

**Aug. 3, 1937.**

C. D. GEER

**2,088,697**

## TRAFFIC CONTROL SYSTEM

Original Filed April 23, 1930 4 Sheets-Sheet 1

*Fig. 1.*

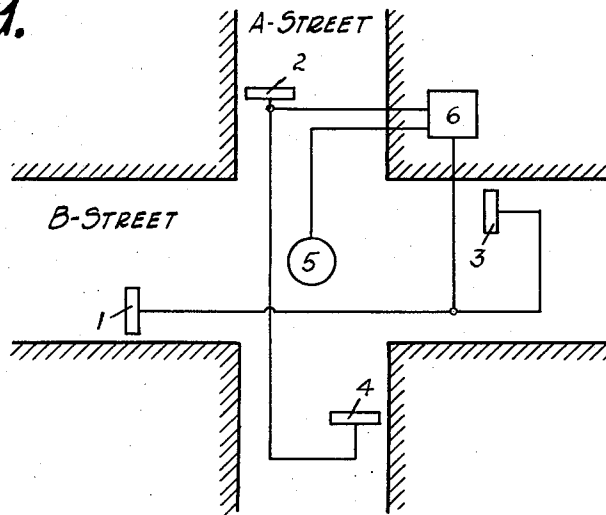
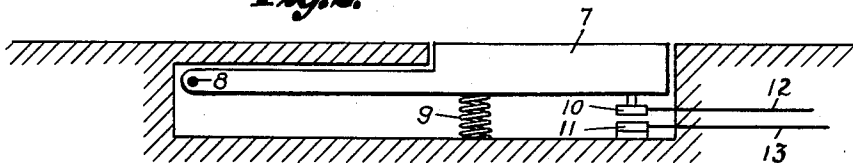


*Fig.2.*



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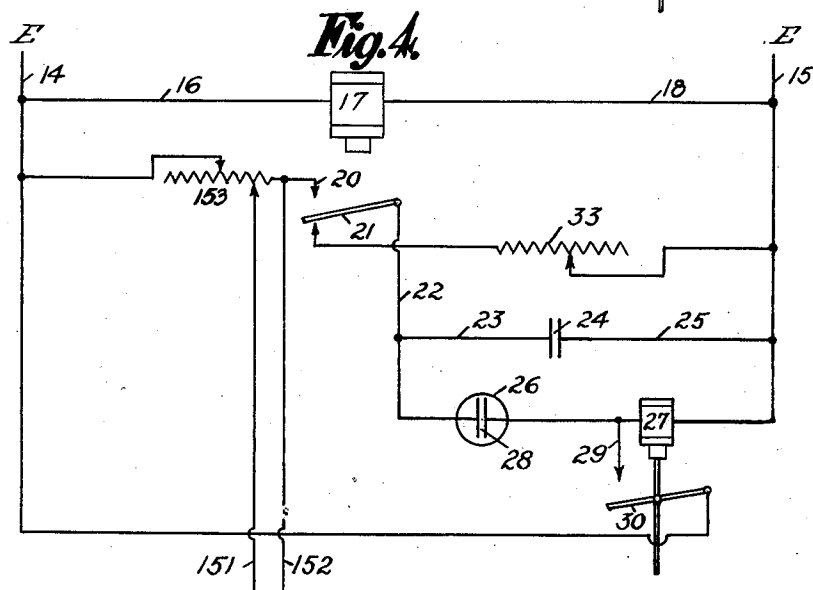
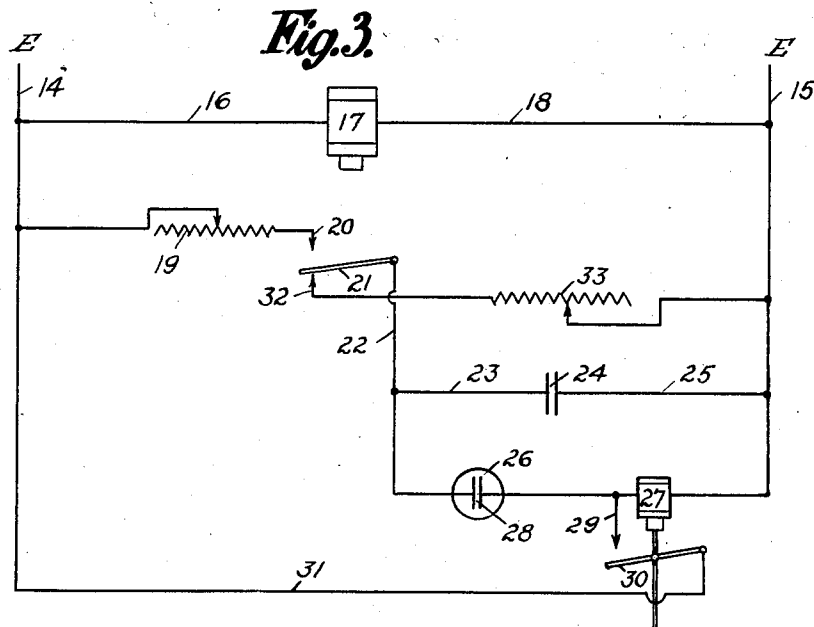
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TRAFFIC CONTROL SYSTEM

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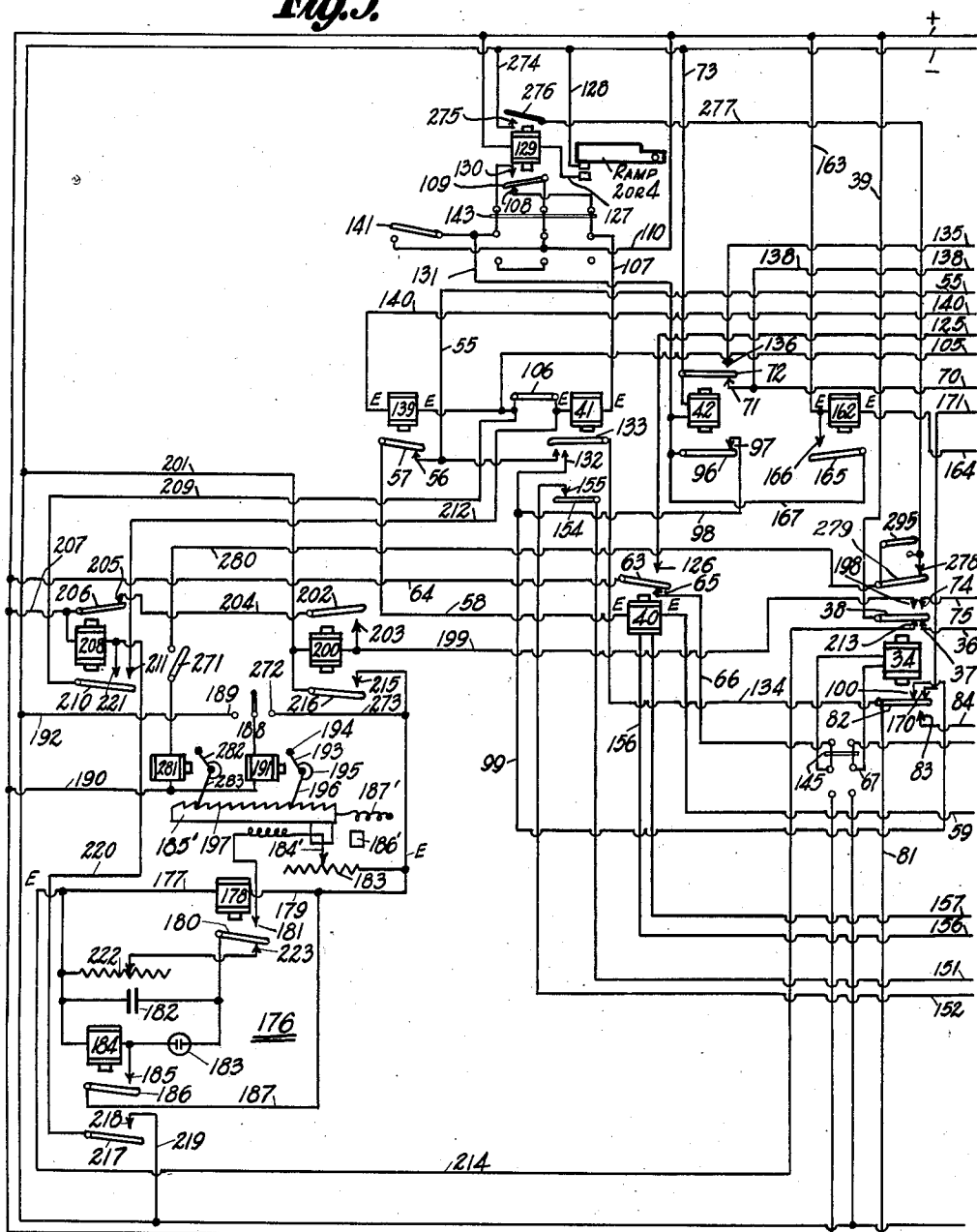
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TRAFFIC CONTROL SYSTEM

