

June 27, 1939.

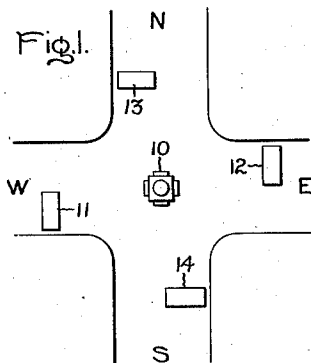
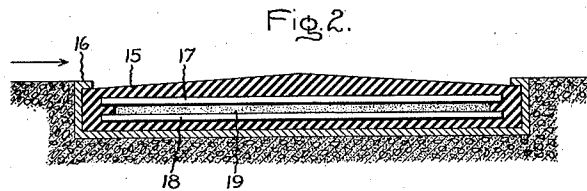
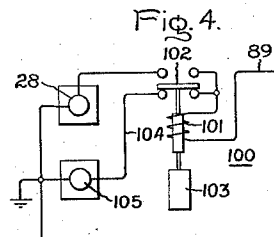
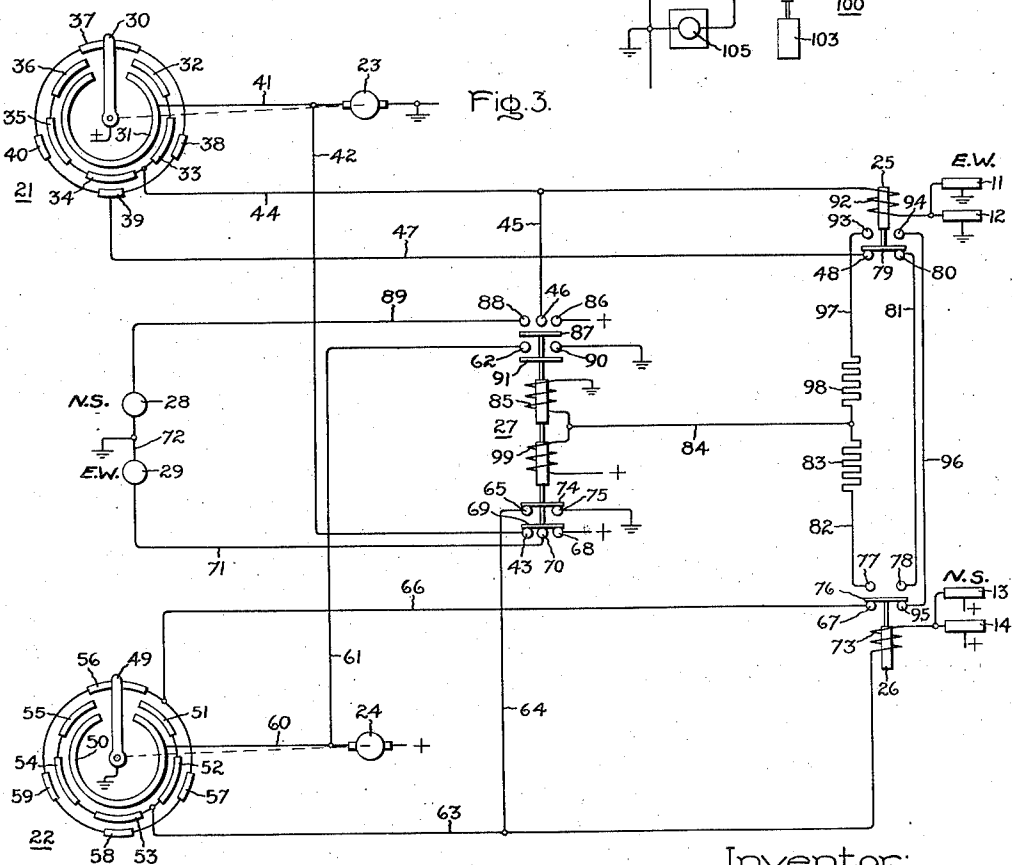
B. W. JONES

2,164,177

TRAFFIC-SIGNAL CONTROLLER

Filed June 24, 1936

2 Sheets-Sheet 1



Inventor:
Benjamin W. Jones,
by *Harry E. Dunham*
His Attorney.

June 27, 1939.

