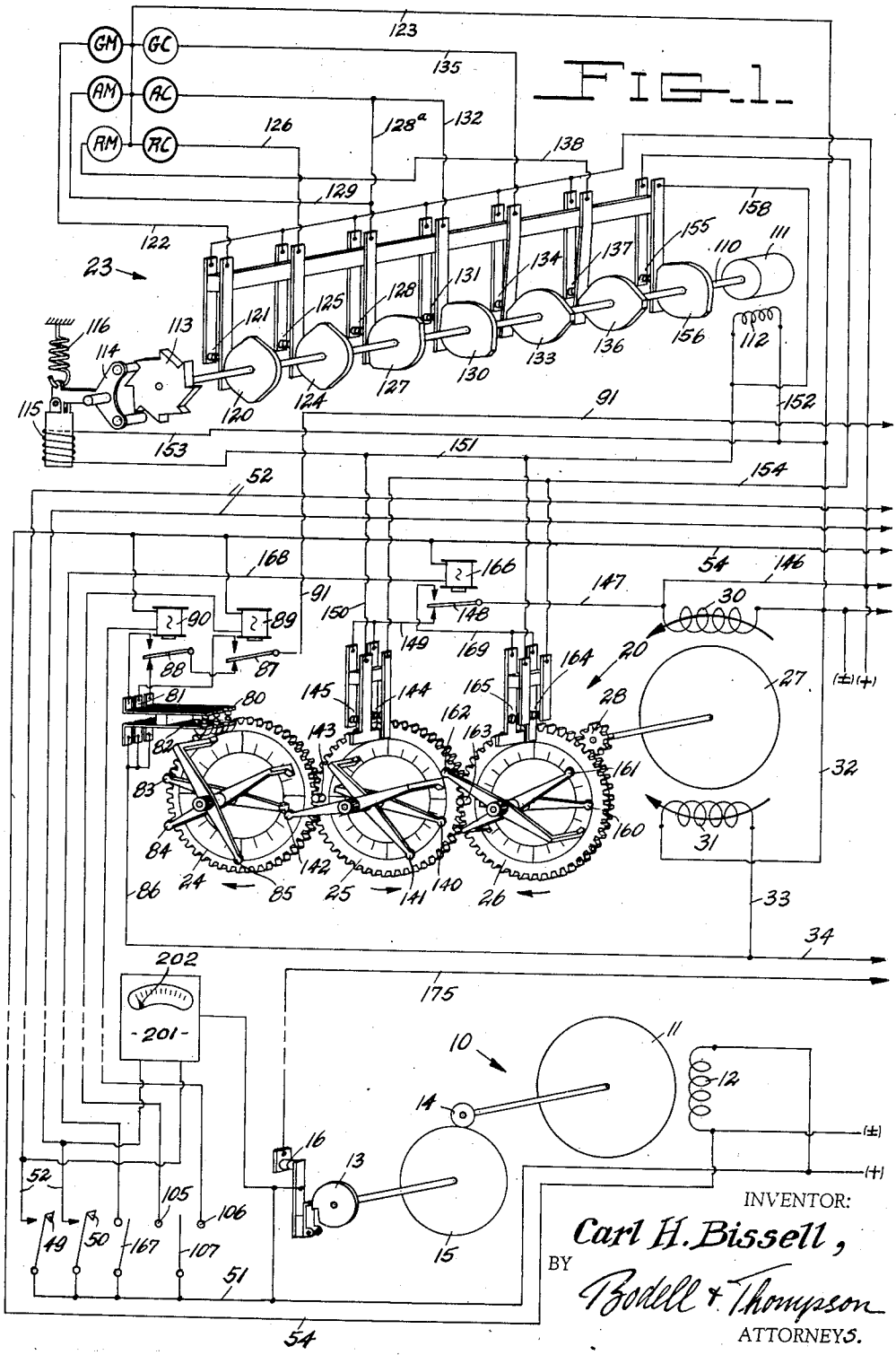
Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

Filed May 22, 1933 10 Sheets-Sheet 1

Fig. 1.