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*Fig. 5.*



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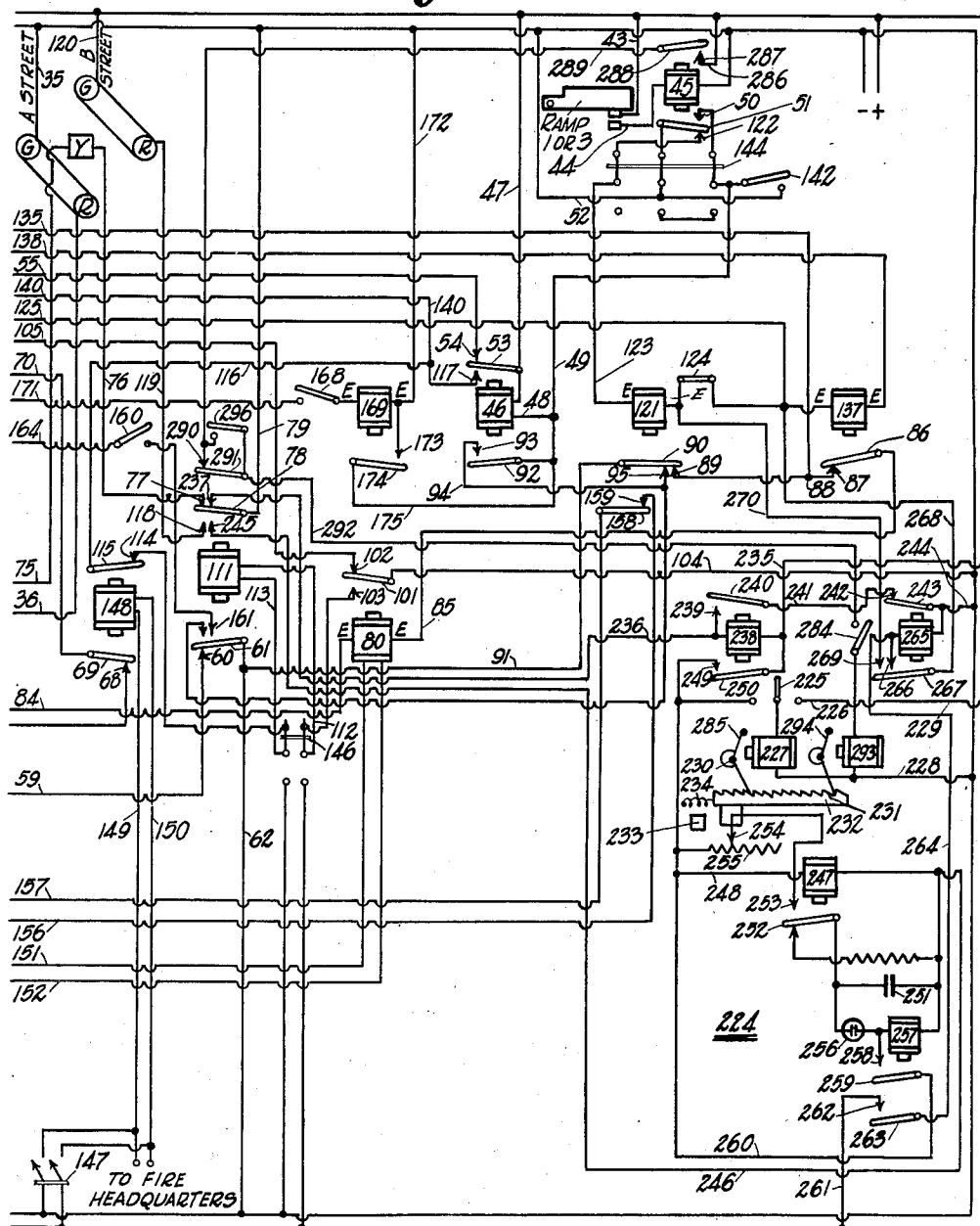
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TRAFFIC CONTROL SYSTEM

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*Fig. 6.*



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## UNITED STATES PATENT OFFICE

2,088,697

## TRAFFIC CONTROL SYSTEM

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Original application April 23, 1930, Serial No.  
446,480. Divided and this application April 7,  
1936, Serial No. 73,156

10 Claims. (Cl. 177—337)

This invention relates to a traffic system capable of use in numerous different associations but primarily intended for employment with vehicle lanes such as roadways, and particularly at points of intersection of roadways, the present invention aiming to provide an automatic system by means of which traffic will be expeditiously handled and which system to the greatest extent if not completely will be controlled in its functionings by the presence of traffic along the vehicle lanes.

This application is a division of application Serial No. 446,480 filed April 23, 1930, and relates particularly to and claims the "periodic call" feature and a traffic control system embodying said "periodic call" feature, both said feature and said system being disclosed but not claimed in said application Serial No. 446,480.

The present application discloses but does not claim the "speed proportional control" feature of application Serial No. 446,480. This latter feature is completely disclosed and claimed in application Serial No. 446,479 filed April 23, 1930, by Frederick G. Kelly, Jr., which application issued on June 23, 1936, as Patent 2,044,907. The present application also discloses but does not claim subject matter relating to the "initial interval", the "variable increment" and "variable amber" features of application Serial No. 446,480, which latter features are claimed in application Serial No. 446,480.

It is an object of the invention to provide an arrangement of apparatus furnishing a system of this character and by means of which traffic will be handled with maximum expediency and minimum delay periods and in which moreover the system will embrace a factor of safety such that the danger of accidents between vehicles or between vehicles and pedestrians will be reduced to a minimum, if not entirely eliminated.

A further object is that of providing a system of this character, the several units of which will be individually simple and rugged in construction and embrace relatively few parts, these units when assembled providing a system operating over long periods of time with freedom from mechanical and/or electrical difficulties. Moreover, these units to the greatest extent will be capable of individual adjustment so that while at the time of their manufacture, conditions may generally be approximated, adjustments may be made at the time of or subsequent to their installation at an actual traffic intersection so as to take into account the characteristics individual to the traffic flow along the vehicle lane comprising such intersection.

A still further object is that of providing a traffic control system in which in the functionings of the system, account will be taken not alone of the density of the traffic but also of the speed with which it is moving so that on the one hand undue delays will not be incurred and on the other hand, the danger of a relatively slow moving vehicle becoming trapped at the intersection will be reduced to a minimum.

Another object is that of providing a system in which even in the absence of vehicular traffic, the system will function to permit pedestrians to traverse the intersection without danger.

A further object is that of providing a traffic actuated right of way signalling system for traffic lanes in which transfer of right of way from either one traffic lane to another will be assured after a relatively long right of way period in the one lane even in the absence of traffic actuation on such other lane.

An additional object is that of providing a traffic actuated right of way signalling system in which in the presence of traffic right of way is transferred from one lane to another in response to traffic actuation and in which after a relatively long period of right of way on one traffic lane with absence of traffic actuation on another lane artificial actuation is produced on such other lane to simulate the effect of traffic actuation on such other lane so as to cause subsequent transfer of right of way to such other lane.

Still another object is that of construction of a system, the several units of which will function in the event of one condition of traffic to substantially instantaneously transfer the right of way from one vehicle lane to the intersecting vehicle lane upon the approach of a vehicle along the latter, but in the event of vehicles passing along the first vehicle lane and approaching the intersection will delay this transfer of right of way for a period adequate to assure safety to transfer.

With these and further objects in mind, reference is had to the attached sheets of drawings illustrating one practical embodiment of the invention and in which:

Figure 1 is a diagrammatic view showing a highway intersection employing a signal system embodying our invention;

Figure 2 is a detailed view showing a section of a vehicle actuated control device;

Figures 3 and 4 show diagrammatic representations of timing mechanisms;

Figures 5 and 6 are a diagrammatic view show-

ing the circuits of an apparatus for operating the signal at intersecting traffic lanes.

A self regulating automatic traffic control system embodying my invention may comprise three parts: a vehicle actuated control, traffic responsive device or detector placed in or at the side of a road or vehicle lane, an electrical time limiting control system, and a signal device to indicate right of way to traffic. A function of the vehicle actuated control device is such that vehicles approaching on the several traffic lanes actuate various electrical control circuits. These actuations control the operation of the electrical time limitation control system, which in turn controls the right of way device. The right of way device, to inform the traffic in each street when to go and when to stop, may be the standard red, yellow and green lights now in general use, but may also be any other convenient or desirable form. The vehicle actuated control may be of several types as hereinafter mentioned:

One means actuated by the approaching vehicle may be of a mechanical nature such as a mechanical switch located in or at the side of the street, an electrical contact being made upon passage of the vehicle.

Another means for detecting and recording the presence of an approaching vehicle may be a beam of light projected across the highway and received upon a photo-electric or light sensitive electrical cell, so that an approaching vehicle causes an interruption or fluctuation in an electrical current passing through the photo-electric or light sensitive cell.

An electrical magnetic device located in this street or at the side of the street may also be arranged in such a manner that an approaching vehicle shall actuate the device to control an electric circuit.

Obviously, any other form of vehicle indicator could be used.

The time limit control circuit operates as follows:

Assume that there are no vehicles approaching on the intersecting streets, designated for example, by A and B. Then the right of way will be indicated to the street which last required it; for example, A street. A vehicle approaching from B street now operates the B street actuating means, and the control mechanism, after showing a suitable warning signal, transfers right of way to B street. B street now has the right of way and vehicles approaching on it may cross the intersection. The right of way will be transferred back to A street under any one of the following conditions:

*Condition I.*—If a vehicle approaches on A street and all B street traffic has passed the intersection.

*Condition II.*—If a vehicle approaches on A street and B street traffic is still moving at the end of a predetermined period, (such as 30 seconds), the right of way is transferred to A street.

*Condition III.*—If no vehicles approach on A street, then after preferably a greater predetermined period, whether or not traffic is moving on B street, right of way will be called for on A street as if a vehicle had approached there and right of way will be transferred to A street as under Conditions I and II above.

The various periods are controlled by suitable timing mechanisms.

Provision to transfer the right of way to A street as outlined under Condition I above is accomplished thru the use of a timing mechanism

which provides sufficient time for the individual B street vehicles to cross the intersection. This timing mechanism is reset toward its starting position each time a vehicle operates the B street actuating means. Hence, if no further vehicles approach on B street, this timing mechanism will eventually complete timing the period it is set for; and when such time is reached, the right of way is transferred to A street. The action is of course similar when the right of way is transferred from A street to B street.

