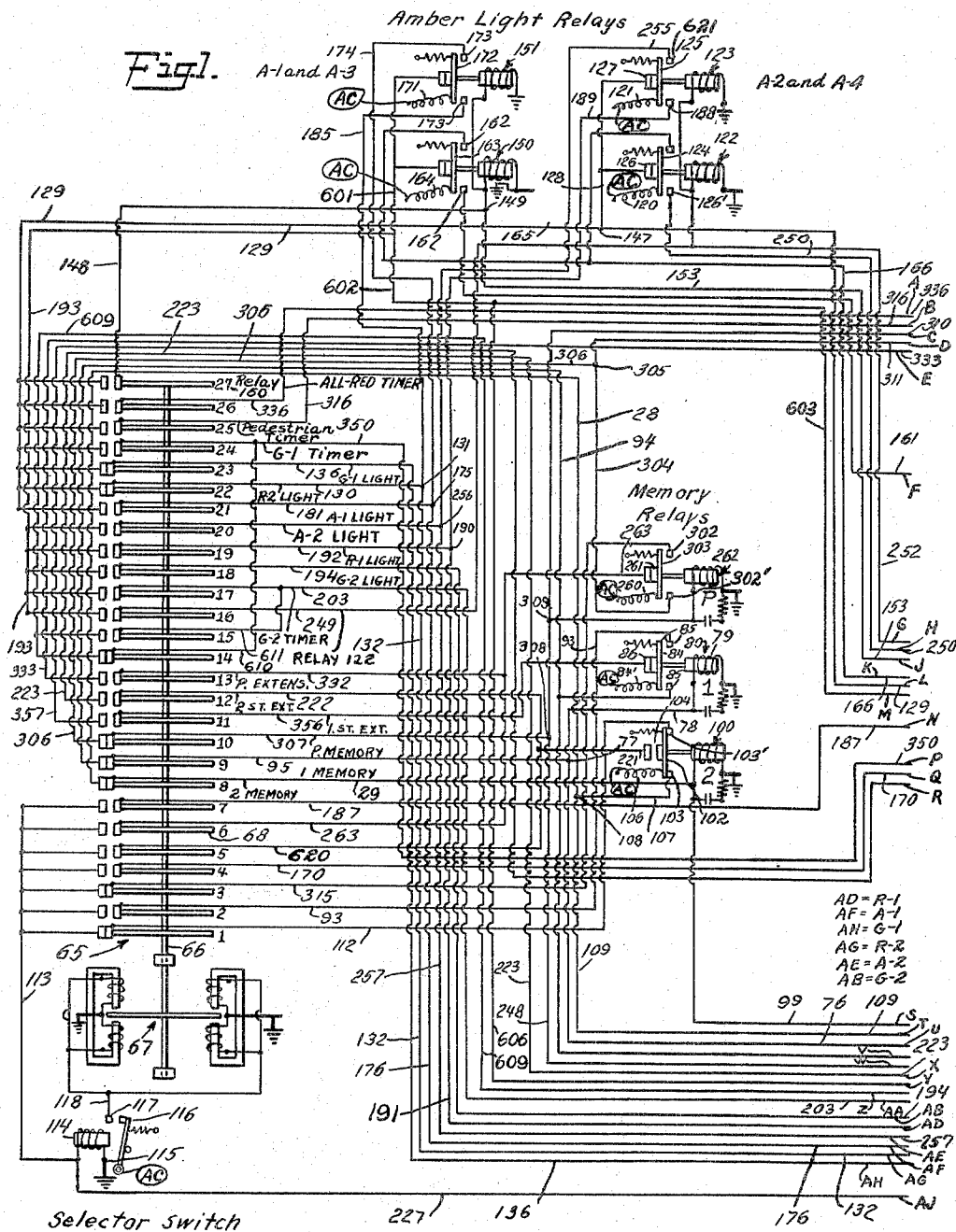


2,215,851

SELECTIVE AUTOMATIC TRAFFIC REGULATING SYSTEM

Filed Oct. 4, 1933

4 Sheets-Sheet 1



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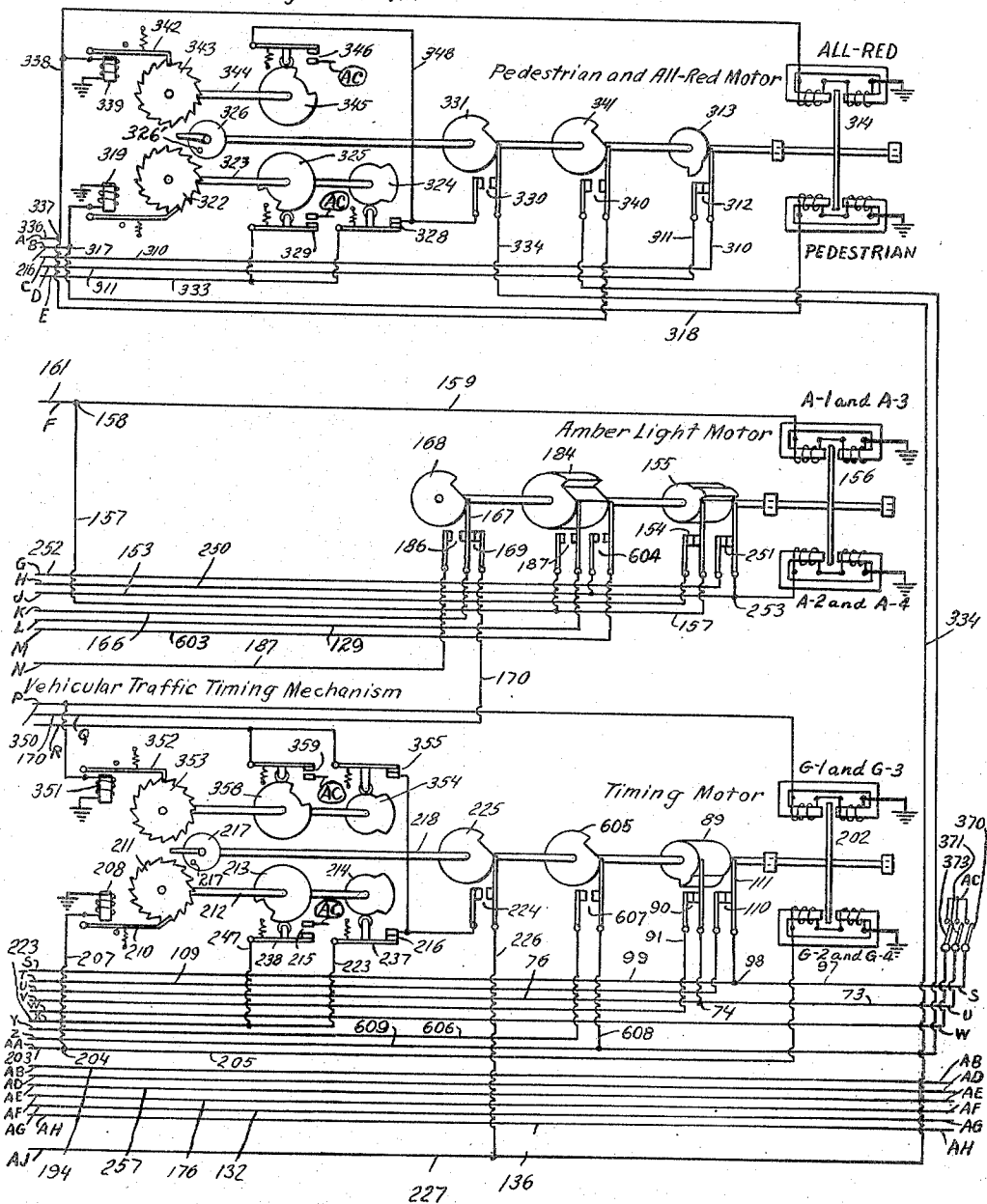
SELECTIVE AUTOMATIC TRAFFIC REGULATING SYSTEM

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4 Sheets-Sheet 2

Fig. 2.

Pedestrian Traffic Timing Mechanism



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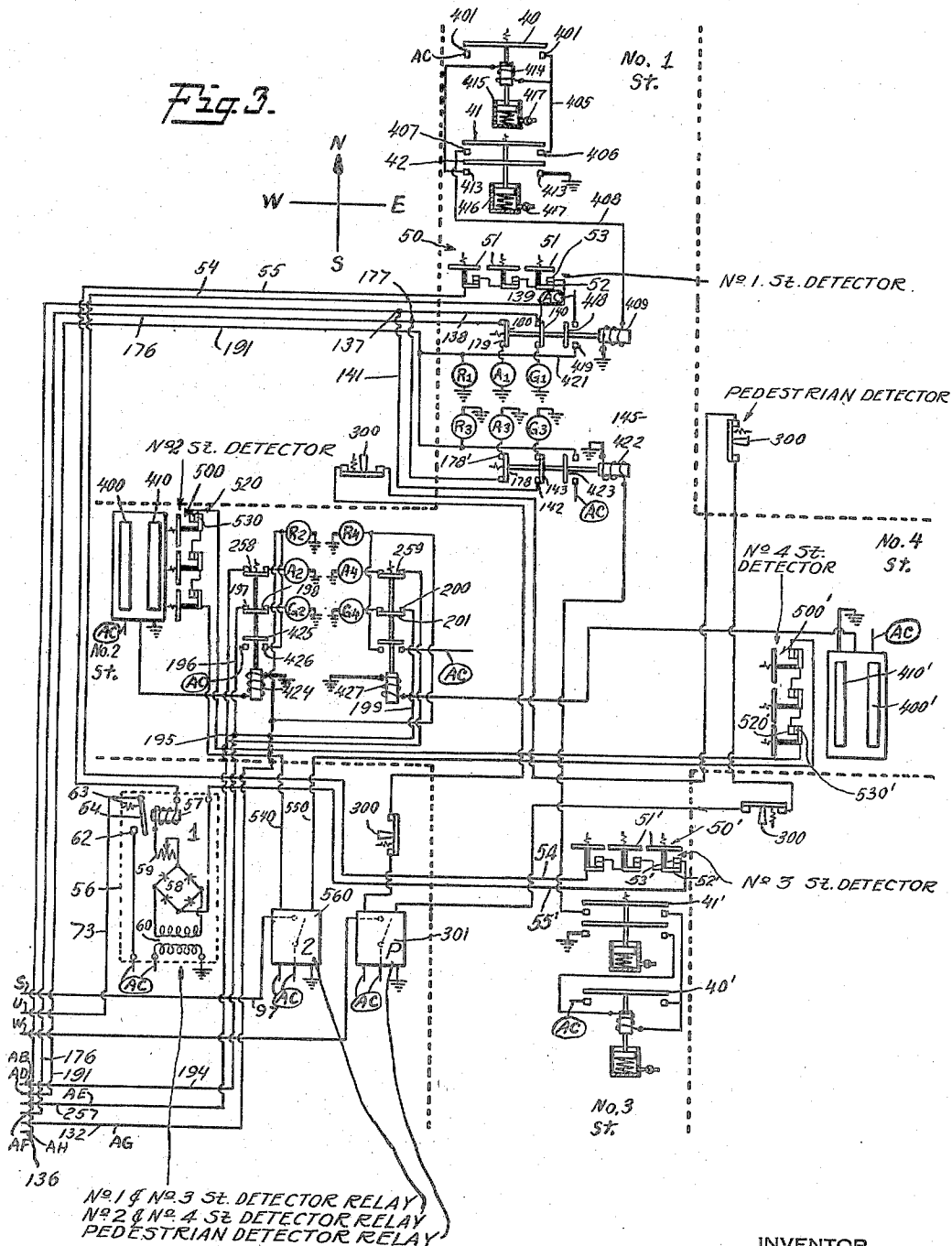
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SELECTIVE AUTOMATIC TRAFFIC REGULATING SYSTEM