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TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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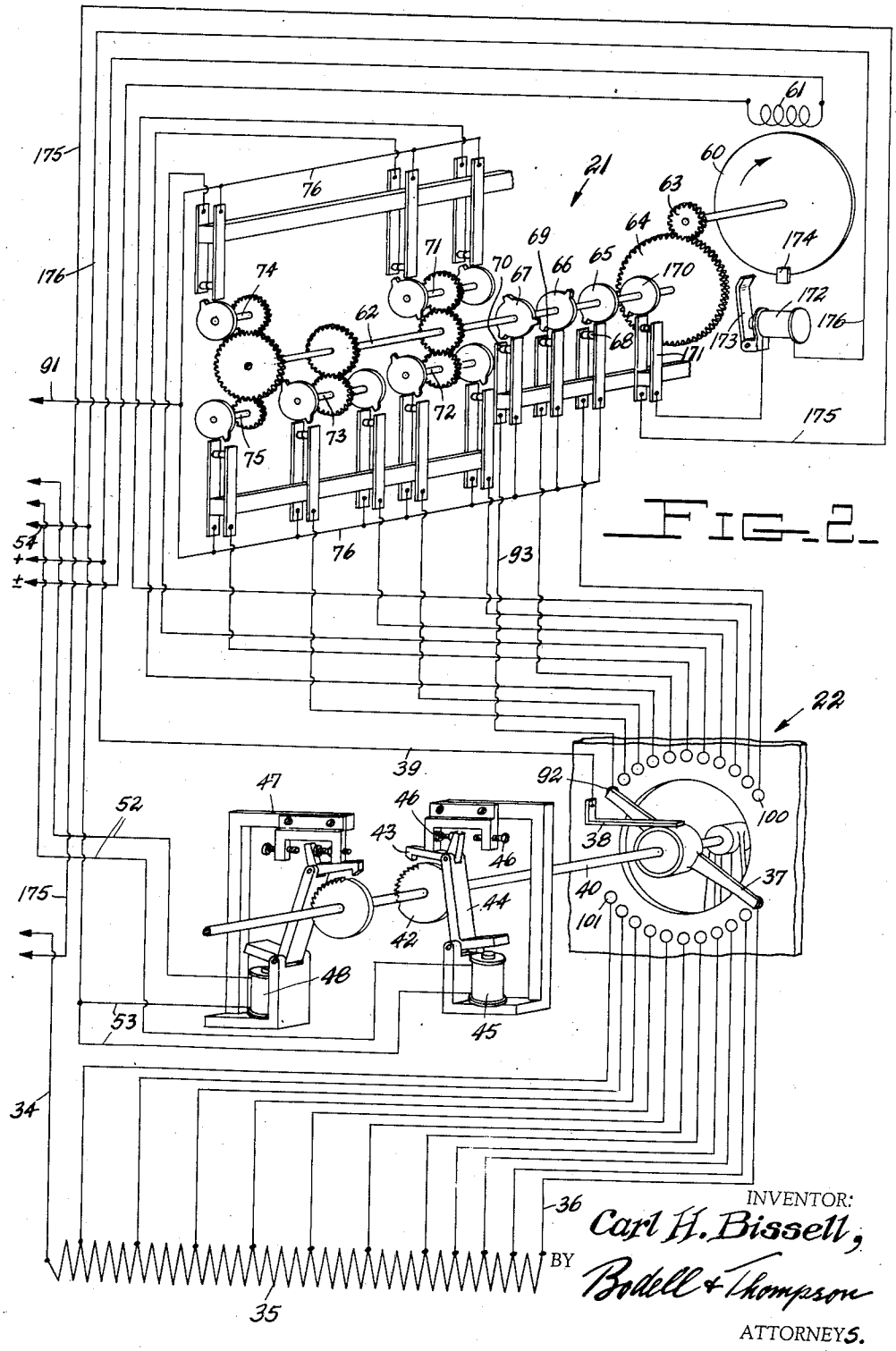


FIG. 2.

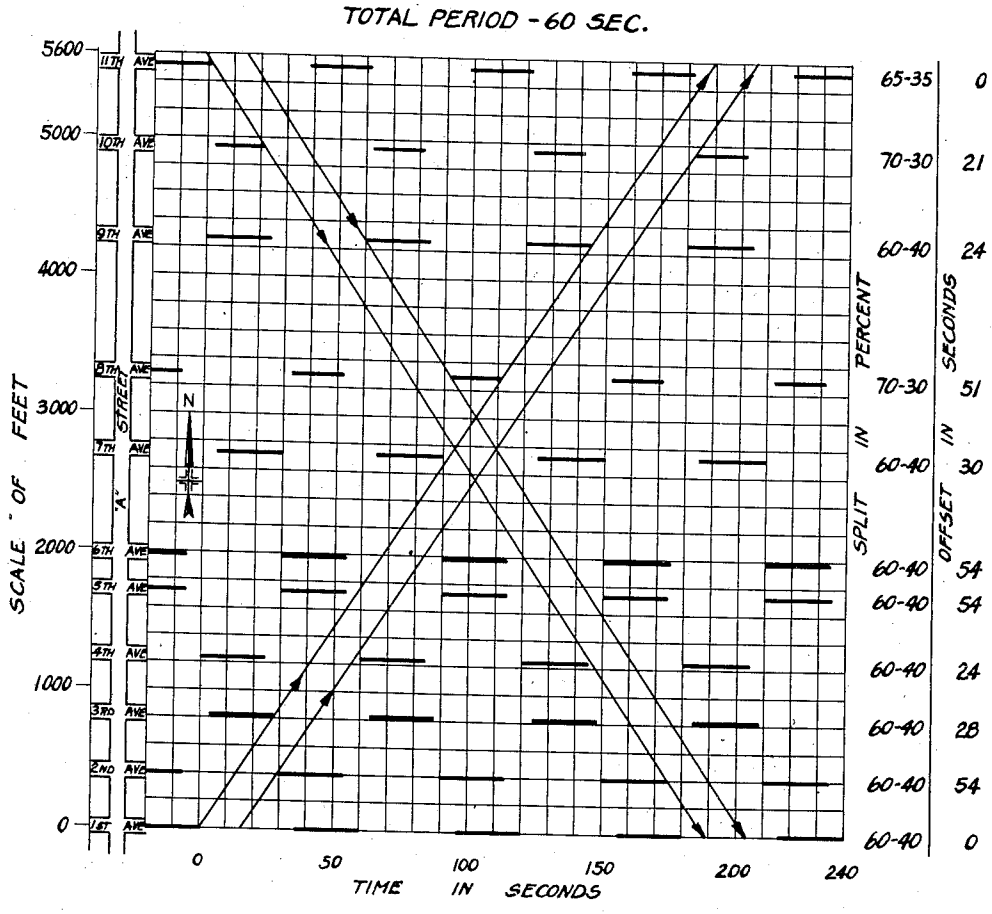
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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Fig. 3.



