position of the camshaft. As soon as condenser KC has been charged to the discharge voltage of tube FC relay CS is operated to complete the time interval and energize the solenoid as previously described to step the camshaft to the B yellow position 4.

However, if in the B vehicle position further vehicles arrive on the cross road actuating the detector DB1 or DB2 the relay BD is reenergized momentarily to interrupt the charging circuit and to provide a rapid discharge circuit via cam contact C15, contact BD5 and resistance R6 to negative so as to reset the timing of condenser

KC and prolong the display of the green signal to the cross road.

Upon cessation of cross road traffic, however, the condenser KC will become charged to operate relay CS to advance the camshaft to position 4 as previously described.

In position 4 the B yellow signal YB will be energized by cam contact C21 and the cross road green signal BG will be deenergized by cam contact C20. A charging circuit for the B yellow interval is provided by the control resistance BYR and cam contact C13 to condenser KB which completes the interval as previously described by discharging through the tube FB to energize relay BS to energize the solenoid and step the camshaft to the A initial position 5.

In this position 5 the cross road yellow signal is deenergized and the cross road red signal is energized by their cam contacts and if no traffic actuation has occurred on either of the highway approaches the highway red signal will be maintained energized by the back contacts A1G3 and A2G3 of the relays A1G and A2G as previously described. Under this condition a short period charging circuit is completed via back contact A2G9 and A1G9 and resistance R7 and cam contact C3 to charge condenser KB in a fraction of a second to discharge through tube FB and operate relay BS and energize the solenoid to step the camshaft to the A vehicle position 6 in which all red signals remain displayed in the absence of actuation as previously described in the starting condition of the controller assumed.

If, however, an actuation had occurred by a vehicle on either approach A1 or A2 on the highway at any time in the cycle of operation after the camshaft had been stepped from the A vehicle position 6 to the next position the corresponding one of the relays A1D or A2D or both would be operated and corresponding relay A1G or A2G or both would be also operated and locked up, both relays being locked up. The A1D relay would be locked up over its contact A1D3 and the cam contact C8, and the A1G relay would be maintained energized after initial energization over the A1D11 relay contact and the A1S5 relay contact by the momentary energization of relay A1S after completion of the delay interval controlled by the resistance A1R for example.

Thus it will be noted that the A1D and A1G relays can be energized and the delay interval for A1 can be completed if the actuation on A1 occurred sufficiently prior to the arrival of the camshaft in the A initial position 5. A1D relay will be locked up as previously described and under these circumstances when the camshaft is stepped into the A initial position the red signal RA1 will be extinguished and the green signal GA1 will be energized by the energization of relay A1G as previously described. Similarly if an actuation occurred on approach A2 the A2G relay would be energized and the green signal instead of the red signal would be displayed to the approach A2 in the A initial position. If either of these relays A1G or A2G are thus energized the short period charging circuit previously described will be interrupted at contacts A1G9 or A2G9 and a normal initial interval time of several seconds will be provided via the control resistance AI to charge the condenser KB and operate relay BS and the solenoid S to step the camshaft to the A vehicle position 6, in which the charging circuit for the A1 vehicle interval and A2 vehicle interval are

prepared by the cam contacts C4 and C25 respectively and completed only if the A1G and A2G relays are energized respectively.

In order to prevent successive vehicle actuation on one road from holding the green signal indefinitely on that road against traffic actuation on the other road there are provided maximum time limits for the two roads by means of the condenser KB. The maximum time limit for either approach of the highway A is provided by a charging circuit from positive DC via control resistance MXA and contact BD11 of the cross road detector relay BD and via cam contact C1 through condenser KB. This is a long time period of 20 to 30 seconds for example initiated by the arrival of a vehicle on the cross road B actuating the detector and energizing the detector relay BD. At completion of the maximum time period the condenser KB discharges through the tube FB to operate the relay BS. The energization of relay BS also energizes relay X from negative power via contacts BS7, cam contacts C5 and relay X to positive power. Relay X locks up over its own contacts X3 and cam contacts C7 to negative power which maintains it locked up into the B initial interval position. Energization of relay X also completes a charging circuit via cam contact C23 in the A vehicle position and via relay contact BD9 and resistance R3, contacts X7 to condenser KC to charge this condenser over a period of several seconds to provide a protective green signal period in case either of the signals on the A approaches has just been switched to green by the arrival of a vehicle at this moment or immediately prior to this moment.