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4 Sheets-Sheet 3



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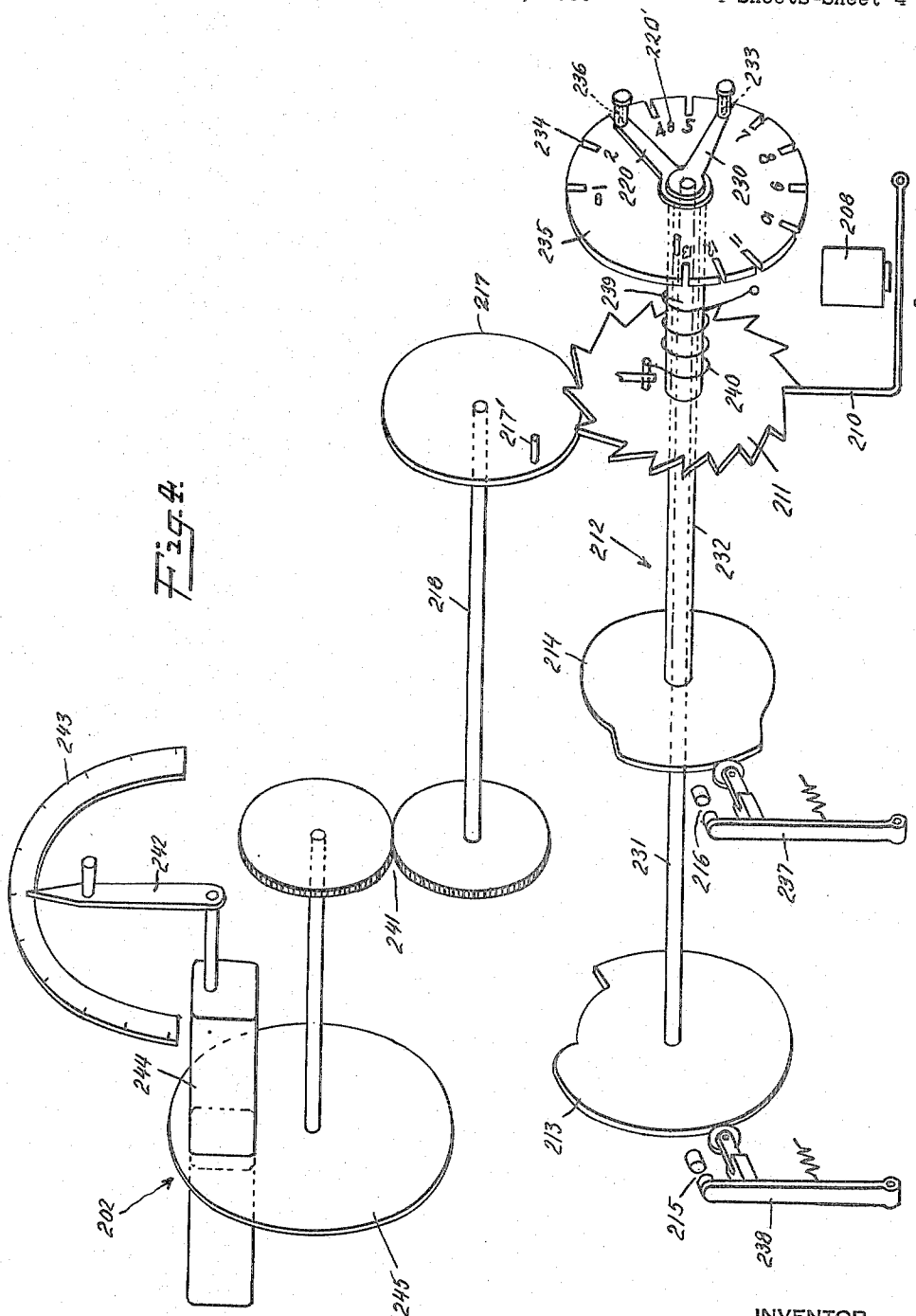
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SELECTIVE AUTOMATIC TRAFFIC REGULATING SYSTEM

Filed Oct. 4, 1933

4 Sheets-Sheet 4



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SELECTIVE AUTOMATIC TRAFFIC REGULATING SYSTEM

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Application October 4, 1933, Serial No. 692,091

8 Claims. (Cl. 177—337)

This invention relates to automatic traffic regulating systems and has particular reference to a system which is selectively operable in accordance with and in response to the volume and nature of the traffic passing the street intersection at which the system is located.

Various forms of automatic traffic control systems have been devised heretofore and include the familiar "prefixed timer" system in which the right of way is alternately transferred from one intersecting street to another; the so-called "fully actuated" system in which all of the streets forming the intersection are provided with devices responsive to traffic approaching the intersection for appropriating control of the signals so as to permit it to negotiate the intersection, examples of which are illustrated in United States Patents No. 1,538,952, issued May 26, 1925, to Ram, and No. 1,551,541, issued September 1, 1925, to Collins; and the "semi-actuated" or "normal go" system in which traffic on a main highway or boulevard retains the right of way until traffic seeking to cross the main highway initiates a signal circuit, whereby the right of way is temporarily transferred to the cross street and is then restored to the main highway after a clearing period by a timing mechanism involving either a commutator or equivalent devices responsive to the passage of cross traffic from the signal zone, examples of which are disclosed in British Patent No. 138,792, to Badger, dated 1919, and in United States Reissue Patents No. 16,666, to Kennedy, dated September 15, 1925, and No. 17,602, to Nelson, dated February 18, 1930.

Each of these systems has certain advantages and disadvantages depending upon several factors, among which are the nature and volume of the traffic negotiating the intersection, the nature of adjacent traffic control systems which may contribute to retarding or congesting traffic instead of dispatching it, variation in the volume and nature of traffic during different times of the day, or at different seasons of the year, and the like. For example, the pre-fixed timer type of traffic control system has a distinct advantage if the nature and volume of the traffic is substantially uniform on all streets forming the intersection, but if this is not the case the system periodically halts traffic on the main highway or boulevard or a heavily traveled street where there is no cross traffic to warrant the delay, so that congestion instead of dispatch of the traffic results.

The fully actuated type of traffic control sys-

tem has distinct advantages for use at intersections where the traffic is variable on several of the streets forming the intersection, so that none of the streets could properly be considered to be a main highway or boulevard, and yet each street passes such a considerable amount of traffic at certain times of the day or other periods that it is warranted in maintaining the right of way for as long a time as is necessary to dispatch the traffic negotiating that street. However, this system has the disadvantage that it is relatively expensive to install in intersections where the traffic is substantially uniform on all the streets, because in that event the system is working most of the time, where the less expensive and simpler pre-fixed timer system would be of greater advantage. Also, where one of the streets of the intersection passes more traffic than another, such as a highway or boulevard, it is more appropriate to maintain the right of way on the highway or boulevard so as to dispatch the heavier traffic rather than cause the main highway or boulevard traffic to initiate a signal cycle each time after cross-traveling traffic completed a signal cycle permitting it to negotiate the main highway or boulevard.

The semi-actuated or normal go traffic control system is of distinct advantage at intersections comprising a relatively lightly-traveled cross street and a main highway or boulevard where the traffic is relatively heavy or dense as compared to the cross traffic, since, with this system, heavier traffic on the main highway or boulevard retains the right of way with a normal go signal at all times, so that it is dispatched, unless and until cross traffic seeking to enter or cross the main highway or boulevard initiates the signal cycle by means responsive to its presence, to permit it to cross the highway or boulevard, the signal cycle upon completion restoring the right of way to the main highway or boulevard. However, this system is not satisfactory at intersections where the traffic is variable on the several streets forming the intersection, nor at intersections where the traffic is substantially uniform on all of the streets constituting the intersection.

In accordance with the present invention a traffic regulating system is provided which is adaptable for use at any intersection, having all the advantages of the pre-fixed timer, the semi-actuated, and the fully actuated systems, and in addition, being capable of automatically accommodating changing traffic conditions whether

hourly, daily, or seasonally, and which embodies many improvements whereby the dispatch of traffic of any nature and volume may be facilitated in accordance with the requirements of the traffic itself or the requirements of the locality through which the traffic is passing. At the same time, the flow of traffic is automatically maintained within predetermined speed limits to prevent speeding and especially racing of operators of vehicles toward an intersection in an effort to negotiate the intersection before the clear or "go" signal facing the street upon which the racing vehicle is traveling changes to the warning or "stop" signal.

The system of this invention includes detector devices in or adjacent the streets constituting the intersection which are responsive to the presence of traffic approaching the intersection in order to negotiate it, these detector devices, upon actuation by a unit of traffic, whether vehicular or pedestrian, establishing a circuit to corresponding memory relays which "remember" that a unit of traffic is seeking to negotiate the intersection and accordingly appropriate control of the signal cycle to permit the passage of the corresponding vehicle upon completion of the signal cycle which was in progress at the time that the corresponding vehicle actuated the detector device and established a circuit to the corresponding memory relay. Vehicular detector devices are preferably located in the surface of the streets forming the intersection and the pedestrian detector devices are preferably located at or adjacent the corners of the intersection, both vehicular and pedestrian detectors having relays which have the same function, i. e., they prepare a circuit which is completed upon completion of the signal cycle then in progress to permit passage of the intersection by the initiating unit of traffic at the proper time.

The mechanism which is energized by the memory relays in response to actuation by the detector devices includes a selector switch which selects predetermined circuits for performing various functions, depending upon pre-arrangement of the system and upon the nature and volume of the traffic seeking to negotiate the intersection. For example, the selector switch prepares circuits to timing mechanism which determines the duration of the signal cycle in accordance with certain predetermined considerations, one of which is the duration of the initial period of time during which the right of way is maintained for one or more streets or a highway or boulevard, and another of which is the duration of the extended period of time during which the same right of way is maintained.

The initial period is adjustable in accordance with observed traffic conditions, i. e., the initial period may be shortened or lengthened in accordance with the volume of traffic which it is desired to negotiate an intersection during any one signal cycle. During this initial period, the traffic units crossing detector devices are rendered ineffective or prevented from interfering with the signal mechanism to appropriate control thereof, but after termination of the initial period, the actuations by other units of traffic become effective.

The extension period is determined by traffic seeking to cross the intersection on the street having the right of way upon termination of the initial period, and the number of units of time comprising the extension period is determined by traffic units following the traffic unit which

originally initiated the extension period on the street which had the right of way during the previous initial period, but the maximum number of units of time by which the extension period may be lengthened is predetermined manually. In other words, within certain limits, the duration of the right of way on any street may be extended as many units of time after the termination of the initial period as there are units of traffic following the traffic which negotiated the intersection during the initial period.

