Jan. 24, 1939. A. P. B. RENSHAW ET AL 2,145,031

TRAFFIC CONTROL SIGNAL

Filed Oct. 15, 1935 2 Sheets-Sheet 1

Fig.1.

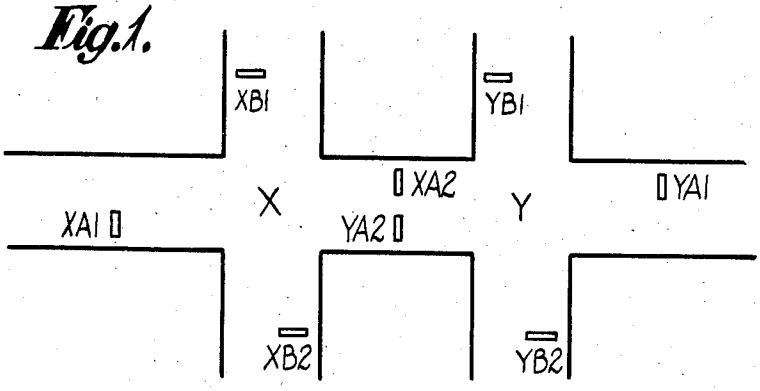


Fig.3.

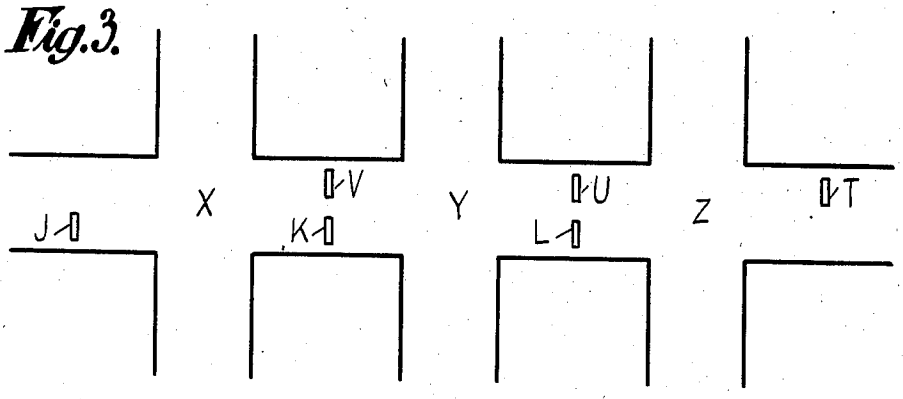
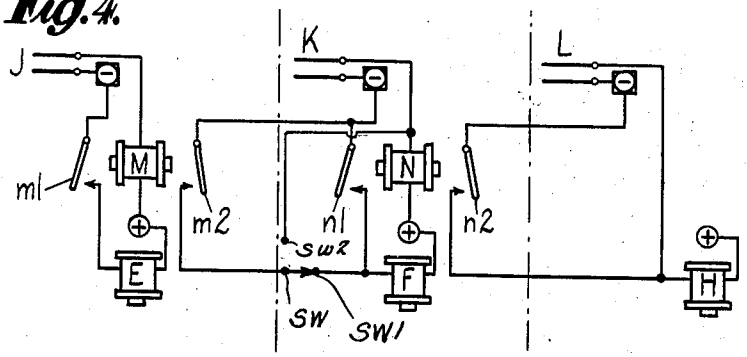


Fig.4.



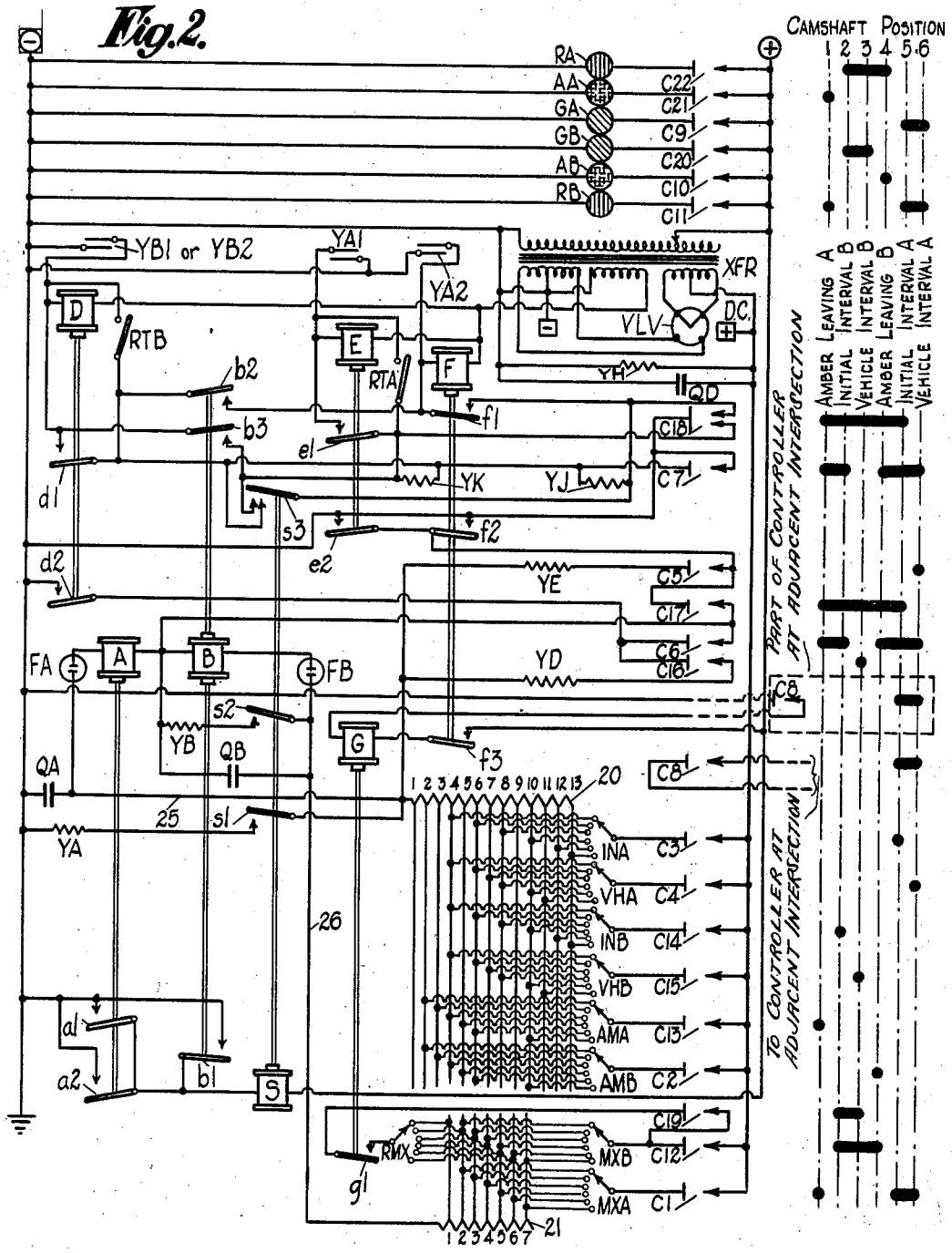
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Fig. 2.