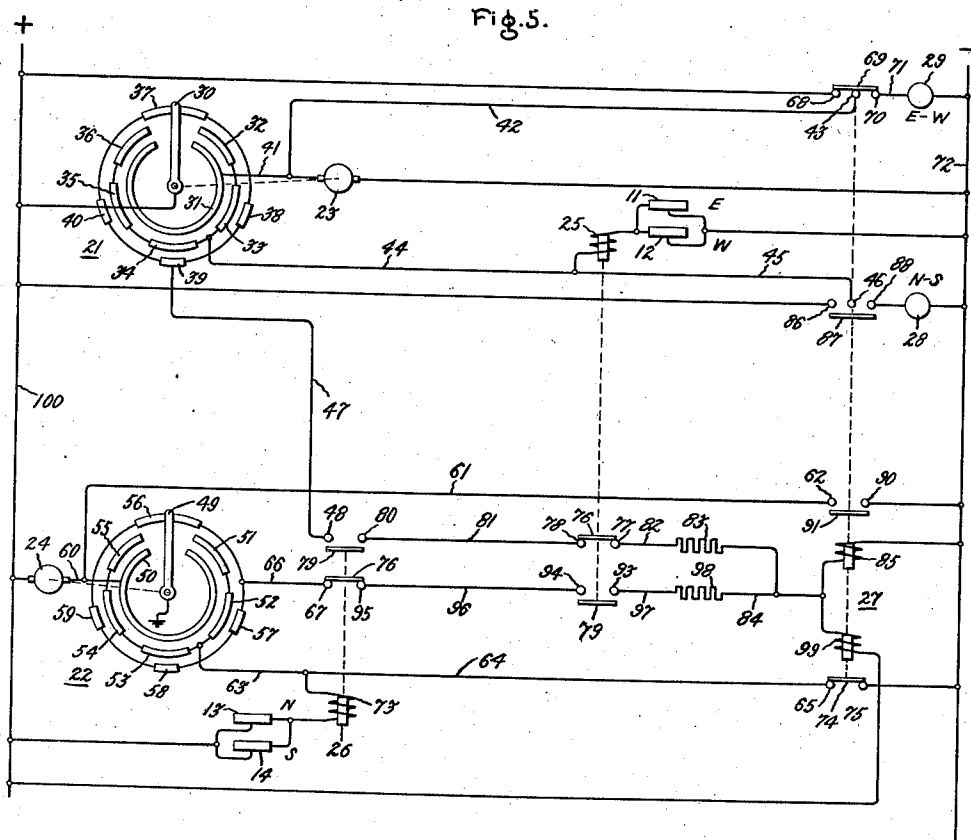
B. W. JONES

2,164,177

TRAFFIC-SIGNAL CONTROLLER

Filed June 24, 1936

2 Sheets-Sheet 2



Inventor:
Benjamin W. Jones,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,164,177

TRAFFIC-SIGNAL CONTROLLER

Benjamin W. Jones, Schenectady, N. Y., assignor
to General Electric Company, a corporation of
New York

Application June 24, 1936, Serial No. 86,909

8 Claims. (Cl. 177—337)

My invention relates to traffic-signal apparatus, and more particularly to vehicle-actuated traffic-signal controllers.

An object of my invention is to provide an improved vehicle-actuated traffic-signal controller responsive to vehicles in each of several intersecting traffic lanes.

Another object of my invention is to provide an improved vehicle-actuated switch.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 is a diagrammatic illustration of a street intersection equipped with a traffic signal and actuating switches in the path of each vehicle lane; Fig. 2 is a sectional view, taken parallel to the axis of the road, of my improved vehicle-actuated switch; Fig. 3 is a schematic diagram of a controller built in accordance with my invention, Fig. 4 is a modification thereof and Fig. 5 is a rearrangement of the diagram of Fig. 3 illustrating a common positive and a common negative conductor for all the elements of the controller.

Referring to the drawings in detail, Fig. 1 illustrates a traffic signal 10 mounted in the center of two intersecting streets running respectively north and south and east and west. Vehicle-actuated devices, such as switches 11, 12, 13 and 14, operable by vehicles, are placed on the approach side of each vehicle lane. The switches 11 and 12 are in the E.-W. street and are connected in multiple with each other. The switches 13 and 14 are in the N.-S. street and are connected in multiple so that when the right of way is obtained for either street, the right of way is for both directions in that street.