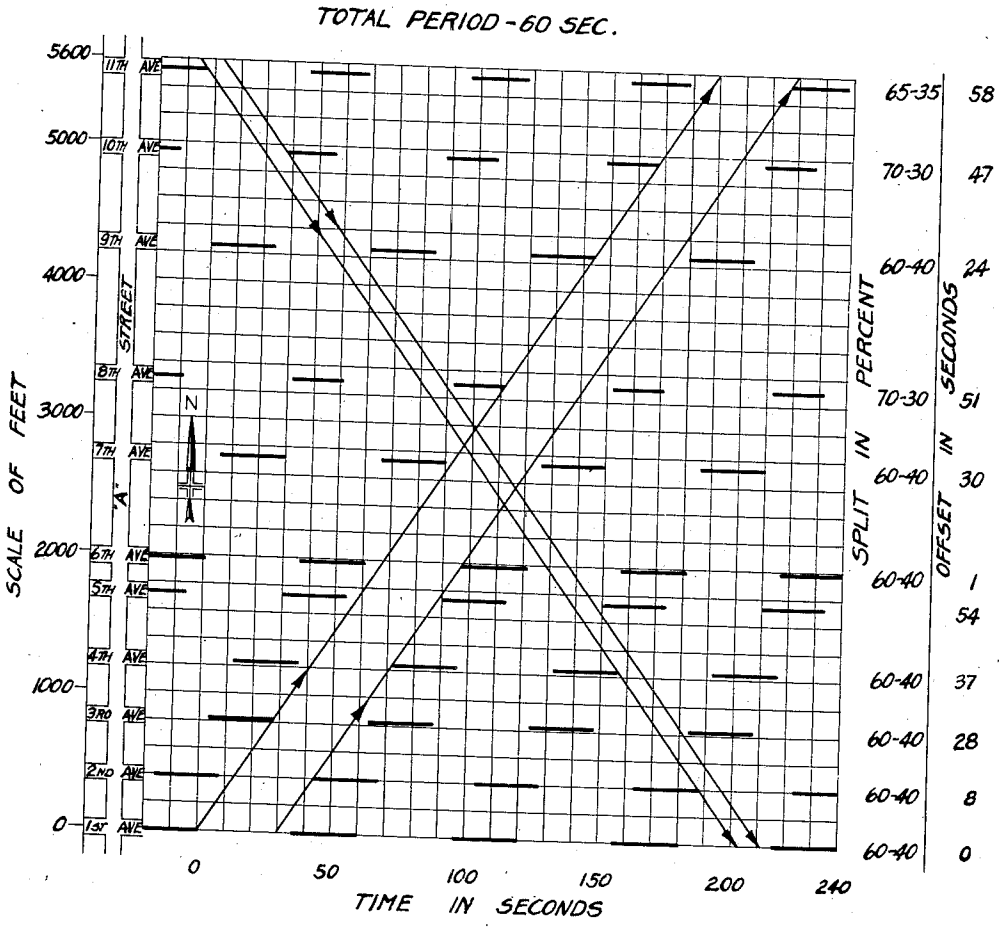
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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FIG. 4.



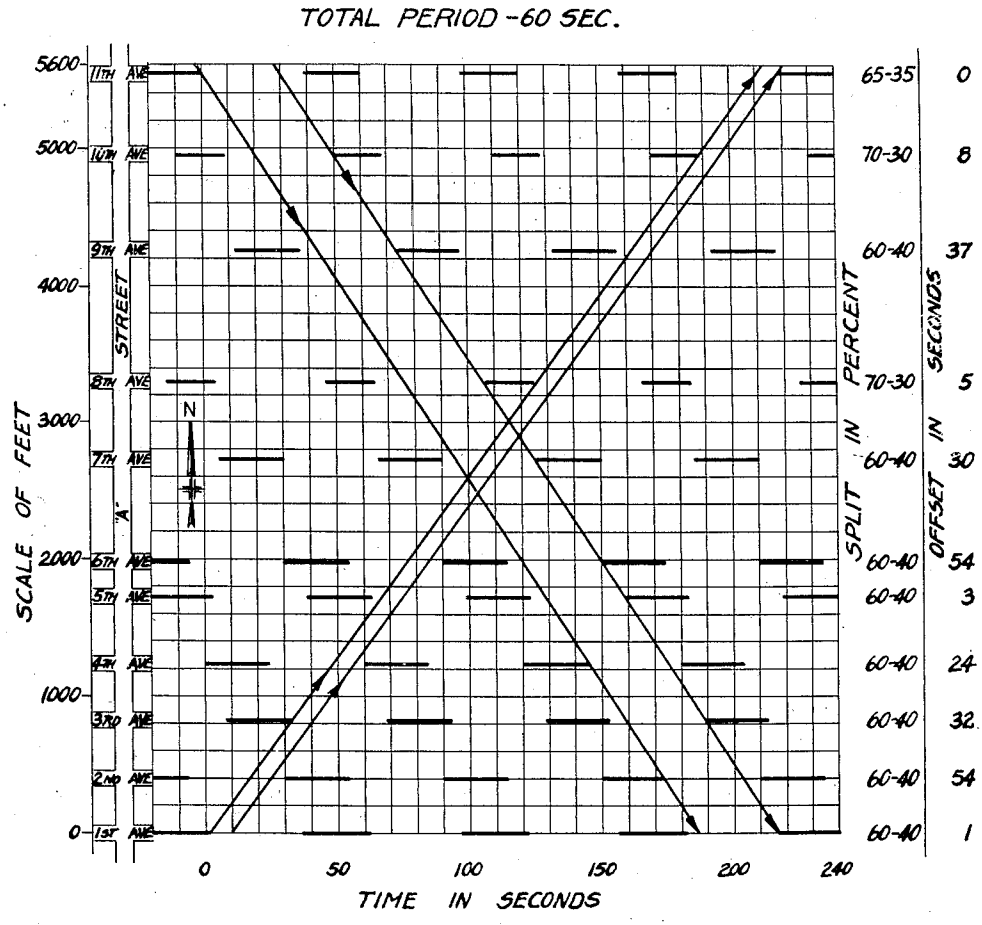
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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FIG. 5