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TRAFFIC CONTROL SIGNAL

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In Great Britain October 26, 1934

18 Claims. (Cl. 177—337)

The present invention relates to traffic control signals for use at road junctions or the like, and is more particularly concerned with systems in which controllers at adjacent intersections are to be interlinked so as to function under certain conditions in related sequence. The invention finds particular application in connection with systems employing vehicle actuated devices such as contact making pads let into the road surface, or other corresponding vehicle detectors.

In systems in which the signals are operated under the control of vehicle detectors and a number of intersections occur comparatively close together on a main road it is important that traffic on the main road shall not be held up at one of the later crossings for a sufficient length of time to accumulate to the extent of blocking one or more of the preceding intersections.

Arrangements have previously been suggested for controlling traffic at a plurality of intersections of this type by the use of an interlinking mechanism between the signal controllers at the several intersections. With such a mechanism if the signal at a later intersection of the group is displaying "stop" to the main road, the period during which this signal is displayed may be reduced if traffic which has proceeded thru preceding intersections of the group has, by actuation of a vehicle detector, signified its intention of passing thru the said later intersection. One example of such an arrangement is the copending application of T. P. Preist and A. P. B. Renshaw, S. N. 1,124 filed January 10, 1935, which has the same assignee as the present application. Certain portions of the disclosure of the copending application, S. N. 1,124 are also included in the present application for purposes of complete illustration of a traffic control system employing the features of the present invention. No claims are made in the present application to any subject matter disclosed in the copending application, S. N. 1,124.

While this latter arrangement has an important effect in avoiding congestion, it is not in all cases completely satisfactory since if the traffic is released in small batches or platoons, as often happens in a congested area, there is a danger that owing to the gaps occurring, the signals will turn to "stop" at a later intersection just as traffic released from an earlier intersection is approaching it. One suggestion for overcoming this difficulty is to bridge small gaps by increasing the so-called vehicle interval or period of extension of right of way which is obtained by a vehicle passing over a detector when the signal is set in its favor, but this arrangement introduces undesirable effects at times when traffic is light.

The present invention is arranged to provide a solution to the above problem; which, while reducing congestion to a minimum in times of heavy traffic does not adversely affect the efficiency of the system when the traffic is light.

An object of the invention is the provision of means in a traffic control system employing vehicle detectors for controlling the signal at an intersection of traffic lanes such that the operation of one detector is arranged to produce the same effect on the control apparatus for the signals at the intersection as the operation of another detector located nearer the intersection.

It is a feature of this invention in a system of this character that operation of a detector adjacent one intersection may produce a desired effect on the control apparatus for the signals at that intersection, and also that this same operation of the detector will activate means for producing an effect on the control apparatus at a second intersection, which latter effect is the same as that produced when a detector at the second intersection is operated.

Apparatus of the present invention, however, may be of utility in a number of instances besides providing a solution to the problem outlined, wherein actuation of a detector associated primarily with the control apparatus at one intersection produces in a control apparatus at the next succeeding intersection, if the signal thereat is displaying "stop" to the main lane, a reduction of the remaining "stop" period. It will be obvious that in view of the above objects this apparatus may be utilized in carrying out either or both of the two usual functions of vehicle detectors; i. e., prolonging right of way in a lane in which it is already being accorded, or placing a call for transfer of right of way to a lane in which it is being denied.

In order to present most clearly application of one embodiment of the invention a system with which it may be used with great utility will first be described. It will be understood that use of the invention with the apparatus to be described is purely exemplary and such use is not to be construed as the only one with which the present invention may be utilized. Such a system, known in the prior art, may be installed at two or more closely spaced intersections on a main road, signals at each intersection being con-

trolled by a controller individual thereto with which are associated vehicle detectors. Operation of the detector located in the main road approaching the second intersection while right of way is being denied to the main lane there causes the controller thereat to transmit a signal to the controller at the first intersection and if the latter is in a particular condition the period for which right of way can be denied to the main lane at the second intersection is reduced.

The invention and its mode of operation will be better understood from the following description of one method of carrying it into effect, reference being had to the accompanying sheets of drawings in which:

Figure 1 represents diagrammatically a plan of a main road intersected by two secondary roads spaced a short distance apart on the main road.

Figure 2 is a diagram of one of the usual forms of vehicle actuated control apparatus for one of the intersections, together with vehicle detectors and interlinking mechanism disclosed in the prior art for connection to the controller at a nearby intersection and similar to the control apparatus for the other intersection.

Figure 3, somewhat similar to Figure 1, represents a main road intersected at comparatively short intervals by a plurality of secondary roads.

Figure 4 shows the circuits actually controlled by the vehicle detectors in accordance with the invention for application to control apparatus which may, for example, be of the type shown in Figure 2 and described below.