During the additional units of time forming the extension period, massed traffic, single units of traffic, or any intermediate number of units of traffic, may negotiate the intersection without affecting the time extension mechanism, and it is only during each extended period of time that a following unit of traffic may set up an additional unit of time to further extend the extension period. That is to say, during the extension period, except at predetermined moments, the devices responsive to traffic are locked against actuation by the traffic or are rendered ineffective to interfere with or otherwise affect the signal mechanism.

If there has been no actuation of detector devices by pedestrian or by vehicular traffic approaching on a street other than that having the right of way, prior to termination of the initial and extension periods, as remembered by the corresponding memory relays, the street previously having the right of way maintains the right of way. If one of the memory relays has been actuated at or previous to the time when the initial period expires, or when the extension period expires if set up, the right of way is eventually transferred to a pedestrian or to the street on which the initiating traffic is waiting to cross the intersection.

Located in one or more or all of the streets forming the intersection are devices responsive to the speed of traffic approaching the intersection on the corresponding street, which, if the traffic is moving at a speed less than the predetermined speed limit, are not affected, but which, if the traffic exceeds a predetermined speed limit, respond to appropriate control of the right of way for that street and flash a stop signal against the speeding traffic without interrupting the signals displayed to the traffic approaching the intersection on the other streets thereof. The stop signal halts the speeding vehicle before it can negotiate the intersection and is maintained a sufficient time to perform its function, when it becomes inoperative and the signal for that particular street is restored to the same condition in which it would have been had the signal cycle for that street not been interrupted by the speeding vehicle.

In order to convert the fully actuated traffic regulating system just described into a semi-actuated system, switching devices are provided whereby the detector devices of the streets which are selected to be main highways or boulevards are disabled and means are provided whereby the right of way or normal go signal is restored after each signal cycle to the street which has been selected as the main highway or boulevard, the detector devices in the other streets remaining responsive to traffic approaching the main highway or boulevard in order that the right of way may be transferred to this traffic for negotiation by it of the main highway or boulevard. In this way, the system of this invention may be readily converted from a fully-actuated system to a semi-actuated or normal go system, and vice versa.

Also, by means of the switching devices all of the detector devices may be disabled to convert the system into a prefixed timer system wherein right of way is alternately transferred from one street to another and back again.

The detector devices which respond to the presence of pedestrian or vehicular traffic are included in normally closed circuits which are broken when the detector devices are actuated to control corresponding detector relays which in turn control the corresponding memory relays. This arrangement provides extreme sensitivity and accuracy as well as being immune from local influences which tend to disable open circuit detector devices, such as corroded contacts and short circuits. However, in the arrangement of this invention, the signal mechanism is not disabled if the detector circuits stick open or are otherwise inoperative, for in that event the system immediately becomes a pre-fixed timer system as to the street having the disabled detector circuit.

The present invention further provides for a system for control by either of the two intersecting streets and by pedestrians which affords the utmost flexibility with respect to the flow of traffic. If there is a demand for the right of way simultaneously by the two streets and pedestrians, the present invention will successively accord the right of way to the streets and to the pedestrian traffic. If this demand should be omitted by the secondary streets or by pedestrians, the signal will automatically eliminate the corresponding right of way period so that the signal will operate alternately between the primary street and the remaining traffic path. It is also possible to substitute for one of the intersecting streets an additional pedestrian lane or by simply omitting one vehicle detecting device of the secondary streets to utilize the present invention for the intersection of a pedestrian cross walk in the middle of a block where no cross vehicular traffic can flow. In such a case, the invention automatically eliminates the corresponding time interval in exactly the same manner that it would under lighter traffic conditions; that is, the pedestrian traffic will have the right of way for a certain predetermined minimum period and possibly for a further period not to exceed a predetermined maximum depending upon the density of pedestrian traffic. At the expiration of the pedestrian interval, the vehicular traffic may again obtain the right of way for a predetermined minimum period and for such extensions beyond the minimum period as conditions of traffic flow may require but not to exceed a predetermined maximum period.

It will be seen that with the traffic system of this invention any traffic conditions may be handled expeditiously and with precise consideration of the volume and nature of the traffic and the changes in the volume and nature of the traffic at any time. Thus, the system of this invention can be mounted at any intersection and readily adjusted at any time to conform to the traffic requirements of the intersection or locality in which it is located. For a more complete understanding of the invention, reference may be had to the accompanying drawings, in which—

Figures 1, 2, and 3 jointly illustrate the complete schematic circuit diagram of the selective and automatic traffic regulating mechanism of this invention, the three sheets of drawings on

which these figures appear being arranged to be laid side by side to form one complete diagram.

Solely for the purpose of facilitating the tracing of leads from Fig. 1 to Fig. 2 and from Fig. 2 to Fig. 3, the several leads have been marked with the characters of the alphabet to identify them as they enter and leave each figure. No further reference to these characters will be made.

Fig. 4 illustrates the arrangement of the initial and extension period counting mechanism.

Referring to the drawings, Fig. 3 indicates the intersection of two through streets crossing at right angles. This form of intersection is employed for the purpose of illustrating the application of the invention to a typical intersection, it being understood that the invention is applicable with equal facility to Y, T, or other forms of intersection. Also for convenience, traffic lanes which pass entirely through an intersection whether on the straightway or whether they curve or are bent at an angle are called main highways, through streets, or boulevards, while those traffic lanes which terminate at the intersection are designated as streets irrespective of whether such traffic lanes may or may not be a component part of a traffic lane passing through the intersection and designated a highway. Thus, in Fig. 3, the through street, boulevard, or highway which runs north and south consists of two streets terminating in the intersection and these streets are designated as #1 street and #3 street, while the two east and west streets are designated as #2 street and #4 street. Suitably located at the intersection and clearly visible from all approaching streets is at least one visual signal device of conventional design including green, amber, and red lights for each street or traffic lane, or the like. The lights which face #1 street are designated for convenience G-1, A-1, and R-1, the lights which face #3 street are designated G-3, A-3 and R-3. Similarly, the lights which face #2 street are designated G-2, A-2, and R-2, and the lights which face #4 street are correspondingly designated G-4, A-4, and R-4.

The traffic control mechanism is adapted for energization by a commercial source of alternating current although by readily understood modifications, it could be made suitable for operation on direct current. Since in ordinary commercial practice it is customary to ground one side of the supply, all points on Figures 1, 2, and 3 which are connected to the grounded side of the commercial supply have been designated by the conventional symbol for ground. Those parts of the circuit which are connected to the opposite ungrounded side of the current supply have been designated by the character AC in a circle. Thus, in tracing any path of current flow, it must begin at "AC" and end at ground.

THE TRAFFIC DETECTING DEVICES

Located on the right side of #1 street, preferably in the surface of the roadway so as to be responsive to vehicles passing thereover, is a detector comprising a plurality of light segments, each carrying a contact normally engaging a corresponding contact, these contacts being connected in series with wires and a similar vehicle detector comprising segments is located in the surface of the right hand side of #3 street. These segments each control a set of closed contacts and 53', which are connected in series with the contacts

of detector 50 and with relay 56 through the wires 54, 55, and 55'. These vehicle detectors are formed in segments 51 and 51' so that more rapid, effective and simpler response by a vehicle passing either one of them is obtained than if the street detector were a longer strip that is necessarily bodily movable in its entirety to close a contact in response to actuation by a vehicle. As indicated, and as will more fully appear, the circuits of all detectors are closed so that they cannot be short-circuited by dirt, ice, or snow, or the like accumulating between contacts as is the case with open circuit detectors and a surer, more positive response results since it is ordinarily easier to break a circuit than to make one. Furthermore, as will be explained later, even if the detector circuits of this system are broken or the detector contacts stick open for any reason, the traffic system is not disabled but automatically provides a fixed time interval with respect to the street having the open detector circuit; that is, in such a case, the street having the disabled detector will always obtain and hold the right of way for its full maximum period and after transfer of the right of way to an intersecting traffic movement, the right of way will automatically return to the street of the disabled detector device and will remain there again for a full maximum period before it can be retransferred to an intersecting traffic lane.

Wire 55 leading to #1 detector relay 56 is connected through coil 57 to one side of a rectifier 58 and wire 55' is connected to the opposite side of rectifier 58. A variable resistance 59 between coil 57 and rectifier 58 permits adjustment of the current intensity and resulting magnetic pull developed in coil 57. The input or alternating current side of rectifier 58 is connected to the secondary winding of a transformer 60, the primary of which is connected to the alternating current supply, designated by the symbols AC, and ground. In actual practice, the transformer 60 delivers approximately 1½ volts of alternating current to the rectifier which in turn has an output of approximately 20 milliamperes at a direct current potential of one volt which is impressed upon the detector circuit including coil 57. A light "needle" armature 64 is normally held disengaged from stationary contact 62 by the attractive force of coil 57 and is continuously urged into engagement with contact 62 by the light spring 63 so that upon deenergization of coil 57 armature 64 will establish a contact with contact 62, such deenergization occurring upon operation of one of the detectors 50 or 50' by the passage of a vehicle.

The surfaces of the roadways of #2 street and #4 street are provided with similar vehicle detectors 500 and 500' which, when actuated, break respective closed contacts 520 and 530 or 520' and 530' connected in series to wires 540 and 550 leading to #2 detector relay 560 which is like #1 detector relay 56 in all respects and is therefore not illustrated in detail.

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SELECTOR SWITCH

Included in the traffic regulating system of this invention is a circuit selector switch 65 which is illustrated diagrammatically in Fig. 1 and which comprises a shaft 66 rotatable by an eddy current motor 67, or the like, and carrying a plurality of spaced cam discs 68, each effecting the engagement and disengagement of a pair of contacts which are numbered serially from one to twenty-seven on Fig. 1 of the drawings for con-

venience. As the selector switch 65 is rotated periodically by the motor, its cams 68 close certain of the sets of contacts and open others to select certain corresponding circuits for operation and open other corresponding circuits. In a preferred arrangement the selector switch has eight positions in each of which certain contacts are closed and the signal lights are energized in accordance with the following table:

First position

At rest for G—1 and G—3

#1 street and #3 street green (G—1, G—3)

#2 street and #4 street red (R—2, R—4)

Contacts: 1—3—8—9—10—14—22—23 closed

Second position

Timing A—1, A—3 interval

#1 street and #3 street amber (A—1, A—3)

#2 street and #4 street red (R—2, R—4)

Contacts: 5—7—8—9—10—21—22—27 closed

Third position

Timing G—2 and G—4 interval

#1 street and #3 street red (R—1, R—3)

#2 street and #4 street green (G—2, G—4)

Contacts: 4—9—10—12—17—18—19 closed

Fourth position

At rest for G—2 and G—4

#1 street and #3 street red (R—1, R—3)

#2 street and #4 street green (G—2, G—4)

Contacts: 2—3—8—9—10—15—18—19 closed

Fifth position

Timing A—2, A—4 interval

#1 street and #3 street red (R—1, R—3)

#2 street and #4 street amber (A—2, A—4)

Contacts: 6—7—8—9—10—16—19—20 closed

Sixth position

Timing pedestrian interval

#1 street and #3 street red and amber (R—1, A—1, R—3, A—3)

#2 street and #4 street red and amber (R—2, A—2, R—4, A—4)

Contacts: 4—8—9—13—19—20—21—22—25 closed

Seventh position

Timing all red interval

#1 street and #3 street red (R—1, R—3)

#2 street and #4 street red (R—2, R—4)

Contacts: 7—8—9—10—19—22—26 closed

Eighth position

Timing G—1 and G—3 interval

#1 street and #3 street green (G—1, G—3)

#2 street and #4 street red (R—2, R—4)

Contacts: 8—10—11—22—23—24 closed

Relay 114 is adapted to energize selector switch 65 motor 67 upon closure of its contacts 116, this current being supplied from AC at armature 116, contact 117, wire 118, and the motor windings to ground. Mechanical provision is made so that a single impulse energizing relay 114 will positively keep contact 117 closed until the switch has completely advanced to the next position. The mechanism for effecting this positive action is not illustrated but it may be of any conventional type. The purpose of this relay is to permit a circuit energizing relay 114 through a selector switch contact which will open during the passage of the selector switch to its next position to positively complete the travel of the switch until the next position has been reached. Without this

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arrangement, the selector switch would stop immediately upon the opening of the selector switch contacts through which energy was being received and this would necessarily cause the switch to stop in a position intermediate to intended positions and might readily disrupt the control of traffic by the mechanism.