To provide for Condition II mentioned above, in which continuous B street traffic must be interrupted, another timing mechanism is provided which is not reset by vehicles on B street, and which starts timing when the vehicle approached on A street. When it has timed the period it is set for, the right of way is transferred to A street.

To care for Condition III mentioned above, there is provided another timing mechanism which starts timing B street right of way as soon as right of way appears on B street. When it has timed the period it is set for, it calls the right of way to A street, similar to the way in which right of way would be called to A street by a vehicle approaching on A street and thus simulates the effect of actuation of the vehicle actuated control on A street by such a vehicle. After right of way has been called in this manner, it will be transferred as outlined in either Condition I or Condition II, depending upon conditions in B street.

When right of way is transferred as in Condition II, vehicles are on B street which have not had sufficient time to cross the intersection, even though they have actuated the B street actuating means. The control system is left in such a condition that as soon as A street traffic permits, right of way will be transferred to B street without requiring any additional actuation of the B street vehicle actuated means.

The timing mechanism which is reset by traffic, is so arranged that it may be reset in accord with the speed of the vehicle causing the resetting. And thus the time or protection period given each vehicle is commensurate with the speed of the vehicle. In this manner, no vehicle receives an unnecessarily long protection period; thus avoiding needless delay in the interfering lane.

The chief function of the warning signal when a stop signal is changing to right of way, is to indicate to waiting vehicles that such change is about to occur, and to get ready to proceed. But, when the change is from right of way to stop, it indicates to moving vehicles that they are about to lose right of way, and accordingly the vehicles must be brought to a stop. The warning signal thus acts as a very important safeguard.

Whenever right of way is transferred as outlined in Condition I, all traffic has ceased on the lane which is losing right of way. Thus, there are no vehicles about to lose right of way, and consequently the warning signal may be quite short. But when right of way is transferred, as outlined in Condition II, some vehicles are about to lose right of way, and accordingly a longer warning signal should be given. This is accomplished by providing a mechanism which times the warning signal in a different way, depending whether the right of way is transferred as outlined in Condition I, or whether it is transferred as outlined in Condition II.

If several vehicles have passed the actuating means while being given the stop signal, some

time will elapse, after they have been given the right of way signal, before the last of said vehicles gets into motion. This time may be quite considerable, and may exceed the protection period provided by the resettable timing mechanism. There is accordingly provided an additional timing mechanism, the time period of which is proportional to the number of vehicles that have passed the actuating means, but are not allowed to proceed. This timing mechanism begins to time as soon as right of way appears on its street; and only after it has finished timing its period, may the resettable timer begin to operate.

While there has been described above the self regulating automatic traffic control system embodying this invention, and there has been shown that this invention may comprise three interconnected parts, there will now be described in detail the construction of one complete and specific system embodying the invention:

Referring to Fig. 1 of the drawings, there is shown a complete self regulating automatic traffic control system applied to intersecting streets A and B. The vehicle actuated controls are indicated by the numbers 1, 2, 3 and 4. The signal means in this particular embodiment is, as preferred, visual, and is indicated at 5. It embraces red and green electric lamp reflectors or lenses visible from either direction on A street, but not visible on B street; red and green electric lamp reflectors, or lenses, visible from either direction on B street, but not visible on A street; and preferably a yellow electric lamp lens or reflector visible from both streets. The electrical time limiting control is indicated by 6. The unshaded lines indicate controlling circuits. Thus, the vehicle actuated devices in A street control the electrical time limiting control 6, and so do the vehicle actuated devices in B street. The time limiting control 6 controls the signal 5.

Fig. 2 shows one form of vehicle actuated device consisting of a ramp 7 hinged at 8 and forced into an elevated position by spring 9. The top surface of the ramp may be substantially at the level of the street. When the wheel of a vehicle passes over the ramp, the weight of the vehicle depresses ramp 7, causing contacts 10 and 11 to be pressed together, closing circuit between wires 12 and 13. When the wheel leaves ramp 7, spring 9 forces the ramp 7 into an elevated position, breaking circuit between wires 12 and 13 by separating contacts 10 and 11. The vehicle actuated devices in A street are connected in parallel. The vehicle actuated devices in B street are also connected in parallel.

The time limiting control uses several timing mechanisms. One embodiment of such a timing mechanism is shown in Fig. 3. When a source of voltage supply is connected between wires 14 and 15, current flows from wire 14 thru wire 16, relay 17, and wire 18, to wire 15, operating relay 17. This allows current to flow from wire 14 through adjustable resistance 19, contact 20, armature 21, wire 22, wire 23, condenser 24, wire 25, to wire 15. Thus the voltage of the supply is applied to condenser 24 through resistance 19, and the voltage of the condenser begins to build up at a definite rate determined by the size of the condenser, the resistance 19, and the voltage of the supply. Shunting condenser 24 is a circuit including a glow tube 26, and a relay 27. The glow tube comprises a bulb containing a suitable gas into which electrodes 28 extend. This tube has such a characteristic that it is

normally non-conducting, but when the voltage across its terminals reaches a certain critical or threshold value, the gas ionizes and becomes a good electrical conductor and will not become conducting again until the voltage across its terminals has dropped considerably below the critical ionizing voltage. The voltage of the supply is greater than the critical voltage of the tube. When the voltage across the condenser is built up to the critical voltage of the tube, the tube suddenly becomes conducting, causing current to flow momentarily from condenser 24 through tube 26, and relay 27, causing relay 27 to operate. This would effect only a momentary closure of the relay were it not for the locking circuit comprising contact 29, armature 30, and wire 31, which is established when relay 27 operates. This places relay 27 directly across the supply, and relay 27 remains energized.

The interval elapsing between the application of the supply voltage to wires 14 and 15, and the operating of relay 27, is the period timed by the mechanism. By suitable adjustment of resistance 19, any desired interval may be obtained. When relay 27 operates it may be used to actuate one or more armatures in addition to armature 30. These additional armatures will be used as described below.

Relay 27 remains energized as long as the supply voltage is connected between wires 14 and 15. If the supply voltage is disconnected, the energizing circuits of both relay 17 and relay 27 are interrupted, both relays become deenergized and drop to their deenergized positions. When relay 17 becomes deenergized, it causes armature 21 to touch contact 32. This shunts adjustable resistance 33 across the terminals of condenser 24, and any energy that may be stored in condenser 24 is dissipated in resistance 33. The rate of dissipation of energy may be varied at will by proper adjustment of resistance 33.

Wires 14 and 15 may be called conveniently the energizing wires of the timing mechanism and are accordingly marked E—E.

*Connection I.*—Figs. 5 and 6 combined show the wiring diagram of a traffic control system embodying the invention. With the various switches, in the positions indicated, the system is so arranged that right of way remains showing on the street which last had right of way, in the event that there be no traffic on either street. Assuming that A street last had right of way, instantaneous operating relay 34 will be energized, thus lighting the A street green light and B street red light through wire 35, wire 36, contact 37, armature 38, and wire 39. It will also be noted that timing mechanisms 40 and 41 are energized, and also instantaneous operating relay 42. The action of the apparatus under various traffic conditions will now be described.

*Case I—Single vehicle approaching on B street.*—Assume a vehicle approaches on B street actuating one of the vehicle actuated devices located there, closing circuit between wires 12 and 13. The B street vehicle actuated control devices are connected to wires 43 and 44; thus whenever one of the B street vehicle actuated devices is actuated, the actuating circuit of relay 45 is closed and it operates. This momentarily closes the energizing circuit of relay 46 through wire 47, wire 48, wire 49, contact 50, armature 51 and wire 52. Relay 46 causes armature 52 to touch contact 53, locking in relay 46 through wire 54, contact 55, armature 56, wire 51 and wire 62. This locking circuit is necessary because relay 45

operates only momentarily, and were it not for this locking circuit, relay 46 would also operate only momentarily. The operating of relay 46 interrupts the energizing circuit of timing mechanism 40, which has been made through wire 47, armature 53, contact 54, wire 55, contact 56, armature 57, wire 58, wire 59, contact 60, armature 61, and wire 62. Timing mechanism 40, its energizing circuit being broken, allows its relay 27 to drop to its deenergized position, operating armature 63. The energizing circuit of relay 34 which had been made through wire 64, armature 63, contact 65, wire 66, switch 145, wire 67, and the contact of switch 145, contact 68, armature 69, wire 70, contact 71, armature 72 and wire 73, is now broken by the deenergizing of timing mechanism 40, and relay 34 drops to its deenergized position. Armature 38 separating from contact 37 extinguishes the A street green light and B street red light. At the same time, the yellow light is energized through wire 39, armature 38, contact 74, wire 75, wire 76, contact 77, armature 78, and wire 79. At the same time, timing mechanism 80 is energized through wire 81, armature 82, contact 83, wire 84, wire 85, armature 86, contact 87, wire 88, contact 89, armature 90, wires 91 and 92. Timing mechanism 80 is similar to the timing mechanism shown in Fig. 3, and similarly, E—E represents the energizing wires. Assume that the resistance 19 in this timing mechanism is adjusted so that the mechanism times an interval of 3 seconds. When relay 34 was deenergized, it deenergized relay 42 because the energizing circuit of relay 42, consisting of wire 73, armature 96, contact 97, wire 98, wire 99, contact 100, armature 82, and wire 81, is broken when armature 82 separates from contact 100. After timing mechanism 80 has been operating for 3 seconds, its condenser discharges through its tube in the manner described above, and its relay, corresponding to relay 27 operates, causing armature 101 to separate from contact 102, and to touch contact 103. When armature 101 leaves contact 102, it breaks the operating circuit of timing mechanism 41 and timing mechanism 41 becomes deenergized. The energizing circuit of timing mechanism 41 consisted of wire 104, armature 101, contact 102, wire 105, switch 106, wire 107, contact 108, armature 109, and wire 110. When armature 101 touches contact 103, relay 111 is energized through wire 104, armature 101, contact 103, switch 146, wire 112, wire 113, switch 146, contact 114, armature 115, wire 116, contact 117, armature 53, and wire 47. Relay 111 operates armature 78. Armature 78 separates from contact 77 extinguishing the yellow light and touches contact 118, lighting the B street green light and A street red light through wire 79, armature 78, contact 118, wire 119 and wire 120. The right of way is now being given to B street and the vehicle which approaches there may cross the intersection. Timing mechanism 121 is the mechanism which provides the necessary time for the individual vehicles on B street to cross the intersection. This timing mechanism is also similar to the mechanism shown in Fig. 3, E—E representing the energizing wires. Assume that the resistance corresponding to resistance 19 is adjusted so that timing mechanism 121 times a period of 10 seconds. The energizing circuit of timing mechanism 121 is made through wire 52, armature 51, contact 122, wire 123, switch 124, wire 125, contact 126, armature 63 and wire 64. It will thus be noticed that this

circuit is completed when timing mechanism 40 becomes de-energized.