Referring now to Figure 1 the respective intersections are designated X, and Y, and they may be considered for the purpose of this description as formed by secondary roads intersecting a common main road having a comparatively heavy flow of through traffic. It may further be assumed that the portion of the main road lying between the intersections is of such short length that it is impossible to stop main road traffic therein for any length of time, because of the danger of the vehicles accumulating and blocking the cross traffic at the intersection behind. It is assumed that the same danger does not occur in connection with vehicles arriving from the secondary roads owing to the small amount of turning traffic; consequently, no special precautions are necessary and for such traffic the controllers are allowed to function independently. The apparatus of Figure 2, assuming this to be the controller at intersection Y, ensures that vehicles which enter this intersection from the direction of X shall be given immediate right of way at Y; that is, in the event of a vehicle actuating detector YA2 while right of way is being denied to the main street at Y and while right of way is being accorded the main road at X, will quickly be accorded right of way in order that such vehicle and vehicles following it from X will not be delayed to cause a fouling of the X intersection. The controller at the X intersection is preferably similar to that at Y, illustrated schematically in Figure 2.

In the absence of traffic, with the arrangement of the controller as illustrated in Figure 2, the right of way signal remains on whichever of the intersecting roads last used it until traffic approaches in the other road. For example, if the last traffic actuation occurred on the main road A and there has been no further traffic on either road, the controller will maintain the green signal lighted on the main road A and the red signal lighted on the side road B. As long as no traffic arrives on the side road these signals remain displayed and each vehicle arriving on the main road under such conditions will reset a time element in the controller to assure continuation of right of way for itself for several seconds, in case a vehicle should arrive on the cross road. If a vehicle arrives on the cross road more than such several seconds after the last such vehicle on the main road, then the right of way is terminated in the main road by the controller and after an appropriate amber clearance period, is shifted to the cross road. Similarly, if traffic should cease to arrive in the side road after it has ceased in the main road, the right of way would then remain on the side street in the absence of further traffic. In each case the arrival of a vehicle on a road not having the right of way will cause transfer of right of way to such vehicle promptly in the absence of vehicles on the other road, and thru operation of a maximum limit timer will assure such transfer within a maximum time after arrival of such vehicle even if vehicles on such other road continue to arrive.

The operation described in the preceding paragraph is the same as that of the usual flexible type of traffic actuated signal controller not provided with interlinking features to other controllers. As pointed out above in this specification however arrangements have already been suggested in the prior art to interconnect two such controllers located at intersections a short distance apart on a main road, so that in the event the controller at one intersection is according right of way to the main road while the controller at the other intersection is according right of way to the cross road, any vehicles on the main road approaching the latter intersection from the first intersection will cause prompt transfer of right of way from the cross road to the main road at such latter intersection, through material reduction in the time period of the maximum timer for cross road traffic.

The present invention provides a means for repeating ahead the effect of vehicle actuation at one intersection so that a vehicle arriving at the one intersection on the main road will actuate not only the right of way controller at the one intersection but will concurrently actuate one or more similar controllers at the following intersections. Such actuation may prolong main road right of way or cause transfer of right of way to the main road at the several intersections which it affects, or it may prolong right of way at one intersection and cause transfer of right of way at another, depending upon which road has the right of way at the respective intersections at the time of actuation. In cooperation with the prior interlinking arrangement described above, the present invention by its actuation repeating feature, provides means for traffic travelling along the main road to obtain right of way shortly in advance of its arrival at each intersection and to maintain such right of way until its arrival.

The traffic signals at each intersection may be of any desired form, such as, for instance, the conventional green or "go", yellow or "caution", red or "stop" electrically lighted signals indicated in Fig. 2. The controller herein is provided with a plurality of sets of contacts operated by cams on a camshaft which is advanced thru a cycle step by step at various intervals by a solenoid. The solenoid is energized and controlled from a timing circuit employing a gas discharge tube condenser combination under the control of vehicle detectors. Initial and maximum timing cir-

cuits are provided and the duration of the various signal displays may be varied to respond to traffic conditions existing from time to time as determined by the detectors. The detectors may be of any desired form, such as switches let into the roadway surface and operated by the weight of traversing vehicles, or may comprise photoelectric, electromagnetic, or microphonic or other detecting means.

In Figure 2 the controller is arranged for example for operation from alternating current mains and suitable rectifying arrangements are provided in the form of a thermionic valve VLV and transformer XFR by means of which direct current is obtained for operating the neon lamps and this is supplied from the terminal marked positive in a square. Conveniently the live main of the alternating current is connected to an appropriate tapping on the transformer XFR, while the grounded main appears as minus in a circle and a square.

A chart at the right of Figure 2 shows the position of the camshaft in which the various cam contacts are operated, a black circle or bar indicating that the contact is closed. The various interval adjusting switches as INA, VHB, MXB, etc., are wired to appropriate tapping points on the two common resistances 20, 21 respectively. Common resistance 20 is built up of resistance of 200,000 ohm units in series, each unit representing a charging time of condenser QA of one second. The other resistance 21 is similar but has larger unit resistances, for instance one or two megohms, and provides long time intervals such as are required for maximum timing purposes.

Signal controllers of this general type, having vehicle detectors in each approach to the intersection, are arranged to time a number of signal periods, there being a different signal displayed for nearly every period timed. As will be noted from the chart, in shaft position 1 a period of amber leaving phase A, i. e., the main road, is timed. Since cam contacts C21 and C11 are closed at this time, the main street amber and cross street red signals are lighted. In this period a current drawn from positive over cam contact C13, amber adjusting switch AMA, resistance 20, lead 25, condenser QA to negative, charges condenser QA. When the potential across the plates of the latter has reached the flash or breakdown potential of the neon discharge tube FA, which with relay A is in shunt with the condenser via a circuit from the right hand side of condenser QA thru tube FA, relay A, cam contact C6, contact *d2* of relay D to minus power and the left hand side of condenser QA since cam contact C6 is closed in this period, this shunt circuit thru relay A becomes conducting for the brief time that the potential across the tube is sufficient to maintain the discharge thru the tube. Relay A is thus momentarily operated, causing at armatures *a1*, *a2* circuits to be completed energizing the solenoid S which notches the camshaft into position 2.

In positions 2 and 3 cam contacts C22 and C20 are operated to illuminate the main street red and cross street green signals. The first of these intervals, period 2, is a period of fixed duration independent of detector actuation, an initial interval in which vehicles on street B that may have been waiting to cross the intersection are allowed to accelerate and pass thru the crossing. The condenser QA is charged by a circuit from positive over cam contact C14, adjusting switch INB, resistance 20, lead 25, condenser QA, to minus and as in the preceding period, the neon lamp FA eventually operates, in turn energizing relay A and solenoid S, notching the camshaft into position 3.