The X relay energization by the maximum time limit operation also serves to prevent the energization of relays A1G and A2G if they have not already been energized over their energizing circuits via the X relay contacts X12 and X14 respectively. If either of these relays A1G or A2G have been energized, however, when the relay X is operated the energization of the relay X will maintain these relays locked up over the contacts X11 and X13 respectively providing auxiliary lockin circuits so that even the operation of the vehicle interval termination relays A1S and A2S will not deenergize the relay A1G or A2G but the green signal once displayed would be maintained for the minimum protective green period determined by the charging resistance R3 until the condenser KC is charged to operate the solenoid by operation of the relay CS and thus step the camshaft to the A yellow position.

The X relay is always energized in the A yellow position by the cam contacts C24 so as to prevent the A1G and A2G relays from being energized in the A yellow position by maintaining their circuits interrupted at the contacts X12 and X14 respectively in case the red delay interval should be completed during the A yellow period on account of an actuation on the highway near the beginning of this period.

The maximum time limit for the cross road is started automatically in the vehicle position by cam contact C12 to charge condenser KB via the control resistance MXB so at the end of the relatively long maximum time limit the condenser KB will energize relay BS and the solenoid S to step the cam shaft into the B yellow position in case the B vehicle timing condenser KC has been kept reset by successive cross road vehicle actuation.

Energization of the relay BS on the maximum for the cross road also automatically energizes the cross road detector relay BD via the relay contact BS7 and cam contact C16 in order that relay BD may be locked in to return the right of way subsequently to the cross road without further actuation.

Similarly when the relay BS is operated to terminate the highway maximum limit and relay X is thus operated as previously described the relay X provides auxiliary energization circuits for the relays A1D and A2D via the X relay contacts X15 and X17 and the A1G relay contacts A1G15 and A2G15 respectively. The solenoid contacts S11 provide an auxiliary locking circuit shunting cam contacts C17 at the moment of energization of the solenoid on the maximum time limit for the cross road.

Summarizing the operation of the controller it will be noted that the camshaft serves as a cyclic switch unit to provide potential initial green interval and vehicle green interval and a yellow interval for the highway and actual initial and vehicle green intervals and a yellow interval for the cross road in the cycle of the camshaft, and that the potential intervals of the highway are converted to actual green or yellow intervals as the case may be by traffic actuation. Traffic actuation on either approach of a highway is able to control its own red and green signals independently of traffic actuation on the other approach and in the event of traffic actuation on the cross road and successive traffic actuation on the highway a highway maximum limit is provided which converts the potential highway yellow interval into an actual yellow interval for whichever approach of a highway has a green signal at the time of the maximum limit.

It will be noted that the actuation on either approach of a highway is able to prolong the right of way for such approach by resetting the vehicle interval green timer for that approach and also by initiating the red delay timer. The transfer of right of way to the cross road is prevented until completion of both the vehicle interval time periods and both the red delay time periods to release the A1D, A2D, A1G and A2G relays to operate the solenoid after the brief time period timed by resistance R5 and timing condenser KC. In the event of successive highway actuation the solenoid is operated by the relay CS which is energized by discharge of condenser KC after charge over a short time period by operation of relay B by relay BS which in time is operated by maximum limit timer condenser KB.

The successive red delay and green vehicle timing period for the highway approaches are provided independently of each other by the relay group A1D—A1G and A2D—A2G respectively by interlocking the relays within the group so that the relays proceed through a sequence of energization and deenergization to provide the successive time period and that these relay groups are made effective to control the red and green signals on the highway approaches only in the initial and vehicle interval positions of the camshaft for highway right of way and are similarly made effective to control the yellow signal for the highway approaches by the camshaft in the highway yellow position.

It will also be observed that these relay groups are able to be energized and proceed through the red delay interval timing to arrive in the vehicle interval position with respect to the re-

lay sequence during the camshaft position for the cross road so that when the camshaft returns to the potential highway right of way positions 5 and 6 the green signal will be accorded immediately to either or both approaches of the highway on which traffic actuation has occurred during the cross road period. Since such traffic has arrived at a time when it must be stopped anyway, the speed control red time delay is not needed and is timed out in advance. However, if actuation occurs on the highway by a vehicle arriving near the end of the cross road yellow period for example the red delay interval will start at that moment and will complete its timing even if it is necessary to continue over into the highway initial interval.