SELECTOR SWITCH FIRST POSITION

Assuming that #1 and #3 streets have the right of way, i. e., that the selector switch 65 is in the first position indicated in the foregoing table and that a vehicle approaching the intersection on #1 or #3 street actuates the vehicle detector 50 or 50' to operate #1 detector relay 56 so that its armature 64 engages contact 62 in a manner described above. Since #1 and #3 streets already have the right of way, nothing happens except that #1 memory relay 80 is energized by a circuit traceable from AC at contact 62 of detector relay 56, armature 64, wire 73, to terminal 74 where the circuit divides, one branch following wire 76 to terminal 77 where the circuit again divides, one branch leading by wire 78 to coils 79 of #1 memory relay 80, the circuit of which is completed by the indicated connections to ground. Armature 84 of memory relay 80 is accordingly drawn into engagement with front contact 85 and breaks back contact 86. The other branch circuits lead to open contacts and need not be described. The bridging of contacts 85 by armature 84 of memory relay 80 establishes a holding circuit therefor which is traceable from AC at pigtail 84', armature 84, contact 85, wire 94, closed contact 9 of selector switch 65, wire 95, terminal 77, wire 78, and coil 79 of relay 80, back to ground. Thus, memory relay remains energized until such time as selector contact 9 opens and for a further period described below. The circuits of the coils of all memory relays include a series combination of condenser and resistor connected in multiple with the relay winding for the purpose of reducing the amount of arcing which will occur at the contacts 62 and delicate "needle" armature 64 of the various detector relays.

Assuming that, with the selector switch in the first position, #3 and #1 streets having the right of way, as indicated in the foregoing table, a vehicle approaching on either #2 or #4 street actuates respective vehicle detector 500 or 500', #3 detector of relay 560 releases its "needle" armature to connect AC to wire 97 and initiate a circuit traceable from wire 97 to terminal 98 where the circuit divides, one branch leading by wire 99 to one terminal of the #2 memory relay 100, the other terminal of which is connected to ground. The armature 102 of memory relay 100 accordingly bridges its front contacts 103 and 103' and breaks back contacts 104. Energization of memory relay 100 completes a holding circuit for the relay and also a circuit to selector switch motor 67. The holding circuit has two shunt paths, one traceable from AC at pigtail 106, armature 102, front contact 103, wire 107 to terminal 108, branch wire 109, closed contacts 110, controlled by the follower 111 of cam 89, terminal 98, wire 99, and relay 100, to ground; and the other shunt path is traceable from terminal 108 by wire 28 to closed contacts 8 of selector switch 65, wire 29, memory relay 100, and ground. The selector switch motor circuit is traceable from AC at pigtail 106 memory relay 100, armature 102, relay contact 103', wire 112, closed contact 1 of selector switch 65, wire 113, relay 114, and ground. Upon

energization, relay 114 pulls its armature 116 into engagement with contacts 117, completing a circuit for the selector switch motor, as described above. The fact that selector contact 1 is the source of energy for relay 114 and that it opens when passing from the first to the second selector switch position is taken care of by the operation of relay 114 together with its mechanical interlocking feature, as described above, so that the selector switch will advance positively to its second position.

SELECTOR SWITCH SECOND POSITION

Selector switch motor 67 rotates to its second position, its contacts, listed in the foregoing table, being closed. Those contacts which were listed as closed in the first position and as omitted in the second position are opened by operation of the cams during the travel of the switch from its first to its second position. Those cams not listed as closed in the first position but which appear as closed in the second position close their respective contacts during the travel of the switch from its first to its second position. Thus, by reference to the table, it can be readily determined which of the contacts are closed, those that are open, and those which change their condition during the travel of the switch.

In this movement, from first to second position, the selector switch opens the circuit of the #1 and #3 streets, green lights, G—1 and G—3, but maintains the circuit of the #2 and #4 streets, red lights, R—2 and R—4. The circuits of these lights are controllable by respective selector contacts 23 and 22, the red light circuit being traceable from AC at pigtails 120 and 121, of respective parallel relays 122 and 123, their armatures 124 and 125, their closed back contacts 126 and 127, wires 128 and 129, selector contact 22, to terminal 131, a branch wire 132, red lights R—2 and R—4, and to ground, and wire 136 leading from selector contacts 23 to terminal 137 where the circuit divides, one traversing wire 138, relay contacts 139, and armature 140 to lamp G—1 and ground, and the other branch traversing wire 141, relay contact 142, and armature 143 to light G—3, and ground. Thus, when contact 23 of selector switch 67 is broken as the switch moves to its second position in the manner described, the green lights G—1 and G—3 which signal the right of way to traffic on #1 and #3 streets are extinguished but red light R—2 and R—4 remain energized because selector contacts 22 remain closed. The selector switch 65, in moving from first to second position, also breaks its energizing circuit by breaking selector contact 1, releasing relay 114, so that the selector switch 65 stops in the second position. The selector switch 65 maintains contact 8 closed in both positions 1 and 2 so that the holding circuit of memory relay 100 which includes this selector contact will remain closed. The closing of selector contacts 27 completes a circuit traceable from AC at pigtails 120 and 121 of relays 122 and 123 and their armatures 124 and 125 through their back contacts 126 and 127, all respectively to wire 128, terminal 147, wire 129, selector contacts 27, wire 148, terminal 149, where the circuit divides, one branch leading to parallel relays 150 and 151 and ground, and the other branch from terminal 149 following wire 70 153, to normally closed contacts 154, controlled by cam 155, to amber light motor 156, wire 157 to terminal 158 where the circuit divides, one branch following wire 159 to amber interval timing motor 156 and ground. Amber interval tim-

ing motor 156 accordingly begins to make one complete revolution at the end of which it breaks its own circuit by opening contacts 154. The other branch terminal 158 follows wire 161 to front contacts 162 of relay 150 which were bridged by armature 163 when the relay was energized by closure of selector contacts 27 in the manner described. The armature of relay 150 is connected to AC at pigtail 164 so that when relays 150 and 151 are energized in the manner described, upon closure of selector contacts 27, causing armature 163 to engage front contacts 162, a holding circuit is established for relay 150 which is traceable from contact 162, wire 161, terminal 158, wire 157, normally closed contacts 154, wire 153, terminal 149, and relays 150 to ground.

The closure of relay 151 establishes a circuit traceable from AC at pigtail 171, armature 172 of relay 151, contact 173 of relay 151, wire 174, terminal 175 where the circuit divides, one branch traversing wire 176 to terminal 177 where the circuit divides, one branch leading to contacts 178', bridged by armature 178 to amber light A-3 and the other branch leading to contacts 179, bridged by armature 180, to amber light A-1, both lights A-1 and A-3 being connected to ground. Thus, the amber lights are lighted, serving as a warning to traffic approaching the intersection on #1 and #3 streets. The other branch of the circuit from terminal 175 is traceable through wire 181, closed contacts 21, and selector switch 65, wire 129, terminal 147, closed back contacts 126 of relay 122 to AC at pigtail 120; the other branch circuit from relay 151 may be traced from AC at pigtail 171, armature 172, contact 173, wire 185, terminal 131, where the circuit divides, one branch following wires 132 to red lights R-2 and R-4, so that relay 151 maintains the red lights against traffic on #2 and #4 streets, in addition to the display of the amber lights A-1 and A-3 to #1 and #3 streets. Upon being energized, amber interval timing motor 156 makes one complete revolution of its cam shaft.

When energized, amber motor 156 begins to make one complete revolution. Before the revolution is entirely completed, the cam contacts 186 close and reopen, completing a circuit to advance selector switch 65 from position 3 to position 4 by energizing relay 114 by a circuit which is traceable from AC at pigtail 164 of relay 150 through upper contact 162, along wire 166 to cam follower 167 which engages cam 168, and upon entering the notch in cam 168, contacts 186 close and the path previously traced from AC continues through wire 187, wire 166, selector contacts 7 which are in position 2 and along wire 113 to the winding of relay 114, and to ground. Relays 150 and 151 remain operated, since although cam contact 27 has opened, breaking one of the parallel holding circuits, the circuit along wire 161, to contacts 154, still remains closed. Shortly thereafter, and after selector switch 65 has had sufficient time to advance to its third position, normally closed contacts 154 open momentarily, breaking the holding circuit for relays 150 and 151, via wire 161, and these relays now release. The selector switch, however, is now in the third position, and the change of lights will be described below. In order to insure that amber interval timing motor will continue to run for a sufficient period to positively permit contacts 154 to reclose, contacts 187 will be closed during the time that contacts 154 are opened and will remain closed until after contacts 154 are also

closed. Contacts 187 will open very shortly after contacts 154 have closed. During the interval that contacts 187 are closed, a path is traceable for energizing the upper winding of amber interval timing motor 156, beginning with AC at pigtail 164 of relay 150 which has been released approximately at the instant of opening of contacts 154, and whose back contacts are consequently now closed, through the closed back contacts of relay 150, along wire 601, wire 602, wire 603, contact 604, and through terminal 253 and the lower motor winding of amber interval timing motor 156, thus keeping the motor in operation until the moment that contacts 604 open when the motor will stop.

SELECTOR SWITCH THIRD POSITION

Selector switch 65 has already advanced into its third position before the relays 151 and 150 have released. In the third position, as soon as these relays close their back contacts, a circuit to the amber lights, A-1 and A-3, will be broken at the upper contact 173 of relay 151, and the circuit of red lights, R-2 and R-4, will be broken at the lower contact 173 of the same relay. As soon as the back contacts close, a circuit is traceable from AC at pigtail 164, through the closed back contacts, wire 601, wire 193, through closed selector contacts 19 and wire 192, terminal 190, wire 191, to lights R-1 and R-3 and ground. Simultaneously therewith, a circuit from wire 193 may also be traced through closed selector contact 18, wire 194, to terminal 195 and through bridged contacts 197 and 200 to lights G-2 and G-4 respectively. Thus, the releasing of relays 150 and 151 has the effect of switching lights from A-1 and R-2 to R-1 and G-2. Memory relay 100 remains held in, although selector contacts 8 are open in selector switch position #3. This circuit may be traced from AC at pigtail 106, through closed contacts 103, terminal 108, wire 109, closed cam contacts 110, terminal 98, wire 99, back to the coil of relay 100 and to ground. In the third selector position, relay 100 is held in through closed contacts 110. Traffic approaching on #1 and #3 streets is halted by the red lights R-1 and R-3 and right away is transferred to traffic waiting on #2 and #4 streets by the display of green lights G-2 and G-4.