Position 3, the cross street vehicle interval, is not fixed in length but is dependent upon traffic conditions on the two roadways. A charging circuit for condenser QA is completed from positive over cam contact C15, switch VHB, resistance 20, lead 25, condenser QA, to minus. Actuations of B phase detectors however, by energizing relay D, since cam C16 is closed in this period, causes over relay contact *d2* a small resistor YD to be placed in shunt across condenser QA which reduces the charge thereon and consequently produces an extension of the time required for condenser QA to reach the flash voltage of lamp FA. Repeated actuations of the phase B detector within short intervals thus produces corresponding resetting of the charge on condenser QA. An actuation of either the phase A detectors YA1 or YA2 during this period initiates functioning of the maximum timer. Actuation of the YA1 detector energizes relay E and locks it in over its armature *e1*, cam C18; actuation of the YA2 detector energizes relay F and locks it in over armature *f1* and cam C18. A circuit is completed at either armature *e2* or *f2*, according to whichever of these relays is energized, from positive over cam C12, maximum adjusting bank MXB, resistance 21, lead 26, condenser QB, cam C17, armature *e2* or *f2*, to minus, for charging condenser QB. In shunt with condenser QB is a second neon lamp FB and a relay B, which are similar to lamp FA and relay A respectively. Operation of relay B, by armature *b1*, energizes solenoid S; subsequently, due either to a gap in the phase B traffic or the expiration of the maximum period, either condenser QA or condenser QB will be charged to the striking potential of its respective neon lamp FA or FB whereupon either relay A or B as the case may be is operated to energize the solenoid S which advances the camshaft into position 4.

In position 4 amber signal AB is displayed to the cross road and red signal RA is continued on the main road by operation of cams C10 and C22 respectively. Timing is achieved by the charging of condenser QA over cam C2, switch AMB, resistance 20, and at the conclusion of the period the camshaft is advanced to position 5.

In positions 5 and 6 cams C11 and C9 are operated to indicate red, RB, to the cross road and green, GA, to the main road. Period 5 is the initial main green period and is similar to period 2 except that condenser QA is charged herein over cam C3, switch INA, and resistance 20.

The minimum period for position 6 is timed by circuit from positive over cam C4, switch VHA, resistance 20, lead 25, condenser QA to minus. Actuations of phase A detectors in this period, by operation of relays E or F, by armatures *e2* or *f2* over cam C5 and resistance YE, shunting condenser QA, reset the latter to produce extension of the period. Actuations of phase B detectors energize relay D, which locks-in over its armature *d1* and cam C7 to minus, and at *d2* a circuit is completed in this period from positive over cam C1, switch MXA, resistance 21, lead 26, condenser QB, cam C6, armature *d2* to minus, thus establishing the maximum time which the actuating vehicle on road B must wait in the event of continuous traffic on road A meanwhile.

Operation of relay A or relay B causes solenoid S to advance the camshaft to position 1.

It will be noted that since cam C18 is operated in all positions except position 6, the main road vehicle interval, actuations of phase A detectors which energize relays E or F in all periods except period 6 will be locked in over armature *e1* or *f1*, and cam contact C18, and will remain locked-in until position 6 is next reached. Similarly actuations of phase B detectors energizing relay D will be locked-in during all periods except cross road vehicle interval 3 over a circuit via armature *d1* and the cam contact C7 to minus power.

Operation of a preferred type of interlinking equipment for connecting controllers at different intersections as disclosed in the prior art and illustrated in Figures 1 and 2, to which the invention may be applied, will be described in more detail. Concerning interlinking equipment connecting the controller at the Y intersection, illustrated in Figure 2, and the controller at the X intersection, which is similar in all respects to the one at Y, assume that the main road traffic previously liberated at the X intersection during the main street green periods at X is to pass also thru the Y intersection. The detector YA2 will be operated by this traffic.

Considering the operation of this detector in relation to the circuit, it will be seen that the road relay F if not already operated immediately operates and locks up and performs similar functions to that of road relay E already described, and in addition at armature *f3* prepares a circuit for the interlinking relay G. The circuit of relay G extends as shown over a pair of wires to the X controller to cam contacts C8 therein, as shown in the dotted rectangle. The X controller will at this time be standing with its camshaft in either position 5 or 6, the main road green period, since main road traffic has been passing thru intersection X and approaching Y, therefore cam C8 in the X controller will be closed and accordingly circuit to operate relay G in the Y controller is completed. The relay G completes a reduced maximum timing circuit by shunting the normal maximum resistance switch MXB over a circuit from the arm of switch MXB via cam contact C19 and over armature g^1 and switch RMX and almost immediately after this circuit becomes operative the condenser QB becomes charged and the tube FB flashes and relay B operates the solenoid S to step the camshaft of the Y controller into position 4 regardless of the phase B traffic. This operation produces the normal amber warning signal after which right of way is changed over in favour of the main road traffic which is thus enabled to proceed substantially without interruption.

The interlinking feature also functions in the reverse direction upon actuation of the XA2 detector and in these circumstances the corresponding relay G in the X controller is operated over another pair of wires, connected to cam contacts C8 of the Y controller to assure prompt return to the main road at X for traffic approaching X from Y.

It should be explained that in these controllers the reduced timing of the maximum does not reduce the normal amber intervals since cam contact C19 is not closed in these periods. The timing of the reduced maximum may preferably also be adjusted not to interfere with the normal initial interval so as to assure that when relay G is operated upon or immediately after transfer of right of way to the cross road, cross road traffic will be assured of a short protective minimum period.

In the case of main road traffic actuating detector XA1 at intersection X, and then turning to the left or right instead of proceeding straight thru the intersection toward Y, it will be noted that the interlinking equipment is not effective since the detector YA2 will not have been actuated and consequently the conditions required for rendering effective the mechanism for reducing the cross road period at the Y intersection will not have been fulfilled.