In Fig. 2, a sectional view, taken parallel to the axis of the road, of my improved vehicle-actuated switch is illustrated. This switch comprises a body 15 of a resilient material, such as rubber for example, embedded in the street pavement 16. Contacts 17 and 18 are embedded in the resilient body 15 and are separated by a material 19 which may be, for example, comminuted carbon which will normally be partially conductive, but becomes increasingly conductive upon the application of pressure due to the weight of the vehicle passing thereover. With this arrangement it is possible to actuate a relay at the instant that the vehicle rides over the switch and

to hold this relay in that position after the vehicle has passed.

Fig. 3, as above stated, is a schematic diagram of a traffic-signal controller built in accordance with my invention. It includes a pair of rotary timing switches 21 and 22 operated respectively by motors 23 and 24. Vehicle-actuated switches 11—12 and 13—14 operate respectively relays 25 and 26. The relays 25 and 26, together with timing switches 21 and 22, operate a signal-changing relay 27 for energizing signals 28 and 29 which, when energized respectively, grant the right of way to the N.-S. and E.-W. intersecting traffic lanes respectively. The motors 23 and 24 are preferably self-starting synchronous motors, so that their speed is dependent upon the frequency of the available current source and, therefore, predetermined for any constant frequency.

Timing switch 21 comprises a rotating arm 30 which is connected to the positive side of a current source and is rotated by the motor 23 through a shaft not shown. The arm 30 engages several sets of concentrically-arranged contacts during its movement. The inner contact 31 is a continuous contact broken only at the top for an arcuate space of approximately 30°. The second or intermediate series of contacts includes contacts 32, 33, 34, 35 and 36, which are equally spaced about the center of the switch, each contact being approximately 50° in length. The third, and outside, series of contacts 37, 38, 39 and 40 are somewhat shorter than the intermediate series of contacts. Contact 37 is spaced above the gap in contact 31 and also above the space between the contacts 32 and 36. It is of sufficient length to close this gap so that the arm 30 engages this segment before it leaves either of the segments 31, 32, or 36. Contacts 38, 39 and 40 are radially spaced so that their centers line up with the centers of the segments 33, 34, and 35. The contact 31 is connected by conductors 41 and 42 to contact 43 of the signal changing relay 27. The contacts 32 to 36 are connected with each other and by conductors 44 and 45 to contact 46 of the relay 27. Contacts 37 to 40 are connected with each other and by conductor 47 to contact 48 of the relay 25.

The timing switch 22 is similar in construction to switch 21. It is provided with a rotating arm 49 connected to the ground side of a current source. It is provided with a stationary contact 50 corresponding to the contact 31 of switch 21, contacts 51, 52, 53, 54 and 55 corresponding respectively to contacts 32 to 36 and contacts 56, 57, 58 and 59 corresponding respectively to con-

tacts 37 to 40 of the switch 21. The contact 50 is connected by conductors 60 and 61 to contact 62 of the relay 27. The contacts 51, 52, 53, 54 and 55 are connected to each other, and by conductors 63 and 64 they are connected to contact 65 of the relay 27. The contacts 56, 57, 58 and 59 are connected to each other and by conductor 66 to contact 67 of relay 26.

The above circuits are so arranged that, when no vehicles cross the intersection the right-of-way indication remains in the street which last had it. This same condition holds when vehicles travel only in this one street. When vehicles approach in an intersecting street the actuation of the vehicle switch in this street energizes the motor of the timing switch corresponding to this vehicle switch and the rotating arm thereof is moved relatively to the stationary contacts at a predetermined speed.

In Fig. 3 the relay 27 is illustrated as being in its lower position in which signal 29 is energized granting the right of way to the E.-W. lanes. The signal circuit may be traced from contact 68 which is connected to the positive side of a source, through movable contact bar 69 of relay 27, contact 70, conductor 71 to signal lamp 29 and conductor 72 to ground. A circuit may also be traced to motor 23, from the contact 68, to contacts 69 and 43, conductors 42 and 41 to motor 23 and ground. The arm 30 is, therefore, rotating clockwise at this time. If, during this condition of the circuits vehicles operate the E.-W. switches 11—12, the relay 25 will be energized only at intervals during which arm 30 traverses the intermediate contacts 32 to 36. When arm 30 is between any two of these contacts, the relay 25 remains in the position illustrated.