*Case II—Single vehicle approaching on A street immediately after transfer of right of way to B street.*—The action of the apparatus is similar to the action as described under Case I, up to the time right of way is actually transferred to B street. The single vehicle now approaching on A street operates, for example, ramp 2. The ramps in A street are connected across wires 127 and 128, and thus the vehicle on A street causes a momentary operation of relay 129. This causes relay 42 to operate by energizing it through wire 110, armature 109, contact 130, wire 131, and wire 73. Relay 42 locks itself in through armature 96, contact 97, wire 98, contact 132, armature 133, wire 134 and wire 81. Contact between armature 133 and contact 132 is made because when relay 129 operated, it separated armature 109 from contact 108, thus breaking the energizing circuit of timing mechanism 41, which immediately dropped to its deenergized position. Assuming that only a single vehicle was approaching on B street, then, after 10 seconds, timing mechanism 121 will operate and armature 90 will separate from contacts 95 and 89. In separating from contact 89, armature 90 breaks the energizing circuit of timing mechanism 80 which becomes de-energized, causing armature 101 to leave contact 103. This deenergizes relay 111, which allows armature 78 to separate from contact 118, extinguishing the B street green light and A street red light. At the same time armature 78 touches contact 77, lighting the yellow light as described above. In deenergizing, relay 111 allows armature 61 to touch contact 60, which reestablishes the energizing circuit of timing mechanism 40. Timing mechanism 40 is similar to the mechanism shown in Fig. 3; and we shall assume that its resistance, corresponding to resistance 19, is so adjusted that the mechanism times a period of 3 seconds. After being energized for 3 seconds, timing mechanism 40 operates, separating armature 63 from contact 126, and allowing armature 63 to touch contact 65. In separating from contact 126, armature 63 breaks the operating circuit of timing mechanism 121, which becomes de-energized. At the same time, armature 63, in touching contact 65 energizes relay 34. Relay 34 operates armature 38, which leaves contact 74, extinguishing the yellow light, and touches contact 37, lighting the A street green light and B street red light, and the right of way is again being given to A street and the vehicle which approached there may cross the intersection.

The above two cases describe transfer of right of way from one street to another in response to a vehicle approaching on this street where right of way is not being given. It will be noticed that once a vehicle has been given right of way, it will retain right of way for a certain minimum period, for example, 10 seconds; and even though a vehicle approached on the other street, right of way cannot be taken away until the end of this minimum period which we assume is sufficient time for the vehicle to cross the intersection. If all traffic has ceased, then the timing mechanism which provides this minimum period, (for street A this would be timing mechanism 41), is in its operated condition, and should a vehicle approach on the other street, right of way will be transferred immediately. If traffic has not ceased, the above mentioned timing mechanism will not be in its operated condition, and should a vehicle ap-

proach on the other street, it must wait until this timing mechanism has operated.

Case III—*Single vehicle approaching on B street followed within ten seconds by a second vehicle on B street.*—Assuming the right of way is being shown to A street and there is no traffic on A street, then the first vehicle approaching on B street will transfer right of way to B street as described in Case I. If a second vehicle approaches on B street, actuating either ramp 1 or 3, this will cause relay 45 to operate momentarily breaking circuit between armature 51 and contact 122. This will break the energizing circuit of timing mechanism 121. We have assumed that timing mechanism 121 times a period of 10 seconds. Assuming the second vehicle to have approached within 10 seconds from the time the first vehicle approached, condenser 24 of this timing mechanism will not be charged up to the critical voltage of tube 26, and relay 27 will not have operated. The breaking of the energizing circuit deenergizes relay 17 and the charge which has accumulated on the condenser will be dissipated in resistance 33, as described previously. Relay 45 is of course energized only for a short time, and consequently the energizing circuit of timing mechanism 121 is immediately reestablished. But it will be noticed that condenser 24 has been de-energized, and consequently a full 10 seconds must elapse before the condenser will again be charged to the critical voltage of tube 26.

The operation of the system under Case II has shown that right of way cannot be taken away from B street once it has received it, until timing mechanism 121 has operated. Thus, whether or not, in the meantime, a vehicle has approached on A street, the second vehicle that approached on B street receives a full 10 seconds in which to cross the intersection. It is apparent that this operation will be repeated if additional vehicles approach on B street. As soon as vehicles cease approaching on B street, timing mechanism 121 will, after 10 seconds have elapsed since the last actuation of either ramp 1 or 3, operate, and assuming a vehicle to have approached on A street, the right of way will be transferred to A street, as described under Case II. Once right of way has been transferred to A street, the operation of the system, should more vehicles approach on A street, is precisely as described above. Relay 129 performs the same function for A street that relay 45 performs for B street; and, similarly, timing mechanism 41 operates when right of way is being given to A street, just as timing mechanism 121 operates when right of way is being given to B street.

In describing Case III, it was assumed that after right of way was transferred to B street, a vehicle approached on A street. If no vehicles approach on A street, then after the last car has passed B street, timing mechanism 121 will operate and right of way will simply remain on B street. This is because, even though the energizing circuit of timing mechanism 80 is interrupted when armature 90 separates from contact 89, timing mechanism 80 remains energized because power continues to be applied through wire 135, contact 136, armature 72, and wire 73. This is because, since no vehicle has approached on A street, relay 42 is de-energized. If vehicles should again come on B street, timing mechanism 121 will again be de-energized, as described above. The B street traffic will again be protected and it cannot lose right of way until all of it has passed the intersection. It is apparent

that as long as no vehicles approach on A street, B street traffic can retain right of way indefinitely.

Case IV—*Continuous traffic on B street with a vehicle waiting on A street.*—When this condition occurs, timing mechanism 121 will be continually deenergized or reset by the B street vehicles, and right of way would remain indefinitely on B street. This is permissible if there is no traffic on A street. But should vehicles approach on A street, there must be some limitation to the length of time B street can continue to hold the right of way after vehicles have approached on A street. This is accomplished with timing mechanism 137. This timing mechanism is again similar to the type shown in Fig. 3, and we shall assume that its resistance 19 is so adjusted that the mechanism times a period of 30 seconds. This timing mechanism does not begin to operate until a vehicle approaches on A street. When this happens, relay 42 becomes energized and current flows from wire 73, through armature 72, contact 71, wire 138, the energizing wires E—E of timing mechanism 137, wire 125, contact 126, armature 63, and wire 64. It will furthermore be noticed that this timing mechanism is not reset by vehicles on B street, and once energized, uninterruptedly continues to time until the end of its timing period, for example, 30 seconds. Assuming B street traffic to be continuous, then after 30 seconds, timing mechanism 137 will operate armature 86, separating it from contact 87. This deenergizes timing mechanism 80 which in turn deenergizes relay 111, and right of way is transferred to A street as described above under Case II. The difference is that relay 46 remains energized because its locking circuit continues to be made through contact 95 and armature 99, since timing mechanism 121 has not been energized long enough to operate. Thus, after right of way is transferred to A street relay 46 is energized, which is equivalent to the approach of a vehicle on B street. The system thus provides that without requiring an additional actuation of either vehicle actuated control 1 or 3, right of way will return to B street as soon as traffic on A street permits. This procedure is necessary because a vehicle may approach on B street within a second or two from the time right of way is going to be taken from B street, and not having had sufficient time to cross the intersection, these B street vehicles would be stranded. The system is thus arranged so that when right of way is transferred, due to the operation of timing mechanism 121, relay 46, during such a transfer, becomes de-energized. But, should timing mechanism 137 transfer right of way, relay 46 will not become deenergized, and right of way will thus be recalled to B street, so that vehicles on B street which did not receive a full 10 seconds in which to cross the intersection, will be given ample time to do so. Timing mechanism 139 performs the same function for A street that timing mechanism 137 performs for B street. The energizing circuit of timing mechanism 139 consists of wire 47, armature 53, contact 117, wire 140, energizing wires E—E, wire 105, contact 102, armature 101, and wire 104.