Similarly in the case of traffic turning from the secondary road at X into the main road, actuating detector YA2, the interlinking feature will not be effective since in this case the controller at X will ordinarily be in positions 2, 3, or 4 and not in the main road green period 5 or 6 at the time of actuation of YA2, and consequently relay G will not be energized.

It will be seen therefore that the controllers at these intersections when equipped with this interlinking device will operate independently as normal vehicle actuated controllers under all conditions except in the case where main road traffic passes thru one intersection and arrives at the second while right of way thereat is being accorded to the secondary road, and under this condition the normal maximum secondary road right of way period is reduced.

When the solenoid S operates it serves to shunt condensers QA and QB over armature *s1* and resistance YA, and armature *s2* and resistance YB respectively to restore them in readiness for the next timing interval. At armature *s3*, in conjunction with circuits either thru armature *b2* or *b3* it is effective to ensure that without any further operation of the associated road detectors right of way will be returned to the phase from which it has been forcibly removed. That is, if right of way is relinquished upon expiration of the period of the maximum timer, right of way will be returned to the lane from which it was taken. In this connection it will be seen from the circuit from the left hand side of relay F over armature *b2* of relay B and via cam contact C7 to minus power that if right of way is forcibly removed from phase A, relay F is operated rather than relay E. Relay B and its armature *b2* forming a part of the above circuit are only operated thru action of the maximum timing circuit either after a normal maximum time interval or the maximum time interval as reduced by operation of relay G in accordance with the invention. This ensures that in the case of substantially continuous main road traffic right of way can only be removed from the A phase for very short intervals since it is immediately returned after the expiration of the reduced maximum period. This precaution keeps the main road traffic moving and prevents congestion which would result if it was allowed to tail back across the intersection for a long period.

The resistances YJ and YK connected in circuit with the road relays D, E and F are de-polarizing resistances which assist in the release of these relays at the correct period. It may happen that the armatures of these relays remain held after the circuit of the coil is opened owing to residual magnetism retained in the core by the presence of a hard spot in the laminations. If this occurs the armature is then forcibly released by arranging for the coil to be connected to the alternating

source of supply through one of the resistances YJ or YK which are of such value as to prevent the operation of the coils in series therewith but nevertheless enable sufficient current to flow to bring about the neutralization of the residual magnetism during the appropriate half cycle.

The arterial switches RTA and RTB are provided to determine the normal condition of the system in the absence of traffic and when operated ensure that right of way shall return to the associated phase even in the absence of traffic thereon. When RTA is closed and RTB is open the right of way normally remains on the main road A in the absence of traffic on B and, after any transfer of right of way to B street in response to actuation thereon, RTA when closed causes automatic return of right of way to A street at the end of the B street right of way period, which latter may be a minimum, a maximum or between these two in accordance with the amount of traffic on B street. Correspondingly with RTA open and RTB closed right of way always returns automatically to B street after any period of right of way on A street and remains on B street in absence of actuation on A street. With both switches closed the right of way would revert back and forth between A and B streets on minimum periods in the absence of traffic and would be extendible up to a maximum by traffic actuation on one street occurring during the right of way period for that street. The switches RTA and RTB accomplish these features by energizing one or both of the relays E and D respectively in cooperation with cam contacts C18 and C7 respectively so that such energization occurs only when the controller is not in the right of way extension position for the respective street.

With both switches RTA and RTB open as shown in Figure 2 the right of way remains on either street to which it was last called by traffic actuation until an actuation occurs on the opposite street. Their effect as will be seen from the drawings is to simulate the operation of the detectors at a time when the phase in question is not receiving right of way though they do not produce any extension effect when the phase already has right of way.

This prior interlinking arrangement described above has the disadvantage of introducing undesirable effects at certain times however, as when traffic on the main road is allowed to proceed into the area in question in small batches, as often happens in a congested area. Gaps occur between the batches and the signals at the second intersection turn to red or "stop" just as traffic released from the first intersection is approaching it.

The present invention overcomes this difficulty and may be used to accomplish other traffic-expediting effects as well.

In Figure 3 is shown a plan of a main road intersected at short intervals by a plurality of secondary roads. Vehicles travelling from the left side of the figure to the right will actuate successively detectors J, K, and L in the approaches to intersections X, Y, and Z respectively. To avoid confusion in cross referencing of the detectors, the designations XA1, YA2, etc., used in the description above of an installation for only two interlinked intersections, the single letters J, K, and L are used here since the detectors have one aspect in respect to one intersection and another in respect to another intersection and therefore the suffixed numbers 1, 2, no longer retain their identity.

Referring to Figure 4 the apparatus for carrying out the purpose of the invention is shown applied to the left-to-right traffic lane of the main road in Figure 3. This equipment comprises essentially additional relays and circuits interposed between the detectors at an intersection and the so-called road relays thereat and shown in Figure 2 as relays E and F.

In the broader aspects of the invention it will be understood that in Figure 4 the interlinking relays M and N may in each case be made to operate a relay of the E type, or any other type, in the usual form of vehicle actuated traffic signal control system, but in the application of the invention to the apparatus of Figure 2, the relays M and N are arranged to operate relays of the E and F type respectively.

According to the invention the detector of Figure 4, corresponding to detector XA1 of Figure 2, for the main road for intersection X does not directly operate relay E but operates an auxiliary relay M which at its armature *m1* energizes the relay E in the controller at intersection X, and in addition at armature *m2* energizes the relay F in the controller at intersection Y. Similarly the vehicle detector K of Figure 4, corresponding to detector YA2 of Figure 2 in the main road for intersection Y operates auxiliary relay N and this in turn at contact *n1* operates the road relay F associated with the controller at intersection Y and also at contact *n2* the road relay H associated with the controller at intersection Z, (relay H being similar to relay F of Figure 2).

It is assumed that owing to the layout of the roadways the process of passing actuations forward need not be continued beyond intersection Z for further illustration and consequently detector L may be arranged to operate the relay H directly. It will be understood that it may be arranged for a call made by a vehicle actuating detector J, if desired, to be passed to the controller at intersection Z as well as intersection Y, for instance by providing that contact *m2* operate relay N instead of relay F directly, as by shifting switch SW from contact *sw1* to *sw2*. Generally, however, the object of the invention will be attained by arranging for a vehicle to put in a call at the intersection which it is immediately approaching and also at the succeeding intersection. It will be appreciated that arrangements similar to those illustrated for traffic from left to right will in a similar manner generally be employed for traffic from right to left, i. e., actuation of detector U, for instance, will energize a relay of the M or N type to energize in turn another relay of the F type in the controller at Y intersection and also another relay of the F type in the controller at X intersection.