Assuming now a car approaching on the N.-S. street and passing a vehicle switch 13 or 14. A circuit will be established from the positive side of a source through the coil 73 of the relay 26, conductors 63 and 64 to contact 65 of relay 27 and through the movable contact bar 74 to the stationary contact 75 which is connected to ground. A circuit is thereby established through the relay coil 73 which lifts its moving contact 76 and thereby establishes a circuit across the two upper contacts 77 and 78 of the relay 26. As stated above the material 19 between the contacts of the vehicle switches is partially conductive. For this same reason the relay, when picked up, remains in that position although the vehicle wheel does not remain on the switch, and remains so until the circuit is broken elsewhere.

When, after the relay 26 picks up, a condition of the apparatus is obtained wherein the relay 25 is deenergized and the rotating arm 30 is in engagement with one of the contacts 37 to 40, a circuit is established whereby relay 27 is operated. This circuit may be traced from the positive side of the source to which the arm 30 is connected, through the arm 30, contact 37, conductor 47, contacts 48, 79 and 80 of relay 25, conductor 81, contacts 78, 76 and 77 of relay 26, conductor 82, resistor 83, conductor 84, relay coil 85 to ground. The relay 27 is thereby energized to move its contacts to their respective upper positions. As a result thereof the circuit through signal 29 is broken and a circuit through the signal 28 is established as follows: From the positive side of the current source through contacts 86, 87 and 88 of the relay 27, conductor 89, signal 28 and conductor 72 to ground. Simultaneously a circuit is established through the motor 24 and timing

switch 22 begins to operate. This circuit may be traced from grounded contact 90, movable contact 91, contact 62, conductor 61, motor 24 to the positive side of the source. The circuit to motor 23 through the contacts of relay 27 is broken, but the motor continues to operate until the arm 30 leaves contact 31 through which it receives current. This circuit may be traced from the positive side of the source to arm 30, contact 31, conductor 41, motor 23 to ground.

The arm 49, of timing switch 22, begins to rotate as soon as the relay 27 contacts are moved upwardly. The arm moves clockwise and engages contacts 50 and 51 before the relay 26 drops to its lower position. During the time arm 49 engages contact 50, the motor 24 receives current irrespective of the position of relay 27. The circuit may be traced from ground to arm 49, contact 50, conductor 60, motor 24 to the positive side of the source. When the motor of the timing switch is started, therefore, it continues to operate for a complete revolution. As long as arm 49 engages one of the contacts 51 to 55, a circuit through relay 26 is established and it holds its contact 76 in the upper position. This circuit may be traced from arm 49, contacts 51 to 55, conductor 63, relay coil 73, switch 13 or 14 to the current source. The contacts 51 to 55 are, however, only some 50° long having 22° spaces between. Therefore, when the contact arm 49, during its movement, leaves one of these contacts, the circuit to relay 26 is broken and cannot be reestablished until another one of this group of contacts is reached, the purpose of this being that unless cars continue to operate the switches 13 and 14, the relay is deenergized to enable cars in the intersecting streets to obtain the right of way.

Assuming, therefore, that one vehicle caused the change of right of way as just described and that a vehicle in the E.-W. street actuated switch 11 or 12 during the time arm 49 was in engagement with contact 51. When the switch 11 or 12 was operated a circuit through the corresponding relay 25 was established. This may be traced from ground through the switch 11 or 12, relay coil 92, conductors 44 and 45, contacts 46, 87 and 86 to the current source. The relay, therefore, raises its movable contact 79 to engage contacts 93 and 94. This does not change the signal setting, however, as long as relay 26 remains in its upper position. When relay 26 does drop to its lower position, due to arm 49 moving off contact 51, an operating circuit to the signal relay 27 is established as soon as arm 49 reaches the outside segment 57. This circuit may be traced from grounded arm 49, contact 57, conductor 86, contacts 67, 76 and 95 of relay 26, conductor 96, contacts 84, 79 and 93 of relay 25, conductor 97, resistor 98, conductor 84 to coil 99 and to the current source. The completion of this circuit energizes the coil 99, and since the circuit to coil 85 was broken when the relay 25 picked up its contacts, the coil 85 is deenergized and the coil 99 moves the relay contacts 27 back to the position shown in the drawings.