There is thus provided a very flexible traffic control system. It is arranged that once right of way is given to a particular street, in response to vehicles approaching there, each vehicle receives a certain protection period from the time it actuates the ramp in the street, during which it may cross the intersection, and is

protected against opposing traffic. If a vehicle approaches on the street where the stop sign is being given, right of way will be transferred to it immediately if traffic has ceased on the intersecting street. If traffic has not ceased, this vehicle must wait until the last vehicle on the intersecting street has had a full minimum period in which to cross the intersection. However, vehicles do not have to wait indefinitely should there be continuous traffic on the opposing street. The system provides that the vehicle need not wait more than a certain predetermined time. At the end of this time, the continuous traffic on the opposing street is interrupted to allow the waiting vehicle or vehicles to cross the intersection. The system, however, is left in such a condition that without requiring the approach of further vehicles, the right of way will eventually revert to the street where continuous traffic was interrupted, to allow the vehicles which did not have sufficient time to cross the intersection to do so.

In describing the operation of the embodiment of the timing mechanism shown in Fig. 3, it was stated that the rate of discharge or reset could be varied at will by proper adjustment of resistance 33. This resetting occurs whenever the energizing circuit E—E is interrupted. While the rate of discharge may be determined by resistance 33, the actual amount of discharge depends upon the length of time the energizing circuit is interrupted. If this time is long, practically all of the stored energy will be dissipated in resistance 33. Thus when the energizing circuit is re-established, charging of condenser 24 will start with practically no stored energy in the condenser, and the time required to charge the condenser will be the time necessary to charge it from zero voltage to the critical voltage of tube 26. If the time of reset is short, condenser 24 will not be completely reset, and thus when the energizing circuit is reestablished, charging of condenser 24 will start with a residual voltage on the condenser, and the period timed by the mechanism will be the period necessary to charge condenser from that voltage to the critical voltage of tube 26. The time period will be shorter by the amount of time that would have been necessary to charge condenser 24 from zero voltage to the residual voltage. It is thus apparent that the amount of reset depends upon the length of time the energizing circuit is interrupted.

The above is the action of the apparatus if the energizing circuit is always interrupted when condenser 24 has been charged to some particular voltage. In practice, as will appear later, the interrupting of the energizing circuit may occur at all sorts of different voltages. Considering the operation of the device more in detail, it will appear that actual amount of discharge, while depending upon the length of time the energizing circuit is interrupted, also depends upon the voltage to which the condenser has been charged when the energizing circuit is interrupted. Thus, for example, a resetting impulse of a certain length of time, if occurring when the voltage of the condenser is 180 volts, resets the condenser to a voltage of 120; a resetting impulse of the same length of time, if occurring when the condenser voltage is 150 volts, will reset the condenser to 100 volts. It thus appears that for a particular setting of resistance 33, resetting impulses of a certain length of time will reset the voltage of the condenser to a certain fraction of its voltage. This becomes apparent from a consideration of

the discharge equation of a condenser. This equation is:

$$E_t = E_0 e^{-\frac{t}{RC}}$$

$E_0$  is the voltage of the condenser when discharge was started;  $E_t$  is the voltage of the condenser after  $t$  seconds;  $e$  is the constant value 2.7183;  $R$  is the value of the resistance 33; and  $C$  the capacity of the condenser.  $C$  is of course fixed, and  $R$  is assumed set at some particular value. Thus it is obvious that for a particular value of  $t$ , the condenser will always be discharged to the same portion of the voltage.

Referring now to Fig. 2, it will be noticed that the vehicle actuated device consisting of ramp 7 is so arranged that circuit between wires 12 and 13 is closed during the time the wheel of the vehicle is on ramp 7. Since the length of time the wheel is on the ramp depends upon the speed of the vehicle, circuit between wires 12 and 13 will be closed for a short period of time, if the vehicle is travelling rapidly, and for a long period of time if the vehicle is travelling slowly. Actuation of either of ramps 1 and 3 operates relay 45, and since this relay is directly connected to the circuit closed by ramps 1 and 3, relay 45 will be energized only while the wheel of the vehicle is actually on the ramp, and consequently the length of time armature 51 is separated from contact 122 depends entirely upon the speed of the vehicle. The energizing circuit of timing mechanism 121 is made through armature 51 and contact 122, and further, the energizing circuit of timing mechanism 121 is interrupted for a length of time which depends entirely upon the speed of the vehicle causing such interruption. Referring now to the above description of the operation of the timing mechanism, it becomes apparent that timing mechanism 121, although giving the first vehicle a full 10 seconds in which to cross the intersection, gives succeeding vehicles an additional period which is dependent upon their speed, and consequently, succeeding vehicles are given just sufficient time to cross the intersection, instead of receiving a full, unnecessary 10 seconds. The faster the vehicle travels, the less the reset, and consequently the less is the time given the vehicle. But, the faster a vehicle travels, the less time it needs.

The above would be the action if succeeding vehicles continually approach just before timing mechanism 121 is about to operate and separate armature 90 from contacts 89 and 95. In practice, traffic rarely approaches in just that manner. For example, the second car may approach within a second or two from the time the first car approached. Thus, if there were no resetting at all, the second car would receive possibly 8 or 9 seconds in which to cross the intersection, which might be ample. But, the apparatus automatically takes care of just such a condition. If the second car approaches, say, after 2 seconds, timing mechanism 121 will have been energized for only 2 seconds and the voltage built up in its condenser will be quite small. Since, as explained above, the resetting does not reduce the voltage of the condenser by a certain number of volts, but instead reduces the voltage by a certain portion of the voltage built up, the amount of reset will be very small, and the additional time given the second vehicle, very small.

Timing mechanism 41, constructed similar to timing mechanism 121, performs the same operation for street A.

Connection II.—The operations described above

occur when the various switches are in the positions shown in Figs. 5 and 6. It may be seen from an inspection of Fig. 5 that if switch 141 is closed, relay 42 is continuously energized, thereby causing the right of way to return to A street not later than 30 seconds after having been given to B street, if B street traffic is continuous, or as soon as B street traffic ceases.

**Connection III.**—It can be readily seen by inspection of Figs. 5 and 6 that if the switches are as shown, except that switch 142 is closed, the operation is as described under Connection II, except that the conditions described for A street and B street are interchanged.

**Connection IV.**—It can be seen that with switches 141 and 142 closed, the right of way is granted alternately to each street and is held by each street for any period between 10 and 30 seconds. If no vehicles actuate the ramp in a particular street during a period of 10 seconds, the 10 second timing mechanism functions to yield the right of way 10 seconds after it is granted. If, on the other hand, when said street is given the right of way, vehicles operate either ramp in said street so that the 10 second timing mechanism continually resets, the 30 second timing mechanism functions to yield the right of way 30 seconds after it is granted.

**Connection V.**—The circuit is so arranged that if, for any reason, it is desired to disconnect the traffic actuated means, this can be accomplished by throwing switches 143 and 144 to their down positions. Under these conditions, relays 42 and 46 are continuously energized and the energizing circuits of timing mechanisms 41 and 121 are continuously interrupted. The system will then function to give right of way alternately to A street and B street for periods of 30 seconds each.

**Connection VI.**—If it is desired to operate a system by hand, this can be accomplished by using switches 145 and 146. If both switches are open, relays 34 and 111 are deenergized, and the yellow light will be shown to both streets, as described previously. If switch 145 is then thrown to the down position, relay 34 will be energized and the A street green light and B street red light will be shown. By again opening switch 145, the yellow light will again be shown to both streets. If, then, switch 146 is thrown to the down position, relay 111 will be energized, thus lighting the B street green light and A street red light. By opening switch 146, the yellow light will again be shown to both streets. Thus the lights can be operated manually in any desired manner.

**Connection VII.**—By closing switch 147, or by applying power to the two wires marked "To fire headquarters", this will, through wires 149 and 150 energize relay 148. This will operate armatures 69 and 115, separating them from contacts 68 and 114 respectively. This interrupts the energizing circuits of both relays 34 and 111 and consequently both of these relays become deenergized. This lights the yellow light visible from both streets. This feature is introduced to provide for emergency control either at the intersection or from a distant point.

**Connection VIII.**—It will be noticed that when right of way is transferred from A street to B street, timing mechanism 80 times the warning interval during which the warning signal or yellow light is shown. As mentioned before, this timing mechanism is the same as the one shown in Fig. 3, and its resistance 19 was assumed adjusted so that it timed a period of 3 seconds.

There is one slight difference in its construction, and its complete wiring diagram is shown in Fig. 4. This difference consists in wires 151 and 152. Wire 152 is connected to one end of resistance 19 as shown, while wire 151 may be adjusted along resistance 19 by tap 153. If circuit between wires 151 and 152 is closed, this will shunt out a portion of resistance 19, and consequently the period timed by the mechanism will be less than 3 seconds, and may be, for example, 1 second. It will be noticed, furthermore, that if right of way is transferred from A street to B street, through the operation of timing mechanism 41, then the circuit between wires 151 and 152 is closed because timing mechanism 41, in operating, causes armature 154 to touch contact 155. Thus the timing mechanism 80 will provide a short warning period, namely, 1 second. If the transfer is caused by the operation of timing mechanism 139, then circuit between wires 151 and 152 is not closed, and the warning signal provided by timing mechanism 80 will be 3 seconds in length because no portion of its charging resistance has been shunted out. When the transfer of right of way is from B street to A street, timing mechanism 40 performs in a manner similar to timing mechanism 80. In this case the shunting out of a portion of the resistance is accomplished through wires 156 and 157, armature 158, and contact 159.

The foregoing indicates that when right of way is transferred through the operation of either timing mechanism 41 or timing mechanism 121, the following warning period will be short, namely, 1 second. If the transfer is caused by the operation of either timing mechanism 137 or 139, the following warning period is long, namely, 3 seconds. This variable warning signal is in accord with traffic requirements. When traffic has ceased, on A street for example, timing mechanism 41 transfers right of way to B street, and since traffic has ceased on A street, no longer warning signal need be given because there are no vehicles on A street to be warned. The action is similar when timing mechanism 121 transfers right of way from B to A street. If timing mechanism 139 transfers right of way from A street to B street, it means that continuous A street traffic is being interrupted, and consequently a longer warning signal should be given so that the vehicles in A street may have ample time to be brought to a stop. The action is similar when timing mechanism 137 transfers a right of way from B to A street. It will be noticed that the mechanism provides a long or a short warning period in accord with the needs of the traffic.