It will be understood that the operation of the signal controller at the Y intersection by the detectors YA1 and YA2 and of the operation of the signal controller at the X intersection by the detectors XA1 and XA2 is the same as disclosed in the prior interlinking arrangement of the copending Preist and Renshaw application, Serial Number 1,124, and is shown and described herein in the present application for the purpose of illustration. The significance of the present invention lies in the fact that as indicated in Figures 3 and 4 the detector at one intersection serves not only to control the signal controller at that intersection but also controls the signal controller or controllers at one or more other intersections. For example, as shown in Figure 4 the detector J at the X intersection through the relay M operates

the relay E in the signal controller at the X intersection and the relay F in the signal controller at the Y intersection. As another example the detector K at the Y intersection through relay N controls the relay F in the controller at the Y intersection and the relay H in the signal controller on the Z intersection, relay H being similar to relay F of Figure 2.

If the intersections X and Y only are considered without reference to the intersection Z for example, the detector J of Figure 3 corresponds with the detector XA1 of Figure 1, and through relay E of the X controller, governs the latter to initiate transfer of right of way and modify the time periods of right of way for the present well-known forms of flexible traffic actuated control. The same detector J is arranged through the invention however, to have the same effect on the signal controller at Y as traffic actuation of the detector YA2 which it will be understood will prolong the time period of right of way on the common main road at the Y intersection if the Y controller is according right of way to the main road for example, or will produce prompt transfer of right of way to the main road at the Y intersection if the Y controller is according right of way to the cross road and the X controller is according right of way to the main road for example.

The control of two or more signal controllers at different intersections by a traffic detector at one of the intersections is thus an important feature of the invention, and one of the advantages of this invention is the use of this feature in connection with the prior interlinking arrangement to improve the operation of such an arrangement by having traffic actuation repeated ahead from one intersection to another, so that a vehicle approaching and passing one intersection in proceeding toward another will exert a controlling effect at the latter intersection to prepare the right of way or hold the right of way for itself, in addition to its usual controlling effect on the one intersection through which it is passing.

In this connection it will be appreciated that whereas in the prior interlinking arrangement the effect is that traffic proceeding from intersection X and operating detector YA2 will shorten the waiting period for the main road at the intersection Y and will not affect the intersection Y in this respect if the latter is already showing green to the main road, according to the present invention traffic proceeding from intersection X in the direction of intersection Y will by its actuation of detector J have simulated the effect of vehicle actuation at detector K so that if the main road already has a green signal at intersection Y the period of this green signal will be extended by this traffic as it approaches each intersection.

It will be observed that these features are provided in the embodiment of the invention by means of a relay interposed between the detector and the usual traffic actuated relay in the signal controller at each intersection, with one contact of the interposed relay operating the signal controller relay at that intersection and another contact of the interposed relay operating the signal controller relay at another intersection. Thus any actuation of a detector at one intersection produces concurrent actuations in the signal controllers at that intersection and the next intersection.

The terms "controller" and "control mechanism" are used herein broadly to designate the mechanism for operating the signals thru their cycle of right of way indications, and in this embodiment such mechanism is jointly controlled by timing and vehicle actuation. The term "detector" is used to designate the device for detection of the passage of vehicles in the roadway, and which is normally arranged to be actuated by vehicles as they approach the intersection controlled. The term "timer" is herein used to designate generally a timing device which will close a circuit or otherwise perform one operation a certain time after its timing action is started by another operation. In the present embodiment of the invention the timer is shown as a condenser and flash tube arrangement in which the charge on the condenser is varied over a period of time toward the flash voltage of the flash tube and the variation of the charge on the condenser is under the control of vehicle actuation in one or more ways as disclosed herein.

According to the invention, therefore, a simple repeating arrangement has been devised for preparing the signals in advance of a batch of traffic, whereby the important main road traffic is kept moving with a minimum of stoppages and blocking back over a preceding crossing causing fouling thereof is prevented. 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.

We claim:

1. In a traffic control system for a plurality of intersections of cross lanes on a common main lane and having traffic actuated means in the main lane and a traffic signal and controller therefor at each intersection, said controller adapted to be actuated by said traffic actuated means to operate said signal to control traffic proceeding along the main lane at such intersection, means operated by the traffic actuated means at one intersection to actuate also the controller at another intersection the same as by actuation of the last mentioned controller by the traffic actuated means at the latter intersection.

2. In a traffic control system for a plurality of intersections of cross lanes with a common main lane and having signals for the accord and interruption of right of way and a control mechanism adapted to control the same at each intersection, traffic actuated means in the main lane at each intersection for the operation of its control mechanism in accordance with actuation by traffic thereat, and interlinking means connecting the traffic actuated means at one intersection with the control mechanism at that intersection and with a second control mechanism at a second intersection for operation of both control mechanisms by traffic actuation at one intersection and means in said second mechanism to cause such actuation to have one effect when right of way is accorded to the common lane and another different effect when right of way is interrupted in such lane.

3. In a traffic control system for a plurality of intersections of cross lanes with a common main lane and having signals for the accord and interruption of right of way and a control mechanism adapted to control the same at each intersection for the control of right of way of traffic in the respective lanes, traffic actuated means in the main and cross lanes at each intersection for the operation of its control mechanism in accordance with actuation by traffic thereat, and

interlinking means connecting the traffic actuated means in the main lane at one intersection with the control mechanism at that intersection and with the control mechanism at another intersection for operation of both control mechanisms by traffic actuation in the main lane at one intersection as if actuation had occurred individually at both.