It is to be understood that various modifications in the structural details or arrangement of the parts, or changes in the design herein exemplified may be made without departing from the spirit of the invention as defined by the claims. In this connection it will be appreciated that the traffic signal colors and sequence used may be modified to meet the local variations found in practice, as for example by substitution of a dark period or partial overlap of the other signal colors in place of the yellow period.

I claim:

1. In a traffic control system for two intersecting roads having stop and go signals for the intersecting roads, traffic detectors for actuation by traffic approaching in the respective roads, and a controller for operating the signals to accord right of way alternatively to the two roads between minimum and maximum time limits responsive to actuation of the respective detectors and to interrupt right of way normally in the two roads in absence of such actuation, said controller including a step-by-step cyclic switching unit having a cycle of positions through which it is adapted to be operated responsive to detector actuation and including a position for potential operation of the go signal for one road and for operation of the stop signal for the other road and another position for operating the go signal for the other road and the stop signal for the first road, and a time controlled relay means for maintaining the stop signal operated and the go signal non-operated in said first road in said potential operating position normally in absence of detector actuation in said first road and for a brief time delay in the event of and responsive to such actuation and for switching the signals at the end of such time delay to maintain the go signal operated and the stop signal non-operated for a further brief time period and for switching said signals back to normal at the end of such further time period and means responsive to detector actuation in said first road during said further time period to reset said time relay means to prolong the condition of operation of the go signal and non-operation of the stop signal.

2. In a traffic control system as in claim 1, means in said controller for stepping said cyclic switch to the right of way position for the other road responsive to actuation of the detector of said other road and to completion of said further time period within said maximum time limit.

3. In a traffic control system as in claim 1, means actuable for stepping said cyclic switch to the right of way position for the other road, timing means responsive to detector actuation on said other road for providing the maximum

time limit and actuating said stepping means at the end of the maximum limit, and means responsive to detector actuation on said other road and to completion of said further time period within said maximum time limit to actuate said stepping means.

4. In a traffic control system for two intersecting roads having stop and go signals for the intersecting roads, traffic detectors for actuation by traffic approaching in the respective roads, and a controller for operating the signals to accord right of way alternatively to the two roads between minimum and maximum time limits responsive to actuation of the respective detectors and to interrupt right of way normally in the two roads in absence of such actuation, said controller including a step-by-step cyclic switching unit having a cycle of positions through which it is adapted to be operated responsive to detector actuation and including a position for potential operation of the go signal for one road and for operation of the stop signal for the other road and another position for operating the go signal for the other road and the stop signal for the first road, relay control means normally deenergized to maintain the stop signal operated and the go signal non-operated in the first road in said potential operating position and energizable to reverse the latter signals, time relay means operating responsive to detector actuation in said first road in said potential operating position to energize the control relay means after a brief time period, further time relay means operated by said control relay means in energized condition to deenergize said control relay means at the end of a further time period in absence of further such detector actuation, and means operated by said control relay means in energized condition to reset said further time relay means responsive to further such actuation.

5. In a traffic control system as in claim 4, means responsive to traffic actuation on said other road and to said control relay in deenergized condition and in absence of detector actuation on the first road to step said cyclic switch to the right of way position for said other road.

6. In a traffic control system for the intersection of a cross road and a highway having two approaches, and including stop and go signals for the cross road and for the two approaches of the highway, traffic detectors for actuation by traffic approaching in the cross road and for actuation by traffic approaching in the respective approaches of the highway, and a controller for operating the signals to accord right of way alternatively to the cross road and to the two approaches of the highway between minimum and maximum time limits responsive to actuation of the respective detectors and to interrupt right of way normally in the two roads in absence of such actuation, said controller including a step-by-step cyclic switching unit having a cycle of positions through which it is adapted to be operated responsive to detector actuation and including a position for potential operation of the go signal for both approaches of the highway and for operation of the stop signal for the cross road and another position for operating the go signal for the cross road and the stop signal for both approaches of the highway, and a pair of time controlled relay means each individual to one approach of the highway for maintaining the stop signal

operative and the go signal non-operative in its associated approach in said potential operating position normally in absence of detector actuation in its associated approach and for a brief time delay thereafter in the event of such actuation, and for switching the signals at the end of such time delay to maintain the go signal operative and the stop signal non-operative in its associated approach for a further brief time period at the end of which said signals are switched back to normal, and means responsive to detector actuation in the same approach during said further time period to reset said time relay means to prolong the condition of operation of the go signal and non-operation of the stop signal in said same approach.