**Connection IX.**—If all the switches are as shown in Figs. 5 and 6, except that switch 160 is closed, then as soon as right of way is given to B street, armature 61 touches contact 161 and the energizing circuit E—E of timing mechanism 162 is made through wire 163, wire 164, switch 160, contact 161, armature 61 and wire 62. This timing mechanism is similar to the one shown in Fig. 3, and we shall assume that its resistance 19 is so adjusted that it times a period of 2 minutes. If right of way is taken away from B street before the end of 2 minutes, the energizing circuit of timing mechanism 162 will be interrupted, its condenser will be discharged, and another 2 minutes of continuous B street right of way must be shown before timing mechanism 162 will operate. Assuming there is no A street traffic, then right of way would remain on B street indefinitely, were it not for timing mechanism 162. After right of way has been showing for 2 minutes on

B street, timing mechanism 162 operates, causing armature 165 to touch contact 166. This through wire 163, contact 166, armature 165, wire 167 and wire 73 energizes relay 42. It will thus be noticed that the operation of timing mechanism 162 operates relay 42, thus performing the very same function that a vehicle approaching on A street would have performed. If, when relay 42 operates, B street traffic has ceased, right of way will be transferred to A street. If B street traffic has not ceased, then right of way will eventually be transferred, as described above in the several cases, depending upon traffic conditions in B street. We thus have a system which, in the event there is no traffic on one street, does, after a certain length of time, shift right of way to that street in order to allow pedestrians to cross. An additional important feature is that it does not arbitrarily transfer right of way at the end of the 2 minutes. It merely puts in a call on the street where the red light is being shown, and the system then takes care of that call just as though it had been caused by a vehicle approaching on A street. The fundamental object of this system is to operate the signal lights in such a way that traffic is controlled most efficiently. Timing mechanism 162 does not disrupt that operation but merely insures that right of way will eventually be given to an opposing street even though there be no traffic upon it, in order to allow pedestrians to cross the intersection.

If switch 168 is closed, timing mechanism 169 will be energized when right of way is given to A street. This is accomplished through wire 81, armature 82, contact 170, wire 171, switch 168, energizing circuit E—E and wire 172. Timing mechanism 169 is similar to timing mechanism 162, and performs the same function for B street that timing mechanism 162 performs for A street. When timing mechanism 169 operates, it closes contact between armature 174, and contact 173, and thus through wire 172, contact 173, armature 174, wire 175, wires 48 and 47, operates relay 46. Right of way is now being called to B street and will be transferred, as described above in the several cases. Briefly reviewing the operation, it will be noticed that when right of way has been showing continuously on one street for 2 minutes, right of way is called to the other street, and will be transferred to that street after not more than 30 seconds. With both switches 160 and 168 closed at the same time, and in the absence of traffic on both streets, when right of way has been showing continuously on one street for two minutes right of way is called to the other street and will be transferred to that street after not more than thirty seconds, and after right of way has been showing continuously on the other street for two minutes right of way is called back to the first street and will be transferred thereto after not more than thirty seconds. Accordingly, in the absence of traffic, right of way reverts between the streets at long intervals.

**Connection X.**—In all of the above description, it was noticed that timing mechanism 41 began to operate as soon as right of way appeared on A street. Experience has shown that it is, in most instances, necessary to place the vehicle actuated devices quite some distance from the intersection. This occurs because vehicles should register their presence some time before they reach the actual intersection. This will allow the mechanism to either give them time to cross the intersection, or if right of way is to be taken

away from the approaching vehicles, give them ample distance in which to stop. Suppose, for example, that the vehicle actuated devices are placed 150 feet from the intersection. Assume now that several vehicles approach on a street where the red light is showing, and assume also that they do not receive right of way immediately and are forced to stop. Eventually, of course, right of way will be transferred to that street and the vehicles will be given time to cross the intersection; in this case, 10 seconds. If all the vehicles got into motion at once, this time would be ample because the period provided should be sufficient to allow a moving vehicle, which has just actuated one of the vehicle actuated devices, to cross the intersection. However, the vehicles will not all move simultaneously. If, say, 10 vehicles are waiting, approximately 15 seconds will elapse before the last vehicle in the line gets into motion. Assuming there are no further operations of the vehicle actuated controls, the vehicle protection timing mechanism on that street will not be reset, and will, after 10 seconds, transfer right of way to the opposing street. This obviously will occur some time before the last vehicle in the line has begun to move, and several of the vehicles will be stranded, without, however, leaving the system in such a condition that right of way will again be given to the stranded vehicles without requiring further actuation. It is thus necessary to provide an initial timing period long enough to allow all of the vehicles to get into motion, and furthermore, not to start the vehicle protection timer until the end of this initial period. If the system is operated in this manner, it will effectively take care of the time required to allow waiting vehicles to get into motion.

This initial timing period is provided by timing mechanism 176. The structure of the actual timing mechanism is similar to the one shown in Fig. 3. When power is supplied to the two wires E—E, current flows through wire 177, relay 178, and wire 179, operating relay 178. This causes armature 180 to touch contact 181, and condenser 182 would be charged through resistance 183. The amount of this resistance is variable by means of contact 184'. Shunting condenser 182 is a glow tube 183 similar to the one previously described. When condenser 182 is charged to the critical voltage of tube 183, the tube becomes conducting and the energy stored in 182 discharges through tube 183 and relay 184, momentarily operating relay 184. This relay locks itself in through contact 185, armature 186, and wire 187. Contact 184' is mounted on a rack-arm 185', mounted so that it can slide longitudinally. This rack-arm is pulled against stop 186' by tension spring 187'. When switch 188 is moved so that it touches contact 189, current flows from wire 190 through magnet 191, switch 188, contact 189, and wire 192, and magnet 191 will be continuously energized. Magnet 191 attracts armature 193, pivoted at 194. The armature 193 is hinged at 195, and when attracted by magnet 191, causes finger 196 to engage the teeth 197 of rack-arm 185'. Thus if the rack-arm is moved to the left, the mechanism operated by magnet 191 will prevent its return motion. It will furthermore be noticed that moving rack-arm 185' to the left increases the resistance in the charging circuit of condenser 182. Assume that the rack-arm is moved so that timing mechanism 176 times a period of 10 seconds. In addition switch 106 must be open.

When right of way is being given to B street, relay 34 is deenergized and current flows from wire 39, armature 38, contact 198, wire 199, relay 200 and wire 201, operating relay 200. Relay 200 operates armature 202 and locks itself in through contact 203, armature 202, wire 204, contact 205, armature 206, and wire 207. Assume that one or more cars are waiting on A street, and right of way is about to be transferred from B street to A street. In the above description it will be remembered that timing mechanism 41 begins to operate as soon as right of way is transferred to A street. With switch 106 open, however, the energizing circuit of timing mechanism 41 is interrupted and will not be closed until relay 208 operates, which will close the energizing circuit of timing mechanism 41, through wire 209, armature 210, contact 211, and wire 212. Relay 208 does not operate immediately as will appear from the following description. When right of way has been transferred to A street, relay 34 will be energized, which allows current to flow from wire 39 through armature 38, contact 213, wire 214, wire 177, relay 178, wire 179, contact 215, armature 216 and wire 201, operating relay 178. This establishes the charging circuit of condenser 182 through wire 39, armature 38, contact 213, wire 214, condenser 182, armature 180, contact 181, contact 184', resistance 183, contact 215, armature 216, and wire 201. Thus, the voltage of the supply is applied to condenser 182 through resistance 183, and the voltage of the condenser will begin to build up. As assumed before, 10 seconds will elapse before condenser 182 is charged up to the critical voltage of tube 183. Although right of way is being given to A street, timing mechanism 41 has not begun to operate, and the vehicles waiting on A street are given opportunity to get into motion and start across the intersection. They are in no danger of having timing mechanism 41 prematurely take away right of way. After 10 seconds have elapsed, condenser 182 reaches the critical voltage of tube 183 and the energy stored in condenser 182 discharges through tube 183 and relay 184, operating armature 186 which locks in relay 184 through contact 185, armature 186, wire 187, contact 215, armature 216, and wire 201. Relay 184 also operates armature 217, causing it to touch contact 218. This allows current to flow from wire 219, through contact 218, armature 217, wire 220, relay 208, and wire 207, operating relay 208. This closes contact between armature 210 and contact 211, completing the energizing circuit of timing mechanism 41.

It thus appears that the waiting vehicles have been given a period of 10 seconds in which to get into motion, and after this period, timing mechanism 41 provides the usual protection period, which of course is resettable by additional vehicles approaching on A street. The action from now on is just as described in the above cases. When relay 208 operates it causes armature 210 to touch contact 221, locking in relay 208 through contact 221, armature 210, wire 209, wire 105, contact 102, armature 101 and wire 104. At the same time relay 208 causes armature 208 to separate from contact 205, interrupting the locking circuit of relay 200 which becomes deenergized. When relay 200 becomes deenergized, armature 216 separates from contact 215, interrupting the energizing circuit of timing mechanism 176, and relay 178 becomes deenergized. This shunts adjustable resistance 222 through contact 223 and armature 180 across the terminals of condenser

182, and any energy stored there will be dissipated in resistance 222. If traffic approaches on B street, then eventually right of way will be transferred to B street. The moment A street loses right of way, relay 34 becomes deenergized, establishing the energizing circuit of relay 200, which operates. The locking circuit of relay 200 is not completed until the end of the warning period. At the end of this period, timing mechanism 89 operates, separating armature 101 from contact 102 which interrupts the locking circuit of relay 208 which becomes deenergized, allowing armature 206 to touch contact 205, and the locking circuit of relay 200 is complete. The mechanism has now returned to the condition at the beginning of operations.