From the foregoing description it is evident that the length of an intermediate contact segment, such as 51, and the distance from this contact to the next outside contact, such as contact 57, determines the time period for which a single car may retain the right of way if a vehicle appears at the intersection in another of the intersecting streets and no other vehicle appears on the street having the right of way. If such other car does appear on the intersecting street, the sig-

nals are changed to transfer the right of way to this vehicle on the intersecting street at the end of this period and it retains the right of way for a similar period. If, on the other hand, a second vehicle appears on the intersecting street before this minimum period has expired the signals can be held in the existing condition for another similar period. Assuming now street E.-W. having the right of way, that a vehicle appears on N.-S. street before the minimum period for E.-W. has expired and that a second vehicle also appears on E.-W. street. As above explained, relay 26 would pick up its contacts responsive to the vehicle in N.-S. street. If nothing else happened, the circuits above described would be established and relay 27 would shift its contacts when arm 30 engaged one of the contacts 37 to 40. The vehicle on E.-W. street, however, in accordance with our assumption, raised relay 25 as soon as arm 30 engaged contact 33. This arrangement of contacts is such that the space between contacts 32 and 33 is sufficient to instantaneously drop the relay 25 and to permit its pick-up by an actuation of vehicle switches 11 or 12 before an outside contact, such as 38 is engaged by the arm 30. If such vehicle actuation does take place the previous actuation of relay 26 in the intersecting street is of no consequence since the relay 25 merely breaks the circuit which would otherwise be established to the operating coil 85 of relay 27. This circuit may be traced from the arm 30, contact 38, conductor 47, relay contacts 48, 79 and 80, conductor 81, contacts 78—76—77, conductor 82, resistor 83, conductor 84 and coil 85. The establishing of this circuit, as already explained, would operate the relay 27 to its upper position and thereby change the signals.

Because of the second operation of relay 25, the vehicle which operated the relay 26 is made to wait another time period equivalent to the movement of the arm 30 over the contact 33 and the additional movement necessary to engage contact 39. When the arm 30 leaves contact 33, the relay 25 is dropped. The energy necessary to operate the signal changing relay 27 is not obtained, however, until a time period later when arm 30 engages contact 39. If in the meantime relay 25 was again operated, the circuit again remains broken until arm 30 leaves contact 34. The process may further be repeated for the time period necessary to traverse contacts 35 and 36. When the arm 30 leaves contact 36, however, it immediately engages the contact 37 and establishes the circuit necessary to operate relay 27 and thereby change the right of way to the waiting vehicle. The space between contacts 36 and 37 is for this reason made greater than between others of this series of contacts. Simultaneously the motor 23 is deenergized by arm 30 leaving contact 31.

When the right of way is given to the waiting vehicles on the N.-S. street, the control of the time period allotted vests in the rotating arm 49. If subsequently another vehicle appears on the N.-S. street to move relay 26 to its upper position, as above described for relay 25 in the E.-W. street, and if by repeated actuations of the vehicle switches 13 and 14, the relay remains in this upper position, the right of way remains on the N.-S. street for a maximum period equivalent to the time necessary to rotate the switch arm 49 for a complete revolution.

From the above description it is evident that a full automatic operation of traffic signals may be obtained with simple apparatus. The time

periods are easily adjusted by regulating the time for a single revolution of the switch arms 40 and 49 and by regulating the length of the contact segments. The length of each intermediate segment determines the time period given for a single vehicle to cross the intersection. In order to give a waiting vehicle in the other street a chance to cross, without unnecessary delay, the rotating switch arm breaks the circuit of the vehicle relay at the end of the minimum time period necessary for the single car to cross. When this relay circuit is broken the vehicle relay in the other street having been operated will change the signal relay as soon as the arm moves to one of the outside contacts. During the period, between the end of the minimum period and the engagement of an outside contact, the first vehicle relay may again be lifted and thus retain the right of way for another minimum period. This process can be repeated until a maximum time is reached after which the flow of traffic in the first street is stopped and the right of way is given to the waiting vehicle. In this second street the process is repeated. The right of way is again held only as long as vehicles operate the switches and corresponding relay and, if that is the case, then it can be done only for a predetermined maximum period.