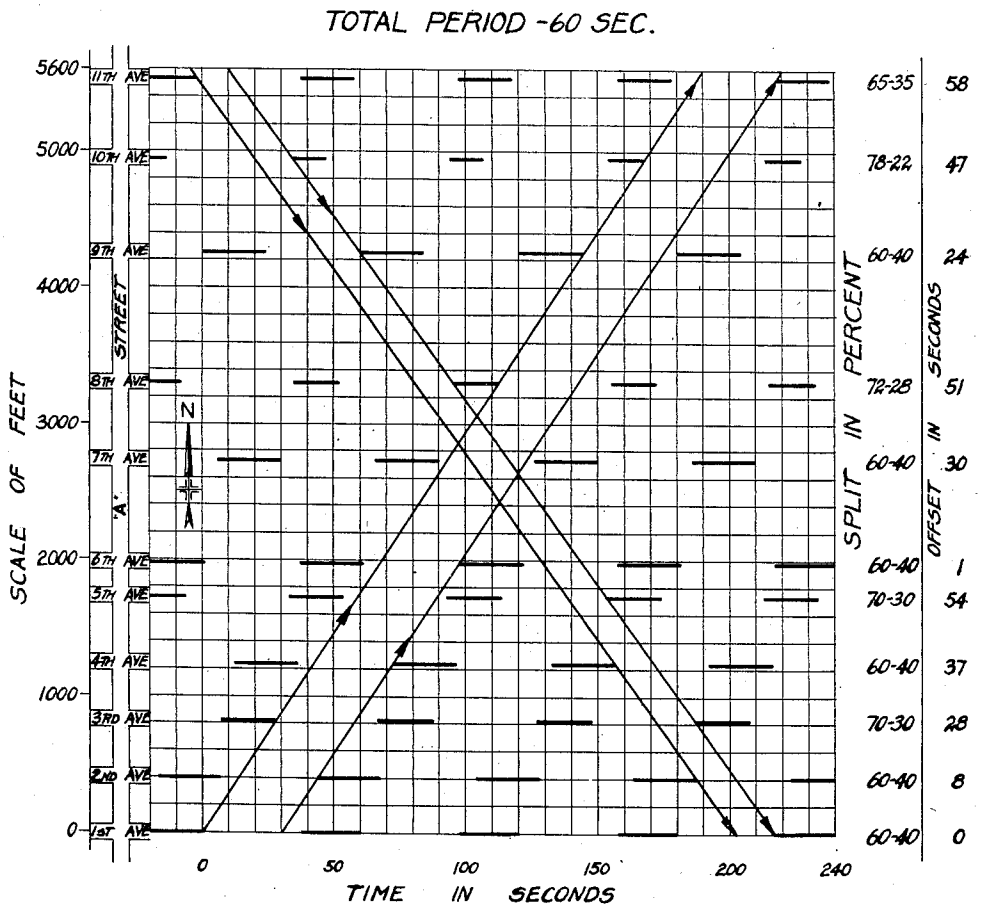
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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FIG. 6.



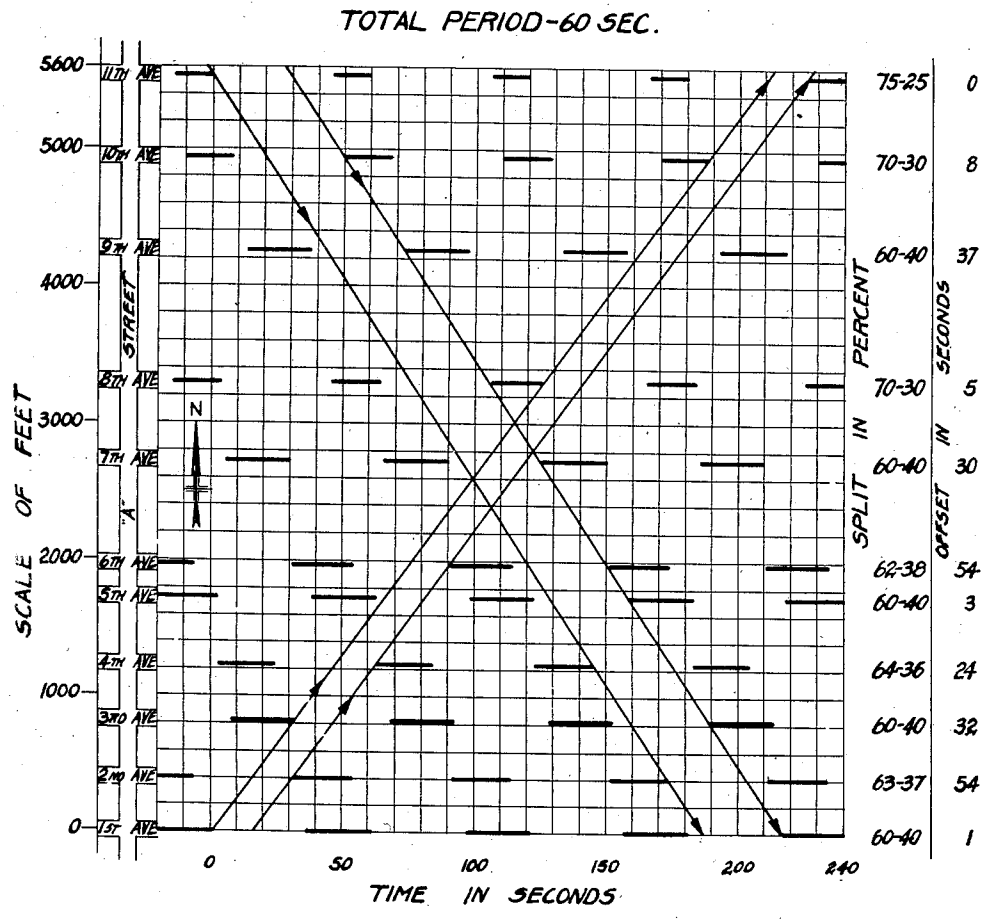
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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FIG. 7.