TIMING MECHANISM

The duration of the signal cycle is timed from now on by timing motor 202, the circuit of which is controlled by closed contacts 17 of selector switch 65. The circuit of the timing motor is traceable from AC at pigtail 164 of relay 150, its armature 163, its closed back contacts, wire 193, closed contacts 17 of selector switch 65, wire 203, terminal 204 where the circuit divides, one branch passing along wire 205 to the lower pair of windings of the timing motor 202 and to ground. The timing motor 202 accordingly begins to revolve. The other branch of the circuit from terminal 204 follows wire 207 to magnet 208 of the time limiting mechanism to ground. Energization of magnet 208 causes it to draw its armature pawl 210 into engagement with ratchet wheel 211, which is secured to a shaft 212, carrying cams 213 and 214. The cams 213 and 214 may be independently adjusted manually by adjustment levers 220 and 230, shown in Fig. 4, into any angular position relatively to each other and relatively to the ratchet wheel 211 so that a greater or lesser number of revolutions of the timing motor 202 will be required to rotate the

THE INITIAL PERIOD

cams 213 and 214 to a position where they will close their respective contacts 215 and 216. The means for rotating shaft 212 comprises a wheel or equivalent device 217 mounted on shaft 218 of timing motor 202 and arranged to engage ratchet wheel 211 by means of pin 217' to advance wheel 211 one notch for each revolution of timing motor 202 in a manner readily understood. Armature pawl 210 serves to hold ratchet wheel 211 in any advanced position during such time as magnet 208 is energized. The foregoing describes the general arrangement of the timing and extension period cam mechanism not given in the diagrammatic representation thereof, shown in Fig. 2. A more complete representation of a preferred mechanical construction of this mechanism is illustrated in Fig. 4. In this arrangement, a shaft 212 comprises three telescopically arranged concentric shafts, the inner shaft 231 carrying maximum period cam 213 at one end and the adjusting lever 230 at its other end. This lever 230 carries a movable locking pin 233 at its free end, adapted to be engaged in any one of a series of notches 234 formed in the disc 235 except the notch occupied by the locking pin 236 of initial period adjusting lever 220 and those notches between initial period locking pin 236 and the lowest index of disc 235. By stop means 220', the movement of the initial period adjusting lever 220 is restricted to four positions although it may have a greater or lesser number of positions depending upon requirements. The maximum period adjusting lever 230 may have any one of a number of positions beginning with the notch 234, next to the stop 220' for the initial period adjusting lever 236, and ending with the notch marked 13, for example, although the lever may be movable to any other number of positions. In the particular arrangement illustrated, all notches 234 represent uniform periods of time, the initial period having a duration of one, two, three, or four revolutions of the timing motor and the maximum period has such an additional number of revolutions of the timing motor as may be determined both by the setting of adjusting lever 230 and conditions of traffic flow, the smaller of these two possible numbers of revolutions being controlling, as will be set forth in greater detail below.

Two similar pairs of electro-magnets are provided, being illustrated in Fig. 2 schematically, one pair being drawn above the shaft 218 and the other pair below. The upper portion of the timing motor is associated with or is used for the purpose of controlling the duration of G-1 and G-3 interval and the lower portion is used for controlling the duration of the G-2 and G-4 interval. The adjustable pole pieces 244, as shown in Fig. 4, are provided in duplicate, the upper set permitting independent adjustment of the duration of one revolution of cam shaft 218 while the G-1 and G-3 interval is being timed, and the lower set, not illustrated in Fig. 4, is independently adjustable and controls the duration of one cam shaft revolution while timing the G-2 and G-4 interval. Independent magnets 351 and 208 determine which of the initial and maximum intervals of timing mechanisms shall be advanced during the operation of the timing motor since it will be observed that unless one of the magnets is energized, the two wheels 211 and 353 will drop back to their initial position after each engagement with pin 217' of wheel 217.

The timing motor 202 controls the timing of green lights for all four streets and when it is energized, it rotates cam 214 during the timing of the G-2 and G-4 interval in the third selector position. The angular position of cam 214, which is determined by the setting of initial period adjustment lever 220, shown on Fig. 4, determines the number of revolutions of timing motor 202 required to effect closure of contacts 216. The minimum time during which the lights G-2 and G-4 will be displayed is determined by the number of revolutions of motor 202, operating on its lower windings, which will be required to allow contacts 216 to close, and this is termed the initial period. This period insures that all vehicles, following the vehicle which initiated the signal cycle and brought the selector switch to its third position, and which following vehicles have already passed the detectors 500 and 500', will be assured of an opportunity to traverse completely the intersection before the signal can be changed, without necessitating of any operation of the extension mechanism. That is, the initial period, when the right of way is first accorded by the timing mechanism, ends when cam 225, to be referred to presently, first closes its contacts 224 after closure of contacts 216 by virtue of the operation of cam 14 which must first have reached the requisite position determined by the setting of initial period adjustment lever 220. A circuit energizing the lower portion of the timing motor is traceable from AC at pigtail 120 of relay 122, closed contacts 126, terminal 147, wire 129, closed selector contacts 17, wire 203, terminal 204 where the circuit divides, one branch traversing wire 207 to energize magnet 208, attracting armature pawl 210 in a position to retain toothed wheel 211 in an advanced position. The other branch passes along wire 205 to the lower driving winding of the timing motor 202 and to ground. The energization of the driving winding of the timing motor 202 causes shaft 218 to rotate. Shortly after it begins its revolution, cam 89 momentarily opens normally closed contacts 110, breaking the holding circuit for #2 street memory relay 100, through wires 109 and 99. This relay is thereupon released, and a circuit is traceable from AC at pigtail 106 through armature 102, the closed back contacts, wire 221, wire 222, through the closed contacts of selector contact 12, wire 223, to the open contacts 216. At the end of each revolution of cam shaft 218, cam contacts 224 close momentarily. Contacts 359, 355, and 215 are all open at this time, the contacts associated with the upper timing mechanism for #1 street being unable to close because toothed wheel 353 drops back each time it is engaged by pin 217', since magnet 351 is deenergized and the pawl 352 cannot hold the toothed wheel 353 in an advanced position. The contacts 215 are associated with the maximum timing mechanism to be described below, and will not close until after contacts 216 have closed. After the predetermined number of revolutions, comprising the initial interval, cam contacts 216 will close; and at the end of the last revolution of the series constituting the initial interval, upon closure of cam contacts 224, AC, which has already been traced to contacts 216, will be applied to wire 226, wire 227, and the winding of selector switch relay 114, energizing relay 114 and advancing the selector switch to the fifth position.

EXTENSION PERIOD

Returning to the situation with the selector switch still in its third position, either traffic on #1 or #3 street or a pedestrian, or continuing traffic on #2 or #4 street may control the signal mechanism, the first of these by transfer of control from the #2 and #4 streets, and the latter by maintaining control by the creation of extension periods. Before an extension period may be added to the initial period, #2 memory relay 100 must be prepared for reactivation, which requires that it must first be released. This is done by the momentary opening of contacts 110 of the timing motor 202. Shortly after the timing motor 202 began to rotate, the holding circuit for #2 memory relay 100 was broken by this momentary interruption, thus releasing the memory relay. With the memory relay 100 in this condition, it is capable of being reoperated and thereby establishing an extension period for #2 and #4 streets, and this effect may be obtained by the actuation of either vehicle detector 500 or 500', by the passage of a vehicle on #2 or #4 street. If memory relay 100 is released, and remains in this condition until initial period cam 214 has closed its contacts 216, the duration of G—2 and G—4 will be terminated as described above, the circuit of selector switch relay 114 having already been prepared for energization by any subsequent closure of contacts 224 which are responsive to cam 25 of timing motor 202. However, if memory relay 100 is reoperated during the interval intermediate the opening of cam contact 110 and the closure of cam contacts 224, it will disconnect AC from wire 221 and contacts 216, and the circuit to the selector switch relay 114 will no longer be completed upon closure of contacts 224 and advancement of the selector switch to its fourth position will be delayed until the next subsequent closure of contacts 224. During this time, any movement of vehicles across the vehicle detectors 500 and 500' can have no effect on the signal circuit, since #2 memory relay 100 is already energized and has not yet been released by the opening of cam contacts 110 at the beginning of the next subsequent revolution of the timing motor. Thus, it will be seen that a vehicle causing the operation of memory relay 100 during the final revolution of cam shaft 218, in the course of the initial interval, may secure for itself one additional revolution of the cam shaft 218 in which this vehicle will be afforded a continuing opportunity to traverse the intersection. This opportunity to obtain an additional period exists only during the last revolution of the initial period, because if the initial period consists of more than one revolution, it will be only during the last portion of the last revolution that cam contacts 110 will remain closed and retain any previous operation of #2 memory relay 100 which has been secured by actuation of the vehicle detectors 500 and 500'. During the final revolution of the initial period, the system may be caused to maintain the right of way on #2 and #4 streets for one additional revolution of cam shaft 218.

If, in the course of this additional revolution, and during the interval between the opening of contacts 110 and the closure of contacts 224, an additional impulse is received, relay 100 will again operate and will hold in, deenergizing contacts 216 and preventing the selector switch from advancing when contacts 224 close at the end of the revolution of shaft 218. In this manner,

a second extension period may be obtained by a vehicle operating #2 street memory relay 100 during the latter portion of the first extension period. Correspondingly, a third extension period may be obtained by the passage of a vehicle across detectors 500 or 500' during the latter portion of the second extension period and this procedure may be repeated indefinitely until cam contacts 215 close. Upon closure of contacts 215, a circuit is traceable from AC through wire 247 and wire 223 to contacts 224, so that upon the next closure of contacts 224, selector switch relay 114 will be energized by a circuit including wire 226 and wire 227, and will advance the selector switch from its third to its fourth position, even though #2 street memory relay 100 may still be energized. If #2 street memory relay should be energized, it will remain held in through closed contacts 110 which have not yet opened and also through the auxiliary holding circuit, including selector contacts 8 which are closed in all but the third selector switch position. Only in the third selector switch position, can #2 street memory relay be released by opening contacts 110.