The signals 28 and 29 may be of any desired type. The preferred type comprises a lamp or group of lamps energized to give a positive right of way indication to one street and a positive stop indication to the intersecting streets. These indications are usually a green lens for the "Go" indication and a red lens for the "Stop" indication. A change of signal warning may be used comprising a "yellow" signal which is energized for a short period before each signal change. Such warning signal may be incorporated in any convenient manner, for example, by incorporating a time delay device in the signal circuit which will energize the warning light at each change of the signal relay before energizing the stop and go signals. An example of such "caution" indication is illustrated in Fig. 4. Any other of the well-known arrangements now in use may be incorporated, however, in this system.

In Fig. 4, I have illustrated a time delay device 100 connected into the conductor 89. The time delay device 100 comprises a magnet coil 101, a movable contact 102 and a time delay device 103, such as the well-known dash pot. When the coil 101 is deenergized the movable contact 102 is in its lower position where it completes a circuit from conductor 89 through coil 101, contact 102, conductor 104 to a caution signal 105, which may be equipped with lenses colored orange or yellow. When conductor 89 is energized, due to the action of relay 27, the caution light is energized for a time period regulated by the device 103. When this period expires the contact 102 moves to its upper position and engages an upper set of contacts, thereby establishing a circuit to the signal 28. The coil 101 remains in series with this circuit and holds contact 102 in this position until the current flow to conductor 89 is interrupted.

In Fig. 5, the elements of Fig. 3 are arranged between a common positive conductor 100 and the common grounded conductor 72. This type of diagram is considered for some purposes to be clearer than the diagram of Fig. 3. In order to keep the diagram in its simplest form, the elements illustrated in Fig. 3 are slightly rearranged, and each of the conductors terminating in a ground indication or in a plus indication is car-

ried to the respective positive and negative conductors running vertically along the opposite sides of the diagram. In arranging the elements to suit this diagram, it is necessary to make one change in the arrangement of the two pairs of contacts operated respectively by the relays 25 and 26. In Fig. 3, the relay 25 operates contacts 93—94 and 48—80, the latter being normally closed, and relay 26 operates contacts 77—78 and 66—95, of which 65—95 are normally closed. In rearranging the diagram to suit the requirements of an "across-the-line diagram", it was found that the same operating result can be obtained by having relay 25 operate contacts 77—78 and 93—94, of which 77—78 are normally closed, and to have relay 26 operate contacts 48—80 and 67—95, of which 67—95 are normally closed. With the above arrangement of the contacts, a complete circuit to one of the coils of relay 27 is obtained when either of the two relays 25 is actuated. This results in exactly the same operation as illustrated in Fig. 3.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a traffic-signaling system, the combination of signals operable to indicate the right of way to several intersecting streets successively and for simultaneously indicating stop to the others, a signal switch operable to several positions to energize the necessary signal combinations in each of its several positions respectively, vehicle-actuated devices in each of said streets, and timing switches operable respectively responsive to actuations of said vehicle-actuated devices in the intersecting streets to control the positioning of said signal switch and for maintaining said signal switch in a selected position for a minimum time period responsive to a single actuation of a vehicle-actuated device.
2. In a traffic-signaling system, the combination of signals operable to indicate the right of way to several streets successively and for simultaneously indicating stop to the others of said streets, a signal switch operable to several positions to energize the signal combinations in each of its several positions granting the right of way to said intersecting streets respectively, vehicle-actuated devices in each of said streets, and timing switches respectively responsive to actuations of said vehicle-actuated devices to operate said signal switch to assume a predetermined position responsive to an actuation of a vehicle-actuated device in one of the intersecting streets, to hold said signal switch in said position for a predetermined minimum time period and to hold said signal switch in said position for a predetermined maximum time period responsive to successive actuations of said vehicle-actuated devices, said actuations being spaced from each other a time period less than said minimum period.
3. In a traffic-signaling system, the combination of a signal positioned at the intersection of several thoroughfares and operable to indicate the right of way to each of said thoroughfares successively and simultaneously to indicate stop to the others, vehicle-actuated devices in each of said thoroughfares, relays responsive to actuations of said vehicle devices and operable to record the presence of vehicles at the intersection on thoroughfares not having the right of way, timing switches for each of said thoroughfares operable in response to the setting of said relays and a signal switch operated responsive to the joint action of said timing

switches to energize said signal thereby to maintain a right of way on one thoroughfare for a predetermined minimum time period responsive to a single actuation of said vehicle-actuated devices and to extend said period to a predetermined maximum responsive to repeated actuation of said vehicle-actuated device.