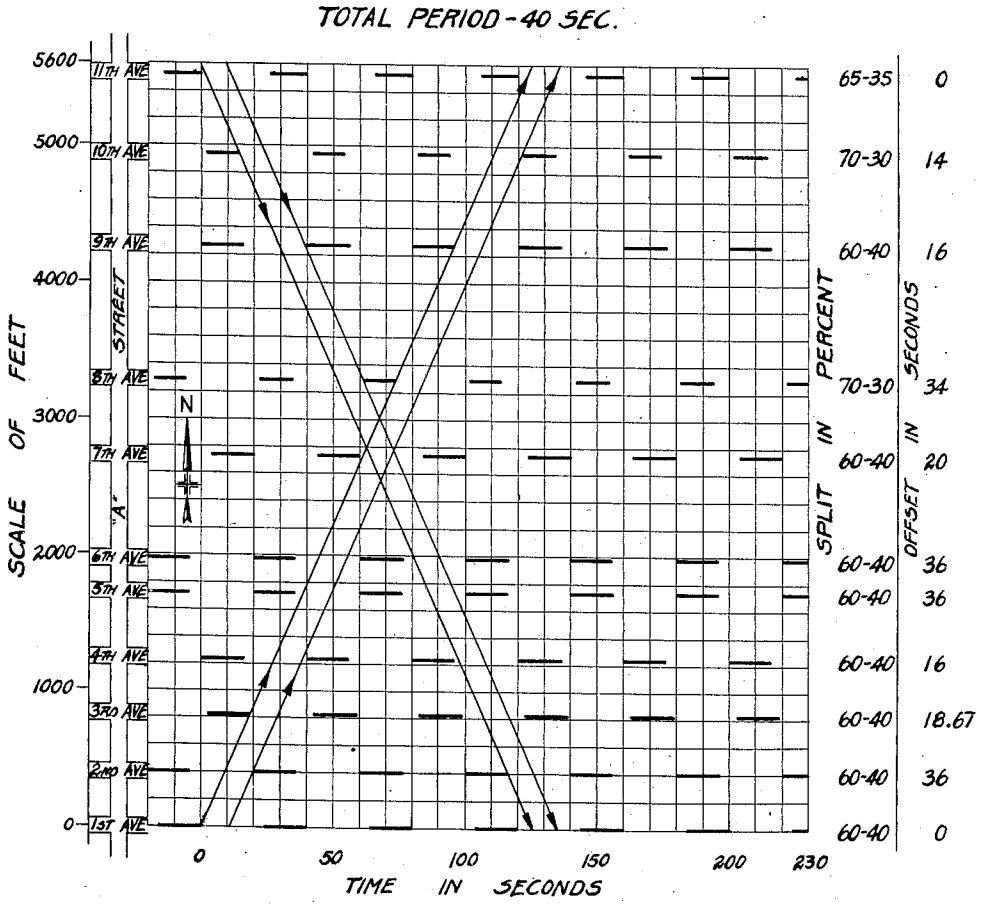
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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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FIG. 8.



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Sept. 7, 1937. C. H. BISSELL 2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

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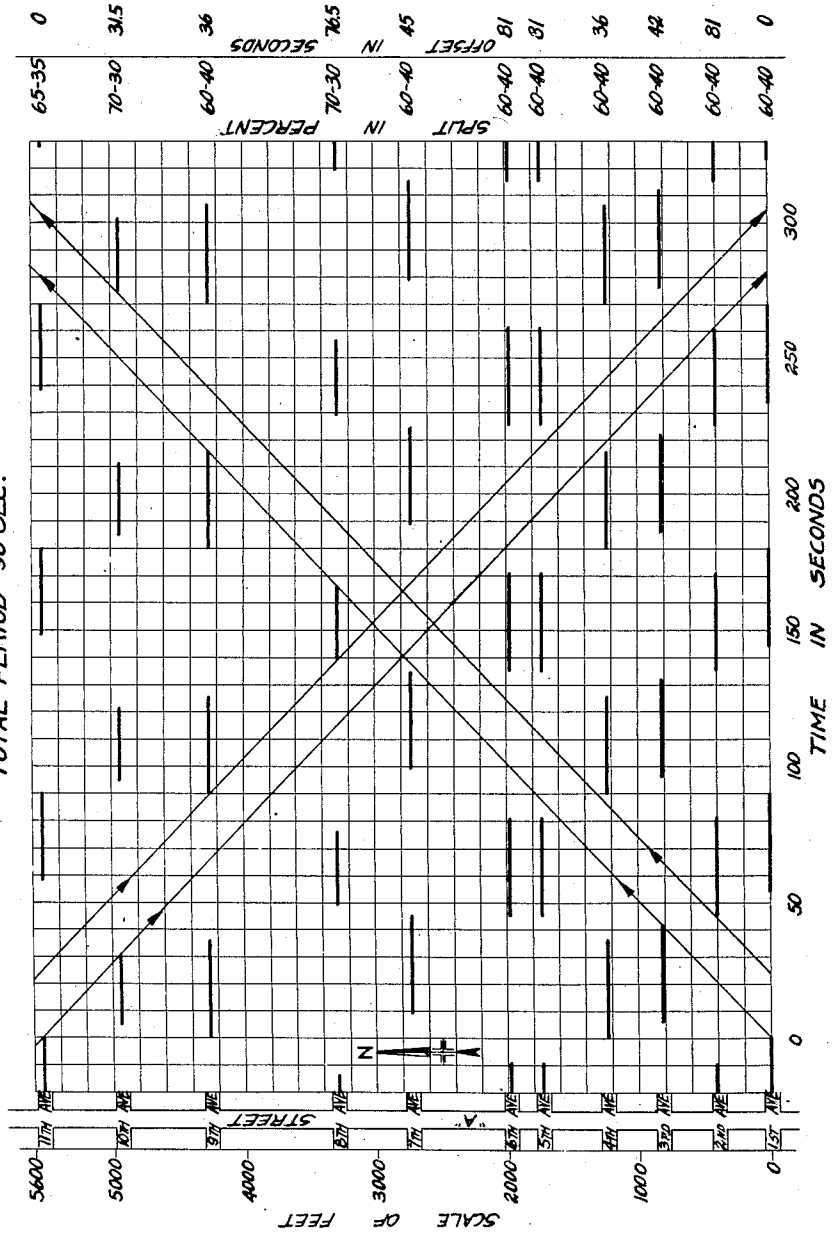


FIG. 9.