It should be observed that the duration of the interval between the opening of contacts 110 and the closure of contacts 224 is sufficient so that any vehicle passing detector 500 or 500' before contacts 110 have opened will have sufficient time to clear the intersection. Otherwise, a vehicle might approach the intersection before contacts 110 had opened and prepared relay 100 for reoperation, and because of the short interval, it would not have an opportunity to clear the intersection before the closure of contacts 224 and the immediate advancement of the selector. Furthermore, it would not have registered its presence, because at the time of its passage over the vehicle detectors, relay 100 had not yet been released and consequently was incapable of reoperating and registering an actuation of the detectors. Any extension period, as described above, can be obtained only during the course of the last timing motor revolution of the initial period and during each subsequent extended period, the number of possible extension periods being limited only by the closure of cam contacts 215, this number of revolutions being determined by the setting of maximum period adjustment lever 230. As the selector advances into the fourth position, the path for the energization of the lower winding of the timing motor is interrupted by the opening of selector contact 17. However, in order to insure that the motor will travel a sufficient distance to open positively contacts 224, the cam 605 is provided. A circuit is traceable from pigtail 164 of relay 150 through the closed back contacts along wire 601, wire 602, wire 606, through contacts 607, wire 608, wire 609, closed selector contacts 15, wire 611, wire 203, terminal 204, and wire 205, to the lower driving winding of timing motor 202. Cam 605 is so adjusted that contacts 607 open later than contacts 224, and consequently motor 202 will not stop running until contacts 607 have opened, although this may be a very small fraction of a second later than the opening of contacts 224. It has the effect, however, of always bringing shaft 218 into the same position for the beginning of each series of timing revolutions. As soon as contact 607 opens, the driving winding of timing motor 202 is deenergized and magnet 208 is also deenergized, releasing pawl 210 and allowing toothed wheel 211

to be restored to its normal position by the influence of coil spring 240, illustrated in Fig. 4. This opens contacts 215 and 216 so that there will be no interference with the timing of the G—1 and G—2 interval, to be described below. It is essential that these contacts be opened since both the upper and lower portions of the timing motor utilizes the same contacts 224 to advance the selector switch at the end of the corresponding green timing period.

SELECTOR SWITCH FOURTH POSITION

The fourth position of the selector switch is a position at which it will remain in the absence of actuation by pedestrians or by traffic on streets #1 and #3. It corresponds in this respect to position #1 of the selector switch. In the fourth position of the selector switch, extension periods cannot be set up to extend the right of way for #2 and #4 streets but pedestrians or traffic on #1 and #3 streets can immediately assume control of the system. Assuming that #1 streets memory relay is energized, a holding circuit is established through selector contact #9, which is closed in all positions except position 8, and consequently it will remain held in through this path, including wire 78, terminal 77, wire 79, closed selector contact 9, wire 94 and contact 85. If #1 memory relay 80 is energized, the selector switch will be advanced to the fifth position by a circuit traceable from AC at pigtail 84', armature 84, upper contact 85, wire 93, closed selector contact 2, and wire 113 to selector switch relay 114 and ground. If, instead, the pedestrian relay P is energized, it will be held in a manner to be described below, and a circuit to advance the selector switch to its fifth position is traceable from AC at pigtail 260, armature 303, contact 302, wire 315 through closed selector contact 3, wire 113, to selector switch relay 114 and to ground. Thus, in the fourth position, closed selector contacts 2 and 3 provide paths permitting the selector to be advanced into its fifth position if either #1 street memory relay set 80 or pedestrian relay 262 is energized. If neither of these two relays is energized, the selector switch will remain in its fourth position, allowing streets #2 and #4 to maintain the right of way by virtue of green lights G—2 and G—4 and red lights R—1 and R—3. The circuit for green lights G—2 and G—4 is traceable from AC at pigtail 164 of relay 150, wire 601, wire 193, closed selector contact 18, wire 194, terminal 195 where the circuit divides, one branch passing through bridged contacts 197 to green light G—2 and to ground; the other branch passing through bridged contacts 200 to green light G—4 and to ground. The circuit for red lights R—1 and R—3 is traceable from AC at pigtail 164 of relay 150, the closed back contacts, wire 601, wire 193, closed selector contacts 19, wire 192, terminal 190, wire 191, to red lights R—1 and R—3 and to ground.

SELECTOR SWITCH FIFTH POSITION

In this position, the parallel amber light relays 123 and 122 are operated. The circuit for their operation is traceable from AC at pigtail 164 of relay 150, wire 601, wire 193, closed selector contact 16, wire 249, to the windings of relays of 122 and 123 and to ground. The holding circuit for these relays is traceable from AC at pigtail 120 of relay 122, contact 126', wire 250, closed cam contacts 251 on amber interval timing motor 156, wire 252, and back through the

relay windings to ground. The back contacts 126 and 127 of these relays open, deenergizing cams 21 to 27 inclusive. A circuit is traceable from AC at pigtail 121 of relay 123 through the upper front contact 621 of relay 123, wire 255, terminal 256, wire 257, through closed contacts 258 and 259 of relays 424 and 457, to amber lights A—2 and A—4 respectively, and to ground, thus displaying warning signals to traffic on streets #2 and #4. A circuit is also traceable from AC at pigtail 121 of relay 123, contact 188 of relay 123, wire 189, terminal 190, wire 191, to red lights R—1 and R—3 and to ground. Thus, relay 123 maintains amber lights on #2 and #4 streets and red lights on #1 and #3 streets. A circuit is traceable from AC at pigtail 120 of relay 122, contact 126', wire 250, to the lower winding of amber interval timing motor 156, energizing this motor. From this point on, the operation of the system is similar to that described for the second position of the selector switch, the contacts 186 closing momentarily to advance the selector switch to position #6 shortly before contacts 251 open to deenergize the parallel relays 122 and 123. When the relays are released, upon their deenergization, a circuit is traceable from AC, through their closed contacts 126 and 127, and wire 129 to cam contacts 187, thus continuing the travel of the motor by energization of its upper winding along wires 157 and 159 until the shaft has advanced to a point where contacts 154 and 251 will be in their initial position, at which point cam contacts 187 will open. Upon the release of relays 123 and 122, control of the lights is restored to the selector switch. As will be explained below, the switch may advance past the sixth and seventh positions during the interval between the closure of contacts 186 and the release of relays 122 and 123 by the opening of contacts 251 so that at the instant relays 123 and 122 release, they will transfer the lights either to the condition established in the sixth selector switch position or the condition established in the eighth selector switch position. The advancement of the selector switch to its sixth position is accomplished in the same manner as described for advancement from the second position to the third position upon closure of contacts 186 and the circuit being completed through closed selector contacts 7.

SELECTOR SWITCH SIXTH POSITION

In this position of the selector switch, the timing mechanism for timing the pedestrian interval is in operation, and red and amber lights are displayed to all four streets, 1 to 4, inclusive. The combination of red and amber displayed simultaneously to each street is one of many possible conventional signals that may be utilized to indicate the right of way to pedestrians and to halt vehicular traffic, as may be readily understood. It would be a simple matter to control any desired form of pedestrian signal, since a separate and distinct selector switch position is provided to control the right of way indication to pedestrians. The operation of the various parts of the system will be described in greater detail below in the portion of the specification describing the pedestrian control.

The method by which the selector switch is advanced from its sixth position to its seventh position will also be described in discussing the pedestrian control.

SELECTOR SWITCH SEVENTH POSITION

In this position of the selector switch, no amber lights are displayed but all four red lights R—1, R—2, R—3 and R—4 are lighted to keep vehicular traffic stopped while pedestrians who are still traversing the street, and to afford pedestrians an opportunity to reach the opposite side of each street after the red and amber pedestrians' indication has been extinguished. In the seventh position of the selector switch, lights R—1 and R—3 are lighted by closed selector contact 19 and lights R—2 and R—4 are lighted by closed selector contacts 22. The holding circuits for all three memory relays are maintained closed by selector contacts 8, 9, and 10. A circuit to the all-red interval timing motor is traceable from AC at pigtail 120 of relay 122, which will be released during the all-red interval, closed back contacts 126, wire 128, wire 129, closed selector contact 26, wire 336, wire 338, to magnet 339 and ground and to the upper winding of the pedestrian and all-red timing motor 314 and ground. Thus, timing motor 314 will rotate wheel 326, causing pin 336' to advance toothed wheel 343 which will be held in its advanced position by attracted ratchet pawl 342. No initial period mechanism is provided for shaft 344 of the all-red timing mechanism, a single adjustment lever being sufficient. The all-red interval is of fixed duration and no initial and maximum intervals are involved. As soon as wheel 343 has been advanced by pin 326' successively to a position where contacts 346 close, AC will be supplied through contacts 346, wire 348, and when cam 331 reaches the position where its cam follower permits contacts 330 to close, AC just traced to these contacts will flow through wire 334, wire 227, selector switch relay 114 and to ground which will advance the selector switch to its eighth position.

SELECTOR SWITCH EIGHTH POSITION

In the eighth position of the selector switch, right of way is restored to streets 1 and 3 and the initial and maximum intervals are timed. In the eighth position, lights R—2 and R—4 are energized through closed selector contacts 22 and lights G—1 and G—3 are lighted through closed selector contacts 23. The holding circuits of #29 memory relay and pedestrian memory relay are held by closed selector contacts 8 and 10 respectively. A circuit is traceable to the upper winding of timing motor 202 from AC at pigtail 120 of relay 122, closed back contacts 126, wire 128, terminal 147, wire 129, closed selector contacts 24, and wire 350, where it energizes ratchet magnet 351, attracting its pawl and armature 352, preparing it to hold toothed wheel 353 in an advanced position. AC, just traced to wire 350, also energizes the upper winding of timing motor 202, one side of which is grounded. This causes shaft 218 to rotate, turning wheel 217, and advancing toothed wheel 253 one notch for each revolution of the shaft 218. As soon as the initial interval has expired, as determined by the setting of cam 354 on its shaft in a manner similar to that described above, for streets #2 and #4, contacts 355 will close. If #1 street memory relay #80 remains deenergized at the instant when cam contacts 224 close, toward the end of the revolution of shaft 218, a circuit will be traceable from AC at pigtail 84' of memory relay 80, closed back contacts 86, wire 356, closed selector contacts 11, wire 357 to contacts 355, through contacts 224 momentarily closed, wire

226, wire 227, through selector relay magnet 114, to ground, advancing the selector switch to the first position. In the eighth position, a holding circuit for #1 street memory relay 80 is maintained from AC at pigtail 84 of relay 80, lower contact 85, wire 91, closed contacts 90 controlled by cam 89, terminal 74, wire 76, terminal 77, and wire 78, to coil 79 of #1 street memory relay 80. Thus, the alternate shunt holding circuit, including selector contacts 9, is opened in the eighth position. Consequently, when contacts 90 open at the beginning of the revolution of timing motor shaft 218, #1 street memory relay 80 will release. If it is reacted, during the last revolution of the initial interval after contacts 90 have opened and before contacts 224 have closed, the circuit to the selector motor, through wire 357, closed cam contact 11, and wire 356, will be broken by the opening of back contacts 86 of relay 79 so that AC will not be applied to selector relay magnet 114 upon the closure of contacts 224 and an additional revolution of shaft 218 will be obtained, thus extending the duration of right of way on streets #1 and #3, accorded by green lights G—1 and G—3. Extension intervals can thus be obtained for #1 and #3 streets by successive operations of #1 street memory relay 80 in a manner exactly similar to that described above for #2 street memory relay 100, and when maximum period contacts 359 are closed by operation of cam 358, the next following closure of contacts 224 will permit AC to flow through closed contacts 359, closed contacts 355, cam contacts 224, wire 226, and wire 227 to selector relay magnet 114, and to ground, advancing the selector switch to its first position. This last described operation will take place irrespective of whether contacts 86 on #1 street memory relay 80 are open or closed since AC now arrives at contacts 355 directly from contacts 359. The selector switch position one has previously been described.