7. In a traffic control system as in claim 6 means responsive to traffic actuation on said cross road and to completion of the further time period by both of said timing means for both approaches of the highway within said maximum time limits to step said cyclic switch to the right of way positions for said cross road.

8. In a traffic control system as in claim 6 means responsive to operation of the maximum time limit for said highway to maintain the time controlled relay means in condition to prevent switching from the stop to the go signal if such switching has not already occurred and to prevent switching back to the normal condition if such switching back has not already occurred, all for a brief time period to assure a minimum go signal period responsive to actuation at the end of which stepping of the stepping switch to the cross road right of way position is initiated.

9. In a traffic control system as in claim 1 means responsive to traffic actuation on the first road in a right of way position for the other road to operate said time controlled relay means to time out its said brief time delay period prior to return of said cyclic switch to said potential right of way position for the first road to prepare for switching the signals for operation of the go signal and non-operation of the stop signal on the first road immediately upon arrival of the cyclic switch in the potential right of way position for the first road without the necessity for such time delay thereafter.

10. In a traffic control system as in claim 6, means responsive to traffic actuation on either approach of the highway in the right of way position for the other road to operate the time controlled relay means associated with such approach to time out its brief time delay period prior to return of the cyclic switch to said potential right of way position for the highway to prepare for switching the signals for operation of the go signal and non-operation of the stop signal on the associated approach of the highway immediately upon arrival of the cyclic switch in the potential right of way position for the highway without the necessity for such time delay thereafter.

11. In a traffic control system for two intersecting roads having stop and go signals for the intersecting roads, traffic detectors for actuation by traffic approaching in the respective roads, and a controller for operating these signals to accord right of way alternatively to the two roads responsive to actuation of the respective detectors and to interrupt right of way normally in the two roads in absence of such actuation, said controller including a step-by-step cyclic switching unit having a cycle of po-

sitions through which it is adapted to be operated and including a position for potential operation of the go signal for one road and for operation of the stop signal for the other road and another position for operating the go signal for the other road and the stop signal for the first road, time controlled relay means for maintaining the stop signal operated and the go signal non-operated in said first road in said potential operating position normally in absence of detector actuation in said first road and for maintaining the last named signal operating and non-operation condition for a brief time delay in the event of and responsive to such actuation and for switching the signals at the end of such time delay to maintain the go signal operated and the stop signal non-operated for a further brief time period determining a minimum time limit for the signals as so switched and for switching said signals back to normal at the end of such further period, means responsive to detector actuation in said first road during said further period to reset said time relay means to prolong the condition of operation of the go signal and non-operation of the stop signal beyond such minimum time limit, further time controlled means operating responsive to detector actuation in said other road to determine a maximum time limit for the last mentioned signal condition as so prolonged, and means responsive to detector actuation in said other road and to completion of timing by either of said time controlled means to operate said cyclic switch through its cycle.

12. In a traffic control system for the intersection of a cross road and a highway having two approaches, and including stop and go signals for the cross road and for the two approaches of the highway, traffic detectors for actuation by traffic approaching the cross road and for actuation by traffic approaching the respective approaches of the highway, and a controller for operating the signals to accord right of way alternatively to the cross road and to the two approaches of the highway between minimum and maximum time limits responsive to actuation of the respective detectors and to interrupt right of way normally in the two roads in absence of such actuation, said controller including a step-by-step cyclic switching unit having a cycle of positions through which it is adapted to be operated and including a position for potential operation of the go signal for both approaches of the highway and for operation of the stop signal for the cross road and another position for operating the go signal for the cross road and the stop signal for both approaches of the highway, and a pair of time controlled relay means each individual to one approach of the highway for maintaining the stop signal operated and the go signal non-operated in its associated approach in said potential operating position normally in absence of detector actuation in its associated approach and for a brief time delay thereafter in the event of such actuation and responsive to such actuation, and for switching the signals at the end of such time delay to maintain the go signal operated and the stop signal non-operated in its associated approach for a further brief time period to determine such minimum time limit and for switching said signals back to normal at the end of said further time period, means responsive to detector actuation in the same approach during said further time period to

reset said time relay means to prolong the condition of operation of the go signal and non-operation of the stop signal in said same approach beyond said minimum time limit, further time controlled means operating responsive to detector actuation in said cross road to determine a maximum limit for the last mentioned

signal condition as so prolonged, and means responsive to detector actuation on said cross road and to completion of timing by both of said time controlled relay means or by said maximum time controlled means to operate said cyclic switch through its cycle.

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