TOTAL PERIOD - 90 SEC.

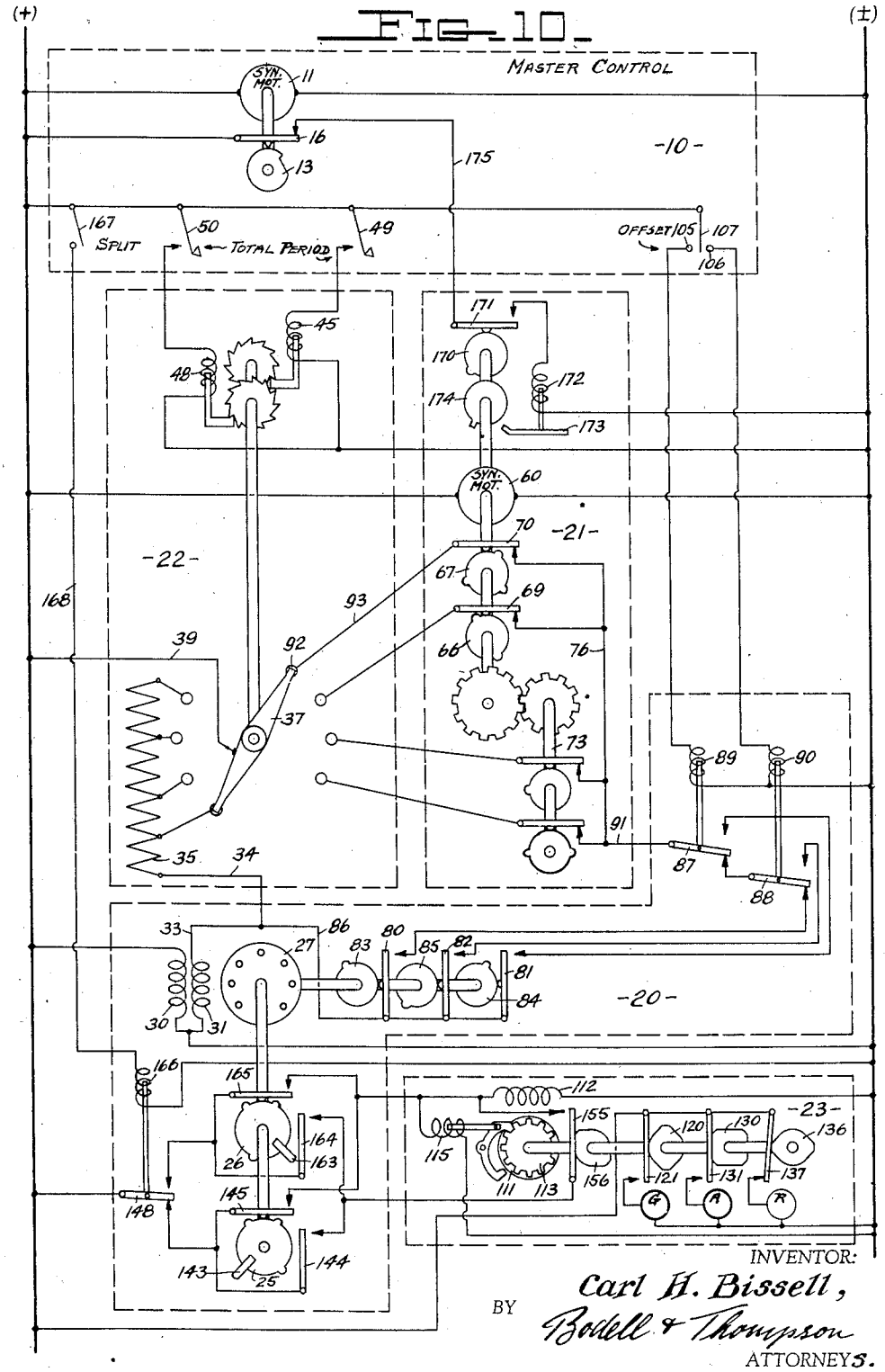
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TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

Filed May 22, 1933 10 Sheets-Sheet 10

Fig. 10.



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Patented Sept. 7, 1937 2,091,954

UNITED STATES PATENT OFFICE

2,091,954

TIMING APPARATUS FOR TRAFFIC SIGNALING SYSTEMS

Carl H. Bissell, Syracuse, N. Y., assignor to Crouse-Hinds Company, Syracuse, N. Y., a corporation of New York

Application May 22, 1933, Serial No. 672,207

6 Claims. (Cl. 177—339)

This invention relates in general to circuit controlling apparatus for controlling a plurality of electrical circuits at different locations. For example, my circuit controlling apparatus is very suitable for controlling a traffic signaling system wherein it is desired to control the signal circuits at a plurality of street intersections in any particular order, and maintain the operation in such order.