Timing mechanism 224 performs the same function for B street that timing mechanism 176 performs for A street. Similarly switch 124 must be opened. Switch 225 when moved to touch contact 226 causes magnet 227 to be continuously energized through wires 223 and 229. The armature 230, operated by magnet 227, is similar to the armature operated by magnet 191, and is arranged to engage the teeth 231 of rack-arm 232. This rack-arm is pulled toward stop 233 by spring 234. When right of way is being given to A street, relay 111 is deenergized, and through wire 235, wire 236, contact 237, armature 78 and wire 79, energizes relay 238. This relay locks itself in through contact 239, armature 240, wire 241, contact 242, armature 243 and wire 244. When right of way has been transferred to B street, current flows from wire 79 through armature 78, contact 245, wire 246, relay 247, wire 248, contact 249, armature 250, and wire 235, operating relay 247. This establishes a circuit from wire 79, armature 78, contact 245, wire 246, condenser 251, armature 252, contact 253, contact 254, relay 255, contact 249, armature 250 and wire 235. Assume that rack-arm 233 is so adjusted that the amount of adjustable resistance 255 is of such a value that 10 seconds are required to charge condenser 251 up to the critical voltage of tube 256. After 10 seconds have elapsed, the energy stored in condenser 251 discharges through tube 256 and relay 257. Relay 257 locks itself in through contact 258, armature 259 and wire 260. At the same time a circuit is established through wire 261, contact 262, armature 263, and wire 264, through relay 265, and through wire 244. When relay 265 operates it locks itself in through contact 266, armature 267 and wire 268, at the same time through contact 269 and wire 270 completes the energizing circuit of timing mechanism 121. The operation of the device from this time on is similar to the operation of timing mechanism 176, except that the functions for A and B streets are interchanged.

The above connection provides for an initial period during which vehicles may get into motion. While this may be satisfactory, in a great many installations, the device may occasionally be inefficient because the timing period, although adjustable manually, is fixed. Thus if, for example, 5 vehicles are waiting, the 10 second period may be just right. If more than 5 are waiting, a longer period may be desirable, and then again, if less are waiting, a shorter period would be ample. Thus it is desirable to provide an initial period that is proportional to the number of vehicles waiting. This may be accomplished on A street, for example, by closing switch 271 and moving switch 188 so that it touches contact 272. When right of way is being given to B street, and

no vehicles are waiting on A street, relay 200 will be energized, as described previously, and so will magnet 191, although the energizing circuit of magnet 191 is somewhat different, being made through wire 273, contact 215, armature 216, and wire 201. As will appear later, rack-arm 185' is resting against stop 186'. Every time a vehicle approaches on A street, it momentarily operates relay 129, allowing current to flow from wire 274, contact 275, armature 276, wire 277, contact 278, armature 279, wire 280, switch 271, magnet 281, and wire 190, momentarily operating magnet 281. This attracts armature 282 which is similar to the armature operated by magnet 191. Finger 283 engages the teeth of rack-arm 185' notching the rack-arm forward by the distance of one tooth. Magnet 191 is so arranged that when the rack-arm is moved forward the distance of one tooth, finger 196 engages the teeth and prevents the return motion of rack-arm 185'. Thus, magnet 281 is momentarily energized every time a vehicle causes relay 129 to operate, and the rack-arm 185' is moved a distance proportional to the number of vehicles that have approached on A street, while right of way is being given to B street. This provides that, since contact 184' moves with rack-arm 185', the amount of resistance 183 in series with condenser 182 is proportional to the number of vehicles waiting, and when timing mechanism 176 begins to time, the period timed by it will be proportional to the number of waiting vehicles. The operation of the device otherwise is the same. At the end of the period timed by mechanism 176, relay 184 operates and thus causes relay 208 to operate, all as described previously. At the same moment, relay 200 becomes deenergized and armature 216 separates from contact 215. This deenergizes timing mechanism 176, but, in addition, also deenergizes magnet 191, allowing finger 196 to move out of engagement with the teeth of rack-arm 185', and rack-arm 185' is pulled against stop 186' by spring 187'. Thus the mechanism has returned to its starting position, so that the next time vehicles register their presence on A street while B street is being given right of way, will again provide themselves with an initial period proportional to their number. It will furthermore be noticed that when right of way appears on A street, armature 279 separates from contact 278, interrupting the notching circuit of magnet 281, and thus the initial period will not be increased by further vehicles registering on A street.

The operation of timing mechanism 224 which provides the initial period for B street, can be adjusted similarly by closing switch 284 and moving switch 225 so that it touches contact 285. Thus, whenever a car operates one of the B street ramps, relay 45 operates momentarily, allowing current to flow through wire 286, contact 287, armature 288, wire 289, contact 290, armature 291, wire 292, switch 284, magnet 293, and wire 228. Thus, magnet 293 is operated every time relay 45 operates. Magnet 293 operates armature 294, notching rack-arm 232 in a manner similar to the notching of rack-arm 185'. It will again be noticed that vehicles registering on B street, after right of way has appeared on B street, do not increase the initial period because the notching circuit is interrupted at contact 290 and armature 291, which are caused to separate when relay 111 operates.

While the above mechanism provides for an initial period that is proportional to the num-

ber of vehicles waiting, it may, under certain circumstances, be desirable to increase the initial period even after right of way has appeared on that particular street. The foregoing discussion shows that the initial period is proportional to the number of vehicles waiting, and presumably the last waiting vehicle has just started to move at the end of the initial period. But if further vehicles have registered their presence, then sufficient time has not been allowed for them to get into motion. And thus it may be desirable to increase the initial period even during timing of the initial period. This may be accomplished for A street by closing switch 295, and as a consequence the notching circuit is not interrupted when right of way appears on A street. If further vehicles approach on A street, they will continue to operate magnet 281, moving rack-arm 185' so as to increase the charging resistance. Switch 296 is provided to perform the same function for B street.

From the foregoing, it will be seen that a traffic control system is provided which operates in such a way that:

1. The right of way is given successively to several traffic lanes in an order which may be predetermined, but in such a way that the length of time one lane retains the right of way is dependent upon either the approach of vehicles in said lane or upon approach of vehicles in one or more other lanes, or upon both.

2. That a traffic lane which does not require the right of way cannot hold it to the disadvantage of one which does.

3. That a vehicle whose progress is prevented by a continuous stream of opposing traffic may not be required to wait more than a predetermined period of time, and that not later than the end of said predetermined period of time said vehicle is given right of way for a period of time sufficient for it and following vehicles to cross the intersection.

4. That interfering lanes of traffic shall not be given right of way simultaneously.

5. That a vehicle which has passed an actuating means is protected against opposing traffic for a period of time sufficient to permit said vehicle to pass the intersection of the traffic lanes.

6. That a vehicle which approaches an intersection on any lane of traffic is given immediate right of way on condition, and only on condition that there be no opposing traffic in or immediately approaching the intersection.

7. That when a vehicle is not given immediate right of way or has right of way taken from it, before it has had sufficient time to cross the intersection, the system will be left in such a condition that right of way will return to the delayed vehicle as soon as traffic conditions permit.

8. That periodically right of way shifts to another lane even though there be no vehicular traffic on that lane, in order to allow pedestrians to cross the intersection.

9. That when the signal means and timing system is disconnected from the traffic actuated means, right of way may be given successively to the various traffic lanes according to a predetermined sequence and to each lane for a predetermined time interval.

10. That the signal means may be disconnected from the traffic actuated means and timing system and be operated manually.

11. That the timing system may be actuated to give a special signal for emergency use.

12. That the warning signal may be interposed between right of way and stop signals, the timing of said warning signal being in accordance with the traffic conditions existing at the moment.

13. That each vehicle is protected against opposing traffic for a period commensurate with its speed.

14. That if one or more vehicles, after passing the actuating means, do not receive right of way immediately, they will be protected against opposing traffic when they do receive right of way, for a period of time sufficient to allow the last of the waiting vehicles to get started.

Summarizing certain of the salient features of the present invention, it will primarily be understood that an extremely efficient traffic control system is herein provided and by means of which among others, the several objects of the invention as specifically afore referred to are achieved. These objects to a great extent are accomplished by a number of factors which for the purpose of convenience may be identified (a) as variable amber, (b) periodic calls, (c) variable increment, and (d) speed proportional control.

Dealing primarily with the question of variable amber, it will be understood that in the case of traffic approaching the intersection along one vehicle lane, and with no traffic in the second vehicle lane, there will be no necessity for a relatively delayed amber or transfer period. Accordingly, and by means of the present disclosure, the system will serve to transfer right of way to the vehicle lane over which traffic is approaching the intersection with a minimum delay period. On the other hand, where need for this delay period exists, as for instance, where there is a continuous stream of traffic along the vehicle lane which has the right of way and vehicles on the intersecting lane are awaiting the right of way, the transfer of right of way will only be completed after a maximum i. e. a three second delay period.

Dealing with the question of periodic call, it will be observed that by means of the present invention, a functioning of the vehicle actuated control in effect occurs periodically even in the absence of vehicles. More particularly, as set herein for example, even if there is no traffic along one vehicle lane and continuing traffic along the other vehicle lane, the right of way over the latter will be interrupted at the end of a two minute and thirty second period for minimum of ten seconds. This will allow pedestrians to cross. The reason for this will readily be understood in that the two-minute timers in the event of continuing traffic along one lane have their functioning qualified by the thirty second timer, the former permitting the initiation of functioning of the latter after two minutes have elapsed. In the case of traffic over neither lane, the two-minute timers would of course operate periodically to permit pedestrians to traverse the intersection without fear of traffic. It will, of course, be appreciated that this periodic call is entirely qualified in the case of continuous traffic approaching the intersection over both vehicle lanes.