4. In a traffic control system for a plurality of intersections of cross lanes with a common main lane having at each of the intersections, signalling means for displaying right of way to each of the intersecting lanes, and control mechanism for the signalling means adapted to operate the latter thru a normal time cycle of right of way indications; vehicle actuatable means in the main lane approach to one of the intersections, means connected to said vehicle actuatable means and to the control mechanism thereat for governing the time cycle of operation of said control mechanism in accordance with traffic actuation, said means also connected to the control mechanism at a succeeding intersection and operable upon actuation of said vehicle actuatable means when the control mechanism at the latter intersection is according right of way to the cross lane to reduce the right of way period substantially below that normally accorded to the cross lane by the control mechanism.

5. In a traffic control system for a plurality of intersections of cross lanes with a common main lane having at each intersection, signalling means for displaying right of way to each of the intersecting lanes, control mechanism and vehicle actuatable means co-operative to operate the signalling means thru a cycle in which right of way is accorded to the main lane for a period variable between a minimum and a longer period by actuation of said traffic actuatable means; means connected to the vehicle actuatable means at one intersection, to the control mechanism thereat and to the control mechanism at a succeeding intersection and operable upon actuation of the said vehicle actuatable means when the control mechanism at the latter intersection is displaying right of way to the main lane for prolonging this right of way period beyond the minimum period of such display.

6. In a traffic control system for a plurality of intersections of cross lanes with a common main lane having at each intersection, signalling means for displaying right of way to each of the intersecting lanes, control mechanism and vehicle actuatable means co-operative to operate the signalling means thru a cycle in which right of way is accorded to the main lane for a period variable between a minimum and a longer period by actuation of said traffic actuatable means; means connected to the vehicle actuatable means at one intersection, to the control mechanism thereat and to the control mechanism at a succeeding intersection and operable upon actuation of the said vehicle actuatable means when the control mechanism at either intersection is displaying right of way to the main lane to prolong such right of way display beyond the minimum period.

7. In a traffic control system for a plurality of intersections of cross streets with a common main street and having at each intersection individual traffic right of way signals and controllers therefor and traffic actuable devices for each direction of approach of traffic in the main and cross streets for operating said controllers for the control of right of way of traffic in the respective streets, means connected to the traffic actuable device for one direction in the main street at a first intersection and connected to the traffic signal controller in the first intersection and to the controller at a second intersection in said one direction to so operate both these controllers upon actuation of the last named device, means connected to the traffic actuable device for said one direction at the second intersection and connected to the traffic signal controllers at the second and third intersections in said one direction to so operate the latter controllers upon actuation of the said traffic actuable device at the second intersection, whereby traffic proceeding along the main street in said one direction will actuate the two controllers next ahead to prepare control of right of way for itself in advance.

8. In a traffic control system for a plurality of intersections of cross streets with a common main street having at each intersection, traffic actuatable means in the main and cross streets, a relay operated by actuation of said means in the main street, a traffic right of way signal, and a controller therefor, each individual to the respective intersections, said controller adapted to operate said signal to accord right of way alternately to traffic in the respective streets at such intersection in accordance with traffic actuation of the respective traffic actuatable means and operation of said relay; means including one circuit having contacts of the relay at one intersection closed upon operation of said relay and extending to the traffic signal controller at said one intersection for so actuating the same, and means including another circuit having other contacts of the said relay closed upon operation thereof and extending to the traffic signal controller at a succeeding intersection for so actuating the latter controller to prepare in advance for accord of right of way to the main street at the succeeding intersection for traffic in the main street passing the said one intersection and proceeding toward the succeeding intersection.

9. In a traffic control system for a plurality of intersections of cross streets with a common main street having at each intersection, traffic actuatable means in the main and cross streets, a traffic right of way signal and a controller therefor, each individual to the respective intersections, said controller including relay means for the respective streets for operation by the respective traffic actuatable means at its intersection and said controller adapted to operate said signal to accord right of way alternately to the respective lanes at such intersection in accordance with operation of said relay means; further relay means connected to be operated by the traffic actuated means actuating by traffic proceeding along the main street in one direction at one intersection, one circuit including contacts of said further relay means and completed via said contacts upon operation of said further relay means to the first mentioned relay means in the controller at said one intersection for so operating the latter controller, and another circuit including other contacts of said further relay means and completed via said last named contacts upon operation of said further relay means to the first mentioned relay means in the controller at a succeeding intersection further along the main street in said one direction for operating the first mentioned relay means at the succeeding intersection concurrently with the first mentioned relay means at said one intersection whereby both controllers at both intersections will be operated by traffic actuation by traffic in the main lane at said one

intersection and proceeding toward said succeeding intersection.

10. In a traffic signal control system for two intersections of cross traffic lanes with a common main lane, the combination of traffic actuatable devices in the several lanes at the two intersections, a right of way signal and controller therefor at each intersection operable in response to actuation of the respective traffic actuatable devices at the respective intersections to effect right of way to the main lane and cross lanes between minimum and maximum periods, means operable in response to actuation of the traffic actuatable device in the main lane at one intersection while right of way is being accorded to the cross lane at said intersection and right of way at the other intersection is being accorded the main lane, to shorten the maximum right of way period in the cross lane at the first intersection and means interposed between the traffic actuatable device in the main lane at the other intersection and its right of way controller and connected to the right of way controller at the said one intersection to produce such shortening effect at said one intersection in addition to its effect at said other intersection.

11. A traffic control system for two spaced intersections of cross lanes with a common main lane including in combination a right of way signal controller for each intersection comprising a switching mechanism adapted to assume a plurality of positions and having switches arranged to be operated in sequence as said switching mechanism is operated thru such positions, signalling circuits operated by certain of said switches and including means for alternately according right of way to the main and cross lanes, two timers forming a part of said controller for providing minimum and maximum limits respectively for right of way, each timer consisting of a condenser, an electronic tube connected to said condenser and having a threshold voltage at which it becomes conducting to pass current, a relay connected to said tube and condenser to be operated thereby and to operate said switching mechanism when the condenser voltage exceeds the threshold voltage of said tube, control circuits operated by certain other of said switches and including adjustable resistance and means for charging said condenser thru such resistance to vary the voltage on said condenser to control the time period of charge of said condenser and corresponding periods of accord of right of way by said signalling circuits, said combination also including traffic actuatable devices in the lanes and connected to said right of way signal controller, and means forming a part of said controller to vary the time periods of accord of right of way by the same between such minimum and maximum limits in accordance with traffic actuating such devices, means connected with the controller in the first intersection and operable upon accord of right of way to the main lane by such controller to provide a partial supervisory circuit including means operating when said circuit is completed to reduce the maximum cross lane right of way period at the second intersection by altering the charging resistance in the controller at the second intersection during the cross lane right of way period at said second intersection, means connected to the controller at the second intersection and when operable functioning upon actuation of the traffic actuatable device in the main lane at the second intersection for completing said supervisory circuit, and means interposed between the traffic actuatable device in the main lane at said first intersection and its right of way controller and connected to said second intersection right of way controller to effect such reduction of the maximum cross lane right of way period at said second intersection in addition to its main lane right of way varying effect at the first intersection.