PEDESTRIAN CONTROL

Located on each of four corners of the intersection is a pedestrian detector 300, consisting of a push button, treadle, or, if desired, a device operable by body capacity or a photoelectric device may be substituted therefor. These four pedestrian detectors 300 are connected in series to detector relay 301 which is exactly similar in all respects to #1 street detector relay 56 and which is therefore not illustrated in detail. Operation of any one of the four serially connected pedestrian detectors 300 will open the circuit of detector relay 301 and close a circuit traceable from AC through the relay armature, shown dotted, wire 248, terminal 308, terminal 309, to the winding of pedestrian memory relay 262, and ground. Assuming that the selector switch 65 is in its first position and that there is no call for the signal by either street #2 or street #4, #2 street memory relay 100 will be released and its back contacts 104 will be closed. A circuit is traceable to selector switch relay 114 from AC at pigtail 260 of pedestrian memory relay 262, contacts 302, wire 315, selector contact 3, which is closed in the first selector switch position, and wire 113 to selector relay 114 and to ground.

Selector switch 65 accordingly advances from its first to its second position. Amber light relays 151 and 150 are energized by a circuit traceable from AC at pigtail 120 of relay 122, wire 128, terminal 147, wire 129, selector contacts 27 which are closed in the second position, and ter-

terminal 149 to the parallel windings of relays 150 and 151. These relays thereupon close their front contacts.

The selector switch is advanced from its second to its third position by a circuit traceable from AC at pigtail 106, closed back contacts 104 of #2 street memory relay 80, wire 221, wire 620, selector contacts 5 which are closed in the second position, and wire 113, to selector relay 114 and to ground, advancing switch to its third position.

The relays 150 and 151 just referred to have closed their front contacts and a circuit is traceable from the upper contact 162 of relay 150, wire 166, closed contacts 169 of amber interval timing motor, wire 170 to selector contacts 4 which are closed in the third position of the selector switch, wire 113, selector relay 114 and ground, advancing the selector from its third to its fourth position.

In the fourth position of the selector switch, a circuit is traceable to advance the switch to its fifth position, from contacts 302 of pedestrian memory relay 262, beginning with AC at pigtail 260, armature 303, contacts 302, wire 315, selector contacts 3 which are closed in the fourth position, and wire 113 to selector switch relay 114, advancing the selector switch from its fourth to its fifth position.

In the fifth position of the selector switch selector contacts 7 are closed and the switch is advanced from the fifth to the sixth position by a circuit traceable from AC at pigtail 164 of relay 150, armature 163, the upper contact 162 of relay 150, wire 166, cam contacts 186 which close before the cam contacts 154 open, releasing the amber light relays 150 and 151, wire 187, selector contacts 7 closed in the fifth position, wire 113, and relay 114. This carries the switch from the fifth into the sixth position where the selector switch is prepared to give the pedestrian indication upon the release of relays 150 and 151. Before contacts 169 reclose, contacts 154 open releasing amber light relays 150 and 151 and deenergizing the cam follower of cam 168 so that it will not advance the selector switch through the sixth position although selector contact 4 is closed in the sixth position.

In the sixth position of the selector switch, lights A-1 and A-3 and lights R-2 and R-4 are lighted during the operation of amber light motor 156 by the front contacts 173 of amber light relay 151. In the sixth position of the selector switch, these lights are also lighted by closed selector contacts 21 and 22 and upon the release of amber light relays 150 and 151 they remain lighted. In addition, the release of relay 150 closes a circuit traceable from AC at pigtail 164 of relay 150, its closed back contacts, wire 601, wire 193, selector contacts 19 and 20, to red lights R-1 and R-3 and amber lights A-2 and A-4 respectively, and since both selector contacts 19 and 20 are closed in the sixth position, immediately upon the release of relay 150 amber lights A-1 and A-3 and red lights R-1 and R-3 will be lighted by the circuit just traced. This results in the display of red and amber on all four streets, giving a distinctive signal to pedestrians as previously described. The timing of the pedestrian period is accomplished as follows: the lower portion of the timing motor 314 is similar in all respects to the timing motor 202 used for the G-2 and G-4 lights and previously described, comprising an initial interval cam 324, a maximum interval cam 325. Corresponding

adjusting levers for these cams are similar to those provided in timing motor 202. A circuit is traceable from pigtail 120 of relay 122, back contacts 126, wire 128, terminal 147, wire 129 to closed selector contacts 25, wire 316, terminal 317, and wire 318 to the lower winding of timing motor 314, which accordingly begins to revolve. A circuit is also traceable from terminal 317 to pawl magnet 319 which prepares to hold toothed wheel 322 in an advanced position. After the completion of the predetermined number of revolutions for the initial interval of the pedestrian period, contacts 328 are closed by the action of cam 324, and if the pedestrian memory relay 262 should not be operated by further pedestrian traffic, it will release and a circuit will be traceable from AC at pigtail 260 of relay 262, closed back contacts 261, wire 263, wire 332, closed selector contacts 13, wire 333 to contacts 328 and immediately upon the closure of contacts 330 at the end of the final revolution of the initial interval, contacts 330 will close, permitting AC just traced to these contacts to flow through wire 334 and wire 227 to selector relay 114, which will thereupon become energized and will advance the selector switch into the seventh, or all-red position.

The timing operations in this all-red position have been previously described and need not be described again.

As in the case of memory relays 80 and 100, two holding circuits are traceable for pedestrian memory relay 262. One of these is traceable from AC at pigtail 260 of relay 262, armature 303, contacts 302', terminal 305, wire 306, the selector contacts 10 which are open only in the sixth position of the selector switch during the timing of the pedestrian interval, wire 307, terminal 308, terminal 309, to the winding of relay 262 and ground. Thus, at all times except in the selector switch position, pedestrian memory relay 262 will have a closed holding circuit including selector contact 10. During the pedestrian timing interval, however, the selector contact is open and the circuit is then traceable from AC at pigtail 360, contact 392', terminal 305, wire 311, contacts 312 controlled by cam 313, wire 310, terminal 309 and the winding of relay 262 to ground. Thus, during the timing of the pedestrian interval, pedestrian memory relay 262 is subject to the control of cam contacts 312. Contacts 312 open momentarily during the early portion of each revolution of the pedestrian motor 314 and pedestrian relay 262 will then be released. If it is reoperated during the final revolution of the initial period, contacts 328 will be deenergized by opening of the back contacts 261 of relay 262 and the selector switch will not advance upon closure of cam contacts 330. An additional revolution of the timing order will result, giving an extension period for the pedestrian traffic. During each extension period an additional period may be obtained, but this succession of additional periods cannot go beyond the maximum which is determined by closure of cam contacts 329. When cam contacts 329 close, a path from AC is traceable through contacts 329, contacts 328 already closed, and contacts 330 which close at the end of the timing motor revolution. This advances the selector switch regardless of the position of memory relay 262. If pedestrian memory relay 262 should be operated, however, the holding circuit including selector contact 10 will keep it operated until the selector switch again comes around to position

6 and timing motor 314 makes another revolution. Thus, a call by a pedestrian during the last timing revolution of the maximum period will be retained and will afford the pedestrian a new interval in the next signal cycle in which to traverse the intersection.

At the beginning of the description of the pedestrian control it was assumed that #2 street memory relay 100 was not operated and that its back contacts 104 were closed. Consequently, circuits were traceable to the selector switch magnet 114 in each of the successive positions from the first position of the selector switch up to the sixth position, which is the pedestrian interval timing position. These successive steps are all accomplished within the duration of the amber interval for streets #1 and #3. If #2 street memory relay 100 had been operated by actuation of a vehicle, its back contacts 104 would have been opened and it would not have been possible to trace a circuit from AC along wires 221 and 620 and through selector contact 5 which is closed only in the second position. It will be observed that one of the contacts from 1 to 6 inclusive are closed in the second position except selector contact 5 and consequently the switch cannot advance into its third position until contacts 186 close toward the latter portion of the revolution of the amber interval timing motor. When contacts 186 close, contacts 169 open and although selector switch 65 has advanced to its third position, it will not skip through this position because contacts 169 do not reclose until after contacts 154 have opened and released the amber light relays which supply AC to contacts 186 and 169. This succession of operations all takes place within the amber light interval for streets #1 and #3 and brings the selector switch 65 into its correct position to display the pedestrian amber and red indications before relays 150 and 151 release.

Similarly, if there is no pedestrian actuation the following description will illustrate how it is possible for the selector switch to skip from its rest position with G—2 and G—4 lights lighted, to its eighth position which transfers right of way to streets #1 and #3, thus avoiding the necessity for holding up traffic when no pedestrians wish to cross the intersections. This operation is accomplished in the following manner: starting from the fourth position of the selector switch with lights G—2 and G—4 and lights R—1 and R—3 lighted, assume that a vehicle from street #1 energizes memory relay 80 as previously described. A circuit is traceable from AC at upper contact 85 of memory relay 80, wire 93, selector contact 2 which is closed in the fourth position, and wire 113 to selector relay 114 which is thereupon energized and causes the selector switch to advance from the fourth to the fifth position.

In the fifth position, a circuit is traceable from AC at pigtail 260 of pedestrian memory relay 262, which we have assumed to be deenergized, through closed back contacts 261, wire 263, to selector switch contact 6, which is closed in the fifth position, and along wire 115 to selector switch relay 114 which thereupon operates and advances the selector switch from its fifth into its sixth position.

In the fifth position, selector contacts 16 were closed, which energized amber light relays 122 and 123 by a path which may be traced from AC at pigtail 164 of relay 150, its closed back contacts,

wire 601, wire 193, closed selector contact 16, which is closed only in the fifth position, and wire 249 to windings of amber light relays 122 and 123 for streets #2 and #4.

As previously described, the upper front contacts of relay 123 supply AC to amber lights A—2 and A—4, and the lower contacts to lights R—1 and R—3. The upper contact of relay 122 provides a circuit to advance the selector switch from the sixth into the seventh position, which is traceable from AC at pigtail 120 of relay 122, wire 166, to closed cam contacts 169, which are closed through the early portion of the timing interval of amber light motor 166, wire 170, to selector contacts 4 which are closed in the sixth selector position and along wire 113 to selector relay 114 which advances the selector switch from its sixth into its seventh position.

Toward the end of the amber interval, contacts 186 close, permitting AC, just traced to wire 166, to pass now through contacts 186 instead of 169 and along wire 187 to selector contacts 7, which are closed in the seventh position, wire 113 and selector switch relay 114, thereupon advancing selector switch 65 from its seventh into its eighth position. The eighth position, as will be recalled, is the position of the selector switch for timing the duration of right of way for streets #1 and #3, and becomes effective immediately upon the release of amber light relays 122 and 123, as previously described.