This circuit controller is particularly adaptable to traffic signaling systems known as progressive systems, such as set forth in the Neill Patents Nos. 1,723,060 and 1,723,062, issued August 6, 1929, wherein a plurality of intersections along a highway are signalized and the signaling system so operated that traffic on the highway may progress up and down, or in both directions with the highest efficiency. In such systems, various problems of circuit control arise, some of which are such that can not be solved with any circuit controlling device with which applicant is familiar

Broadly, a progressive traffic signaling system is one operated so that the go signals progress successively up and down the highway. To those skilled in the art, it is understood that there must be maintained, a particular time relation between the signals at each intersection and that this time relation must be strictly maintained, otherwise, the system loses its efficiency to move traffic.

It has been found that the flow of traffic on a highway is not constant throughout the day. Accordingly, any street including a progressive system that operates at high efficiency during one part of the day may operate to hinder traffic during another part of the day. Also, it has been found desirable to vary the speed at different times of the day at which the traffic signaling system is operated. It is highly desirable to have a system wherein these variations may be effected from a central point. My circuit controller is such that these adjustments can be made in the system and also be made from a central point.

To those skilled in the signaling art, it is understood that the total period is the time duration of a complete traffic cycle, that is, the time during which the red light is displayed, the green light is displayed, and the amber or caution lights, if any, are displayed. Obviously, the shorter the total period the quicker each green light appears, and the quicker the green lights appear the greater the speed at which the system operates. It is therefore desirable to have circuit controlling apparatus for progressive signaling systems with which the total period of the signals in the system may be varied. An important object of my circuit controller is the provision of means whereby the speed of the circuit controlling apparatus may be varied from a central point.

However, it is also obvious to those skilled in the art that increasing the speed at which the system operates does not necessarily mean an increase in the traffic capacity of the system. As a matter of fact, increasing the speed alone materially reduces the platoon length of traffic moving through the progressive system. The length of the traffic platoons depends upon the relative timing between one intersection and another, or more particularly, between adjacent intersections. If the green light at a succeeding intersection appears relatively early, or relatively late, the platoon of traffic passing through the preceding intersection will be stopped. The time relation between adjacent intersections of a progressive system is known as the offset. In as much as the traffic flow during part of the day may be heavy in a northerly direction, and during another part of the day heavy in a southerly direction, it is very desirable to have the system such that the offsets may be shifted to favor the heavier flow of traffic at a particular time.

My invention has, as another important object, means whereby the time relation of the operation of the signals at each intersection, that is, the offsets, may be varied from a central point.

A third problem presented in progressive systems regards the split feature, or the relative duration of the red and green signals at each intersection. For example, at intersection A, the traffic flow on the cross street and on the highway may be substantially equal, in which case, the duration of the red and green lights would be equal, or fifty-fifty percent, while at intersection B, the cross street might be of minor importance relative to the highway and the time relation between the red and green signals might be seventy-thirty percent. As the traffic flow varies also on cross streets, it is desirable to have circuit control apparatus by which these splits may be varied.

By my invention, I provide means whereby the split or time relation between the signals at each intersection may also be varied from a central point.

A fourth object of my invention is the provision of means whereby upon failure of any circuit between the central station and any of the intersections, or between any of the intersections themselves, the control apparatus at each intersection will remain in synchronization with the control device at all other intersections in the system.

Other objects and advantages of my invention will appear as the description proceeds.

The invention consists in the novel features and in the combinations and constructions hereinafter set forth and claimed.

In describing this invention, reference is had to the accompanying drawings in which like characters designate corresponding parts in all the views.

Figure 1 is a schematic view and wiring diagram of the apparatus located at headquarters, the cycle timer and the signal circuit controller located at the street intersections.

Figure 2 is related to Figure 1 and is a schematic view and wiring diagram of the resynchronizer and selector appartus associated with each secondary timer.

Figures 3, 4 and 5, are graphs depicting the flow of traffic on a given street, as effected by change in offset.

Figures 6 and 7 are graphs showing the movement of traffic on the same streets, with the same total period and offsets, as shown in Figures 3, 4 and 5, and with the relative period of display of the red and green lights, or split, being different at certain intersections than that of Figures 4 and 5 respectively.

Figure 8 is a graph showing the traffic flow resulting from decreasing the total period and employing the same relative offset.

Figure 9 is a graph showing traffic flow resulting from increasing the total period and employing the same relative offset.

Fig. 10 is a simplified diagram in across-the-line form of the electrical wiring system of the apparatus.

The invention comprises generally a master circuit controller located at a central point, a plurality of secondary circuit controllers each including a cycle timer for opening and closing the signal circuits, a resynchronizing device for maintaining the cycle timer in synchronism, and a selector apparatus, operable from a central point, for regulating the speed at which the cycle timer operates, and simultaneously selecting the proper circuit between the resynchronizer and the cycle timer for maintaining the latter in synchronism at the speed selected by the selector.

Referring to the drawings, 10 designates generally a circuit controller located at a central point, as for example at police headquarters. This circuit controller includes a synchronous motor comprising a rotatable disk 11, and a drive coil 12. This motor is connected to a cam 13 through suitable gearing 14, 15. The cam 13 periodically opens and closes a switch 16. A circuit is connected through, and controlled by, the switch 16, which circuit is utilized to keep the synchronizers of the secondary controllers in step with each other, if for any reason any of them should get out of step.

Each secondary controller includes a cycle timer designated generally as 20, a synchronizing device designated generally 21, a selector mechanism designated generally 22, and a circuit controller designated generally 23.

The cycle timer 20 includes three dials 24, 25 and 26, here shown in the form of gears which are driven by the induction motor 27 through the pinion 28. The dials 24, 25, 26, carry adjustable fingers which make and break circuits to the actuating mechanism of the controller 23, which in turn directly controls the display of the traffic signals at the various street intersections of the system. The detail operation of the dials 24, 25, 26, with their associated switches and the operation of the controller 23 will be described hereafter.