4. In a traffic-signaling system, the combination of a signal positioned at the intersection of two thoroughfares and operable to alternately indicate the right of way to each of said thoroughfares respectively while indicating stop to the other, vehicle-actuated devices in each of said thoroughfares, relays responsive to actuations of said vehicle devices in the thoroughfares respectively and operable to record the presence of vehicles at the intersection on the thoroughfares not having the right of way, a timing switch for each of said thoroughfares operable responsive to the setting of the relay corresponding to the vehicle-actuated device in one thoroughfare, and a signal switch operated responsive to the joint action of said timing switches to energize said signal to maintain the right of way on one thoroughfare for a predetermined minimum time period responsive to a single actuation of a said vehicle-actuated device in that thoroughfare and to transfer the control of said signal to the second of said timing switches at the end of this period.

5. In a traffic-signaling system, the combination of a signal positioned at the intersection of several thoroughfares and operable to indicate the right of way to each of said thoroughfares in succession and simultaneously indicating stop to the others of said thoroughfares, vehicle-actuated devices in each of said thoroughfares, a recording switch for each of said thoroughfares responsive to actuations of said vehicle devices in corresponding thoroughfares and operable to record the presence of vehicles at the intersection responsive to the momentary actuation by vehicles on the thoroughfare not having the right of way, a timing switch for each of said thoroughfares and responsive to actuations of said recording relay and operable at a predetermined speed for establishing operating circuits to a signal switch, a signal switch operable to energize said signals and connect it to said timing switches alternately during their respective operations, whereby said signal switch is maintained for a predetermined minimum period in one position responsive to a single actuation of a device in one of said thoroughfares and is maintained in another position for another predetermined minimum period responsive to an actuation of the vehicle device in another thoroughfare.

5. In a traffic-signaling system, the combination of a traffic signal located at the intersection of several thoroughfares, vehicle-actuated devices in each of said thoroughfares, relays responsive respectively to actuations of said devices, a timing switch for each thoroughfare and a signal switch, said signal switch controlling said signals to grant the right of way to said thoroughfares responsive to operations of said devices and arranged to initiate the movement of the timing switch corresponding to the thoroughfare having the right of way, means controlled by said timing switch for locking said signal switch in its position for a predetermined minimum time period after which an actuation of the device in another thoroughfare may change the position of said signal switch to shift

the right of way to that thoroughfare and simultaneously start a second timing switch.

7. In a traffic-signaling system, the combination of a signal located at the intersection of several thoroughfares, a switch for said signal to grant the right of way to the thoroughfares respectively, vehicle-actuated devices in each of said thoroughfares, relays operated by said devices to record the presence of vehicles, and a timing switch for each of said thoroughfares, said timing switch being set into motion when the right of way is obtained by its corresponding thoroughfare in response to an operation of the said device and its corresponding relay in said thoroughfare, said timing switch being provided with means for maintaining its movement for a predetermined maximum time period and provided with means to intermittently release its corresponding relay during said maximum period whereby the right of way is maintained in said thoroughfare for a minimum time period in response to a single actuation of said relay and whereby said relay is periodically released for the purpose of enabling said devices and corresponding relay in another thoroughfare to obtain the right of way for said thoroughfare.

8. In a traffic-signaling system, the combination of a signal located at the intersection of several thoroughfares, a switch for setting said signal to grant the right of way to the said thor-

oughfares respectively, means for operating said switch comprising vehicle-actuated devices in each of said thoroughfares, a relay corresponding to each of said thoroughfares and operated to closed position by the said device in the corresponding thoroughfare, a timing switch for each of said thoroughfares, said timing switches being set into motion by said signal switch when the right of way is granted thereby to the thoroughfare corresponding to each of said timing switches, said timing switches being provided with means for maintaining its motion for a predetermined minimum time period, with means for intermittently releasing the relay corresponding to said thoroughfare and with means for operating said signal control switch to return the right of way to the corresponding thoroughfare in case another thoroughfare is not using said right of way, whereby each of said thoroughfares obtains the right of way for a minimum period for each vehicle passing thereover and whereby said right of way may be obtained for a maximum period in response to vehicles operating said devices at intervals smaller than said minimum time period and whereby the right of way is automatically changed at the end of said periods in case a vehicle is waiting on another thoroughfare.

BENJAMIN W. JONES.