Three switches, 370, 371, and 373, are provided, each of which serves to energize permanently one of the three memory relays previously described. Closure of switch 370 will connect AC to wire 97, wire 99, #2 street memory relay 100, holding this relay permanently energized so that it cannot be released. In this condition, irrespective of actuations by pedestrians or traffic on #1 street, the right of way will always return to #2 street and remain there for the maximum period before it may be obtained by either pedestrians or #1 street.

Similarly, closure of switch 371 will apply AC to wire 73, wire 76, terminal 77, wire 78, to the winding of #1 street memory relay 80. Correspondingly, switch 373 will supply AC to wire 248, terminal 309 and the winding of pedestrian memory relay 262. When any one of these relays is thus permanently energized, its corresponding maximum time interval will be included in each signal cycle and the signal mechanism will always accord right of way permanently to the street having the energized memory relay in the absence of actuations by vehicles or pedestrians on either of the other two relays remaining deenergized.

If two such relays are simultaneously permanently energized by closure of these switches, the signal will alternately accord right of way first to one street and then to the other. It should be noted that no provision is made for skipping the eighth position of the selector switch and thus omitting the minimum interval of right of way to streets #1 and #3. It is contemplated that lights 1 and 3 will be displayed to the more heavily traveled of the two intersecting thoroughfares. It will be noted that if there is no traffic on either #1 or #3 street and pedestrian relay 262 is permanently energized by closing switch 373, the mechanism will accord the maximum pedestrian interval followed by at least the minimum traffic interval for streets #1 and #3, it being impossible for the mechanism

to skip through the right of way interval for streets #1 and #3. The right of way interval for streets #2 and #4, however, will be omitted in the event that there is no actuation of relay 100 by traffic on either of these streets. Thus, if any detector circuit is disabled by the breaking thereof, it will have the same effect as permanently closing one of the switches 370, 371, or 373, and the worst possible effect is to accord the maximum interval of right of way in each signal cycle to the street having the disabled detector.

If all three switches, 370, 371, and 373, are closed simultaneously, the mechanism will automatically first accord the maximum interval of right of way to #1 street, then to #2 street, and then to the pedestrian interval, these periods following each other in rotation. This would be the result obtained if all three detector circuits were simultaneously broken. It will also be noted in the case of conflicting calls on the various streets and the pedestrian detectors, that the memory relay holding circuits are opened by selector switch 65 only during the timing interval for each particular street, so that the memory relays will remain energized until these timing intervals permit them to be reset, and the signal cycle will successively proceed to each right of way interval in rotation.

In the case of conflicting calls where one street is already in its timing interval, extensions will be granted to the street whose timing interval is in progress, until the maximum period has expired.

VEHICULAR SPEED CONTROL

Each of the streets leading to the intersection, or one or more of them, may be provided with devices arranged to display automatically a red light to the street upon which vehicle approaches. These devices may be mechanical or electrical and of any convenient form which will respond to the passage of a vehicle, although they are illustrated diagrammatically in the drawing of Fig. 3 as of the mechanical type for purposes of simplicity in illustration.

The speed detectors comprise two spaced depressable bars, plates, or the like, arranged across the traffic lane and responsive to vehicles approaching the intersection. For example, in #1 street, these detectors are designated 40 and 41; in #3 street, they are designated 40' and 41'; in #2 street, they are designated 400 and 410; and in #4 street, they are designated 400' and 410'. The detector plates or bars may be very closely placed to each other and to corresponding traffic regulating detectors 50 and 50', 500 and 500'. If desired, all three detectors may be enclosed in any convenient form of common housing which is adapted to be inserted in street. The circuits in the arrangement of the speed detecting devices are illustrated for #1 and #3 streets and it will be understood that the arrangements of circuits for the speed detectors for #2 and #4 streets are the same. The leading detector 40, which is engaged by the front wheel of a vehicle approaching the intersection, is arranged to bridge contacts 401, the left contact being connected to AC and the right contact being connected by wire 405 to one of the contacts 406 of the second detector 41; the other contact 407 is connected by wire 408 to the coil of relay 409; the other side of the relay coil being grounded.

The second detector 41 is provided with a sec-

ond armature 42, arranged to bridge contacts 413 in the circuit of holding magnet 414 of the first speed detector 40. Each of the speed detectors, 40 and 41, is provided with a dash pot which, when actuated, holds the corresponding armature in engagement with its contacts for a predetermined period of time, the dash pot for the first speed detector 40 being designated 415; the dash pot for the second speed detector being designated 416. These dash pots may be of conventional design and are adjustable by means of valves 417 so that their periods of closure may be adjusted at will.

The relay 409 is provided with three armatures, 180, 140, and 418. Armature 180 is normally engaged with contacts 179 in the circuit of #1 street amber light A-1. Armature 140 normally bridges contacts 139 in the circuit of #1 street green light G-1, while armature 418 is disengaged from contacts 419 which lie in a normally open circuit from AC to #1 street red light R-1.

The dash pot 415 of the first detector contact 40 is adjusted by its valve 417, so that when the front wheels of a vehicle engage detector 40, the closed contacts 401 will open before the front wheels of a vehicle engage the second detector 41, provided that the vehicle is traveling at a speed less than the maximum permissible rate. If the vehicle is exceeding the predetermined maximum speed limit, such as when an operator observes the amber light and attempts to speed across the intersection before the signal is changed to red, leading speed detector 40 will still be closed when the front wheels of the vehicle engage the second speed detector 41 to bridge contacts 407 and 406. The circuits established thus provide a path traceable from AC at contacts 401, coil 414 of detector 40, contact 413 of detector 41, to ground at contact 413, thus holding contacts 401 closed. From contacts 401, a path is traceable from AC through contacts 401, wire 405, contact 406, through closed detector 41, whose dash pot has not yet permitted its contacts to open, contact 407, and wire 408 to the coil of relay 409 and to ground, thus energizing relay 409 and breaking the circuit of green light G-1 at contact 139, and the circuit of amber light A-1 at contact 179, and closing a circuit from AC through contact 419 to red light R-1. Thus, if amber light A-1 or green light G-1 is lighted, it will be immediately changed to red. The duration of the period of illumination of the #1 street red light R-1 is predetermined by the adjustment of valve 417 of dash pot 416 of the second speed detector 41 and when the contacts of this detector disengage, detector 40 is permitted to restore to normal and open the contacts 406 and 407; the circuit of the winding of relay 409 is opened and this relay then releases restoring lights R-1, A-1 and G-1 to their normal control by the timing mechanism. Speed detectors 40' and 41' are similarly arranged as are the detectors 400', 410', 400 and 410 so that description of the operation of these detectors is not necessary.

While this speed detector system is preferably associated with a main traffic regulating system to appropriate the control of the street on which the speeding vehicle is traveling, from the main signal system, nevertheless, this speed arrangement may be arranged separately to extinguish a normal "clear" signal such as a green light, and illuminate a red light or other "stop" signal in

the manner described. Also, in certain instances, it may be advisable simply to employ no "clear" signal whatever but simply a normally extinguished red light, which is flashed against the speeding vehicle if it exceeds the predetermined speed limit in the manner described.

It will be seen that the new traffic regulating system automatically adapts itself to the volume and nature of the traffic negotiating the intersection at which it is located. Furthermore, the new system is selectively adjustable to provide the exact type of traffic control which the local requirements may dictate. Thus, the new system may be mounted at any intersection and easily adjusted at any time to conform to traffic requirements.

I claim:

1. In a traffic regulating system providing signal control for permitting pedestrian traffic to traverse a vehicular traffic lane, a traffic signal for said vehicular traffic lane, to provide a "stop" and "go" signal therefor, switching means for energizing said traffic signal, control mechanism for actuating said switching means, and traffic actuable means responsive to pedestrian traffic desirous of negotiating the vehicular traffic lane for appropriating the control of the traffic signal to energize the "stop" signal controlling the flow of traffic in the vehicular traffic lane to accord pedestrians the right of way.

2. In a traffic regulating system providing signal control for permitting pedestrian traffic to traverse a vehicular traffic lane, a traffic signal for said vehicular traffic and pedestrian traffic lanes, to provide a "stop" and "go" signals therefor, switching means for energizing said traffic signal, control mechanism for actuating said switching means, and traffic actuable means responsive to pedestrian traffic desirous of negotiating the vehicular traffic lane for appropriating the control of the traffic signal to energize the "stop" signal controlling the flow of traffic in the vehicular traffic lane and energize a "go" signal for the pedestrian traffic lane.

3. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices, mechanism for operating them, means responsive to traffic connected to said mechanism for initiating operation of said devices to signal the right of way on at least one street to said traffic, means for operating said devices to maintain the right of way on said one street for a predetermined period of time, means for extending the period of operation of said signal devices to maintain the right of way on said one street for additional predetermined periods of time, each of which is measured from the expiration of the preceding period, said period extending means being operable to provide an additional right of way period on said one street in response to actuation by following traffic on said one street only during a time interval occurring near the end of the preceding period, and means for adjusting said period extending means to vary the number of permissible additional periods.

4. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices, mechanism for operating them, means responsive to traffic connected to said mechanism for initiating operation of said devices to signal the right of way on at least one street to said traffic, means for operating said devices to maintain the right of way on said one street

for a predetermined period of time, means for extending the period of operation of said signal devices to maintain the right of way on said one street for additional predetermined periods of time, each of which is measured from the expiration of the preceding period, said period extending means being operable to provide an additional right of way period on said one street in response to actuation by following traffic on said one street only during a time interval occurring near the end of the preceding period, means for adjusting said second means to vary the initial period of operation of said signal devices, and means for adjusting said period extending means to vary the number of permissible additional periods.

5. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices including a "stop" signal for each street, vehicular traffic responsive means controlling the energization of the devices to accord the right of way to vehicular traffic on the respective streets in response to the approach of vehicles on such streets, and means responsive to pedestrian traffic seeking to negotiate at least one of the streets of the intersection for appropriating the control of said signal devices to energize the "stop" signal devices for all streets.

6. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices including a "stop" signal for each street, vehicular traffic responsive means controlling the energization of the devices to accord the right of way to vehicular traffic on the respective streets in response to the approach of vehicles on such streets, means responsive to pedestrian traffic seeking to negotiate at least one of the streets of the intersection for appropriating the control of said signal devices to energize the "stop" signal devices for all streets, and means for rendering said pedestrian traffic responsive means unresponsive to pedestrian traffic for a predetermined period of time.

7. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices including a "stop" signal for each street, vehicular traffic responsive means controlling the energization of the devices to accord the right of way to vehicular traffic on the respective streets in response to the approach of vehicles on such streets, means responsive to pedestrian traffic seeking to negotiate at least one of the streets of the intersection for appropriating the control of said signal devices to energize the "stop" signal devices for all streets, and mechanism actuated by said pedestrian traffic responsive means for maintaining said "stop" devices energized for a predetermined period of time.

8. In a traffic regulating system for an intersection of at least two streets, the combination of signal devices including a "stop" signal for each street, means controlling the energization of the devices in the alternative to provide the right of way to vehicular traffic on the streets, means responsive to pedestrian traffic seeking to negotiate at least one of the streets of the intersection for appropriating the control of said means to energize the "stop" signal devices for all streets, and mechanism responsive to successive actuation of said means by following pedestrian traffic for extending the period of operation of said "stop" signals a predetermined period of time.