With regard to the variable increment feature, it is understood that as previously brought out there is grave danger in the case of a number of vehicles awaiting right of way and all of which have operated the vehicle actuated control due to the necessary sluggishness of the last

vehicles of this group. Consequently the right of way once accorded this group of vehicles would be liable to be transferred before the last of the vehicles could negotiate the intersection. This difficulty, however, is anticipated by means of the present disclosure in that a timer functioning after right of way has been accorded such a vehicle group does not begin actually until a time period has elapsed proportionate to the number of vehicles which are awaiting the transfer of right of way. Accordingly, the last vehicle of this group will still be accorded a minimum right of way time period to negotiate the intersection. As a practical matter, it may of course be in many instances desirable according to the present invention to manually set this portion of the apparatus to approximate for this condition, but in any event, the time factor will be adequate and the system will take into account those vehicles arriving just after right of way has been accorded and which vehicles necessarily slow down as they become part of the group which is negotiating the intersection.

With respect to the speed proportional control, it will be understood that by the present disclosure, the timer resetting is not simply effected in an arbitrary manner which might in one instance result in undue delay to transfer of right of way and in another instance result in the transfer being effected at such an early moment as to trap a vehicle at the intersection, but that the resetting of this timer will actually be in proportion to the speed of the vehicle which is approaching the intersection.

Obviously, one or more of these factors might under certain instances be dispensed with and the several units of the apparatus while preferably embodying a construction substantially of the type illustrated and described, might be changed in numerous respects without departing from the spirit of the invention as defined by the claims.

I claim:

1. A traffic control system for interfering traffic lanes including a signal operable to accord and interrupt right of way to the several lanes, vehicle actuated devices in the lanes, a timer connected to said signal and devices adapted to operate said signal so as to accord and interrupt right of way over said lanes, means forming a part of said timer to cause each accord of right of way to be maintained for minimum and up to maximum right of way periods according to actuations of the vehicle actuated devices, and means forming a part of said system and acting only in the event of the vehicle actuated device of one lane remaining non-actuated for a period of time in excess of such maximum period to cause transfer of right of way for a certain period to the lane of said non-actuated device even in the absence of traffic.

2. A traffic control system including, in combination, signalling means to be disposed adjacent the point of intersection of traffic lanes and operable to accord and interrupt right of way to the several lanes, a timer for operating said signalling means to accord and interrupt right of way over said lanes, a traffic actuated device disposed in each lane in advance of said intersection and connected to said timer to govern the operation thereof, timing means forming a part of said timer and acting in response to a functioning of any one of said traffic actuated devices to accord, through said signalling means, right of way to the lane of said one device for a

minimum period of time, resetting means for said timing means and acting in response to a functioning of said one device during such right of way period to cause said timing means to supplement said right of way period by a further time interval inversely proportionate to the speed of the traffic which actuated said device, and means acting periodically in the absence of traffic actuated device actuation in one lane to transfer to such lane right of way indication for a period of time.

3. A traffic control system including, in combination, a signalling means for according and interrupting right of way to traffic moving over intersecting lanes, a timer connected to and controlling the operation of said signalling means, a traffic actuable device for each lane and connected to said timer to cause said signalling means to accord, responsive to actuation of said device in either one lane, right of way to such one lane, means forming a part of said timer for maintaining the right of way so accorded to any lane for at least a minimum period and in the absence of actuation in any remaining lane for maintaining right of way beyond said minimum, and means forming a part of said timer and functioning in such absence of actuation of said device in any remaining lane after a period, always longer than said minimum and beginning substantially with said accord of right of way to automatically simulate an actuation of said device for said one of said remaining lanes whereby to transfer right of way through said means to the lane of the last mentioned controller.

4. A traffic control system including in combination a signalling means for according and interrupting right of way to traffic moving over intersecting lanes, a timer connected to and controlling the operation of said signalling means, a traffic actuable device for each lane and connected to said timer to cause said signalling means to accord, responsive to actuation of said device in either one lane, right of way to such one lane, means forming a part of said timer for maintaining the right of way so accorded for at least a minimum period, means forming a part of said timer and functioning in response to further device actuation in such one lane during the right of way for such one lane for assuring maintenance of right of way up to a maximum period after any actuation in another lane, and means operable only after a period of such right of way, with absence of actuation in the other lane, longer than said maximum to automatically cause transfer of right of way to such other lane.

5. In a traffic control system for interfering traffic lanes, a signal operable to accord and interrupt right of way to the several lanes, traffic actuated devices for the lanes, a timer connected to said signal and including control means for such lanes and connected to such devices and operable in response to actuation of such traffic actuated devices to operate said signal so as to accord right of way to either one lane in which such actuation has first occurred, and to interrupt right of way in the other lanes, and means acting only after right of way has been accorded to any one lane for a predetermined time, without actuation in any other lane, beginning substantially with such accord of right of way to said one lane to automatically produce the same effect on said control means as that of actuation in another lane.

6. In a traffic control system for interfering traffic lanes, a signal operable to accord and inter-

rupt right of way to the several lanes, traffic actuated devices for the lanes, a timer connected to said signal and including control means for such lanes and connected to such devices and operable in response to actuation of such traffic actuated devices to operate said signal so as to accord right of way to either one lane in which such actuation has first occurred and to interrupt right of way in the other lanes, means forming a part of said timer to cause such accord of right of way to be maintained for at least a minimum period and to be extendible by actuations on said one lane up to and within a maximum period initiated by any actuation occurring on another lane, and means operating only after right of way has been accorded to said one lane for a predetermined period of absence of actuation on another lane, said period beginning substantially with such accord of right of way to said one lane, to affect said timer like such an actuation on another lane so as to assure transfer of right of way from said one lane to such another lane within said predetermined maximum period thereafter.

7. In a traffic signal system for interfering traffic lanes, a signal operable to accord and interrupt right of way to the several lanes, vehicle actuated devices in the lanes, a controller connected to said signal and devices for operating said signal in response to actuations of said vehicle actuated devices so as to accord right of way to any one lane in which such actuation has occurred and to interrupt right of way in the interfering lanes and means acting only in the event of a relatively prolonged predetermined period of absence of actuation of the vehicle actuated device in such interfering lanes, said period beginning substantially with such accord of right of way to the said one lane, to simulate a functioning of such device in one of the interfering lanes to cause transfer of right of way from said one lane to the last said interfering lane.

8. A traffic control system including, in combination, signalling means to be disposed adjacent an intersection of traffic lanes and operable to accord and interrupt right of way to the several lanes, a timer for operating said signalling means to accord and interrupt right of way over said lanes, traffic actuated devices in said lanes and in advance of said intersection and connected to said timer to cause the latter to function in response to actuation of the former, timing means forming a part of said timer and acting through operation of said signalling means to provide alternately in such lanes upon actuation of the devices in both lanes right of way periods variable between minimum and maximum limits, said minimum right of way periods being extendible through said timing means and through operation of said traffic actuated devices up to said maximum periods, means acting while right of way is accorded to one lane and in the absence of operation of the traffic actuated device in the other lane, to extend the right of way period in said one lane beyond said maximum, and means acting only thereafter, and despite continued absence of operation of the traffic actuated device in such other lane, to automatically transfer right of way to such other lane.

9. A traffic control system for a plurality of interfering traffic lanes comprising signalling means adapted to accord and interrupt right of way in such lanes, traffic responsive means in each of said lanes, a timer connected to the signalling means and traffic responsive means to govern the former in accordance with actuations

of the latter, the timer including relay means for each lane and connected to the corresponding traffic responsive means for repeating to the timer the effect of traffic actuation of the traffic responsive means and cooperating with the timer to store the effect of actuation until the timer is in condition to accord right of way to the actuating traffic, said timer also including means operable upon operation of such relay means to accord right of way alternately to the lanes between minimum and maximum periods in accordance with traffic actuations, and means associated with said timer but independent of the maximum timing means mentioned and operable only after right of way has been accorded to any one lane for a predetermined period, and in absence of actuation on the other lane, to operate said relay means for such other lane to produce the same effect on the timer as that of traffic actuation on said other lane.

10. A traffic control system for a plurality of interfering traffic lanes comprising signalling means adapted to accord and interrupt right of way in such lanes, traffic responsive means in each of said lanes, a timer connected to the signalling means and traffic responsive means to govern the former in accordance with actuations of the latter by traffic, the timer including relay means for each lane and connected to the corresponding traffic responsive means for operation

by traffic actuation of the latter, means associated with said relay means and cooperating with the timer to maintain said relay means so operated in the event it is operated momentarily while right of way is interrupted in its corresponding lane and until the timer causes the signalling means to accord right of way to the lane of such actuation, said timer also including minimum timing means to maintain the right of way for a minimum period when accorded and adapted to prolong right of way beyond the minimum by actuations in the same lane, and also including maximum timing means for providing a limit to such prolongation, means forming a part of said timer cooperating with said minimum and maximum timing means to cause said signalling means after such minimum and such prolongation, if any, to interrupt right of way in one lane and accord right of way to another lane when the relay means of the latter is operated, and super-maximum timing means also forming a part of said timer and active, to time, while the right of way is accorded to any one lane, a period longer than said maximum at the end of which it operates said relay means for the other lane whereby the timer will be actuated to accord right of way subsequently to said other lane even in the absence of traffic actuation on said other lane.

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