12. In a traffic signal control system for two intersections of cross lanes with a common main lane including at each intersection traffic actuatable devices in the several lanes and a right of way signal and controller therefor operable in response to actuation of such devices to accord right of way alternately to the main lane and cross lane between minimum and maximum periods in accordance with traffic actuating said devices, means including interlinking means connecting the traffic actuatable device in the main lane at the first of said intersections with the controller at the first intersection and with the traffic actuatable device in the main lane at the second intersection for shortening when operable in response to actuation of the main lane device at either intersection the maximum right of way period on the cross lane at the second intersection when the first intersection controller is displaying right of way to the main lane and the second intersection controller is displaying right of way to the cross lane.

13. In a traffic signal control system for two intersections of cross lanes with a common main lane including at each intersection traffic actuatable devices in the several lanes and a right of way signal and controller therefor operable in response to actuation of such devices to accord right of way alternately to the main lane and cross lane between minimum and maximum periods in accordance with traffic actuating said devices, means including interlinking means connecting the traffic actuatable device in the main lane at the first of said intersections with the controller at the first intersection and with the controller at the second intersection and operable in response to actuation of the traffic actuatable device at the first intersection when the controller at the first intersection is displaying right of way to the main lane and the controller at the second intersection is displaying right of way to the cross lane both to maintain right of way on the main lane at the first intersection and to shorten the maximum cross lane right of way period at the second intersection.

14. In a traffic control system for a plurality of intersections of cross lanes with a common main lane and having at each intersection traffic actuated means in the main and cross lanes and a traffic right of way signal and controller therefor adapted to be actuated by said traffic actuated means in the respective lanes to accord and interrupt right of way alternately in said lanes for the control of traffic thereat, means forming a part of one said controller at one intersection and operated by such actuation of said controller by traffic on the main lane while it is according right of way to the main lane to prolong such accord of right of way, and means at another of said intersections and operated by the traffic actuated means at such other intersection actuated by traffic approaching said one intersection in passing said other intersection to so actuate the said controller at said one intersection as well as the controller at said other intersection whereby said one controller will also so prolong accord of right of way to the main lane at said

one intersection to prepare for such approaching traffic when right of way is so accorded to the main lane at said one intersection.

15. In a traffic control system for a plurality of intersections of cross lanes with a common main lane and having at each intersection traffic actuated means in the main and cross lanes and a traffic right of way signal and controller therefor adapted to be actuated by said traffic actuated means in the respective lanes to accord and interrupt right of way alternately in said lanes for the control of traffic thereat, means forming a part of one said controller at one intersection and operable when said controller is so actuated by traffic on the main lane while right of way is interrupted in the main lane to cause transfer of right of way to the main lane within a predetermined maximum period, and means at another of said intersections and operated by the traffic actuated means at such other intersection actuated by traffic approaching said one intersection in passing said other intersection to so actuate the said one controller at said one intersection as well as the controller at said other intersection whereby said one controller will also cause such transfer of right of way to the main lane at said one intersection to prepare for such approaching traffic when right of way has been interrupted in the main lane at said one intersection.

16. In a traffic control system for a plurality of intersections of cross lanes with a common main lane and having at each intersection traffic actuated means in the main and cross lanes and a traffic right of way signal and controller therefor adapted to be actuated by said traffic actuated means to accord and interrupt right of way alternately in said lanes for the control of traffic thereat, means forming a part of the controller at each intersection and operable by such actuation of the controller when the controller is according right of way to the main lane to prolong such accord of right of way, and other means forming a part of the controller at each intersection and operable by such actuation of the controller when right of way is interrupted in the main lane to cause transfer of right of way to the main lane within a time period, and means at one of said intersections and connected to the traffic actuated means thereat to be operated by actuation thereof by traffic at said one intersection and connected to the controller at said one intersection and also to the controller at another of said intersections to actuate both of said controllers, whereby traffic actuation in the main lane at one intersection will prolong accord of right of way in or cause transfer to the main lane at said one and said other intersections in accordance with whether right of way is already accorded to or interrupted in the main lane at the respective intersections.

17. In a traffic control system for a plurality of intersections of cross streets along a highway and having traffic right of way control signals and controllers therefor at each intersection, each controller adapted to be actuated to operate the signal at its intersection for the accord of right of way alternately to traffic in the highway and cross street thereat in accordance with such actuation, means including a relay at one intersection and arranged to be operated by traffic proceeding along the highway at said intersection in one direction, a circuit including an armature of said relay and cooperating contact thereof and connected to the controller at said one intersection to so actuate said controller when said relay is operated, and a second circuit including a second armature and second cooperating contact of said relay and connected to the controller of a second intersection in said one direction to so actuate the latter controller when said relay is so operated, whereby traffic on the highway at said one intersection and proceeding toward the second will actuate substantially simultaneously the controllers at both intersections.

18. In a traffic control system for a plurality of intersections of cross streets with and spaced along a common main street, and having right of way signals, traffic actuated means for each direction of approach of traffic in the main and cross streets, and control mechanism adapted to operate said signals to accord right of way alternately to the main and cross streets at the respective intersections individually in response to traffic actuating said means in the respective streets, interlinking means connecting the traffic actuated means for one direction in the main street at one intersection to the mechanism at said one intersection and also to the mechanism at another of said intersections further along the main street in said one direction, for such operation of both mechanisms by actuating traffic approaching in said one direction at said one intersection as if corresponding actuation occurred individually at both.

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