It is sufficient to assume for the present, that the speed at which the controller 23 is operated, depends upon the speed at which the motor 27 of the timer 20 is operated. I will now describe the speed and synchronizing control apparatus for the motor 27. The motor is driven in a counter-clockwise direction (Figure 1) through the action of the driving coil 30. This coil is energized generally, by a local pick-up at the street intersection. It is to be kept in mind that the timer 20, resynchronizer 21, selector 22, and controller 23 comprise, in their entirety, the control apparatus located at each intersection.

The speed at which the motor 27 operates depends upon the force exerted by the bucking coil 31 which tends to operate the motor 27 in a clockwise direction. The coil 31 is energized through the wires 32, 33, 34, and, as here shown, through the total resistance 35, wire 36, switch arm 37, brush 38, wire 39, back to the positive side of the source. It will be noted that as the entire resistance 35 is cut into the circuit, there is relatively low voltage impressed upon the coil 31 and accordingly, produces a relative weak bucking effect to the motor 27, permitting the motor 27 to operate at a relatively high speed. Obviously, a transformer with variable taps to procure different voltages might be used in place of the resistance shown at 35.

It is to be observed that the speed at which the motor 27 will operate depends with which of the contacts the switch arm 37 of the selector 22 is in engagement.

The switch arm 37 of the selector 22 is actuated from one contact to another by any suitable mechanism. In fact, the selector itself may be of any suitable design and construction, which will effect, in the desired manner, the purpose for which it is intended. As here shown, the switch arm 37 is carried on the shaft 40 which is rotatably mounted in suitable bearings. The shaft 40 is rotated in clockwise direction by means of the ratchet wheel 42, pawl 43, armature 44, and electromagnet 45. When the electromagnet 45 is energized, the angular armature 44 is moved clockwise (Figure 2) bringing the pawl 43 into engagement with the ratchet wheel 42. Suitable adjustable stops 46 are provided to adjust the action of the pawl 43. With this means, the shaft 40 is rotated one notch upon each time the electromagnet 45 is energized. Similar apparatus, designated generally 47, is employed to rotate the shaft 40 in a counter-clockwise direction. The electromagnet 48 is energized through actuation of the push button 49, and the electromagnet 45 energized by the actuation of the push button 50. These push buttons may also be located at headquarters with the controller 10. One side of the push buttons is connected to the positive side of the source through the wire 51, the circuits from the push buttons being: wires 52, to the electromagnets 45, 48, wires 53 and 54, back to the common side of the source.

I have thus far described apparatus operable from headquarters for varying the speed of the motor 27, which in turn, controls the time of actuation of the controller 23, and accordingly, the duration or total period of the signals.

I will now proceed to describe the resynchronizing apparatus 21 and its connection with the cycle timer 20. It is obvious to those skilled in the traffic signaling art, that it is of utmost

importance to maintain the time relation between the signals at each intersection in a progressive system. If this time relation varies, that is, if the signals at one intersection get out of step with the system, all of the advantages of the progressive system are lost. It is therefore necessary to provide some means to keep the control apparatus for each intersection in step with the control apparatus at all other intersections. Heretofore, this has been accomplished by resynchronizing each secondary control once during each revolution with a master controller at headquarters. The disadvantage of such system is that should there be any failure in the circuits between the master and any of the secondary timers, the secondary timers would not be resynchronized but would continue to run as ordinary cycle timers. In my circuit control apparatus, the resynchronizing device is driven by a synchronous motor 60, the driving coils 61 of which are energized by local pick-up, as the coil 30 of the motor 27.

Except in the case of extreme emergencies, the motor 60 of each secondary control apparatus will remain in step with the others, due to the fact that they are synchronous motors and all operated on the same frequency current. The motor 60 operates shaft 62 through suitable gearing as 63, 64. On this shaft is mounted a plurality of cams and gears. The cams operate switches and the gears drive additional cam shafts at various speeds according to the respective gear ratio. With this arrangement each of the various switches is periodically opened and closed at various speeds. For example, assuming the shaft 62 is so geared to the motor 60 that it makes one revolution in 120 seconds, the cams 65, 66 and 67 will likewise each make one revolution in 120 seconds. However, the switch 68 will be opened and closed once in 120 seconds, while the switch 69 will be opened and closed once every 60 seconds, and the switch 70 opened and closed once every 40 seconds. This due to the fact that the cam 65 has one lobe, the cam 66 two lobes, and the cam 67 three lobes. The cam shafts 71, 72, and 73 are each rotated through gearing of different ratios and each carry two cams, one with one lobe, and the other with two lobes. The cam shafts 74, 75 each carry one cam. All of the switches operated by the respective cams are normally closed, and the movable contacts thereof are all connected to the common wire 76, while each of the stationary contacts are connected to respective terminals of the switch of the selector 22.

Each of these switches, operated by the cams of the synchronizer 21, control an additional circuit for the bucking coil 31 of the cycle timer 20 in the manner now described. Associated with the cycle timer 20 are normally open switches 80, 81 and 82, operated by the adjustable arms 83, 84, 85 respectively. These arms are rotatable with the dial 24, and each arm is adjustable relative to the dial. The movable contacts of these switches are all connected to the common wire 86 which in turn is connected to the wire 33 forming the positive feed for the bucking coil 31 of the motor 27. The stationary contacts of the switches 80, 81, and 82, are connected through armatures 87, 88, of relays 89, 90, to the wire 91, which is connected to the wire 76 which is common to all of the movable contacts of the switches associated with the synchronizer 21. As explained above, each stationary contact of these switches is connected to a terminal of the selector 22.

I will now trace a circuit through the apparatus just previously described in the position shown in the drawings.

The brush 38 of the selector 22 is connected with the positive source of current which passes through the switch arm 37, contact 92, wire 93, normally closed switch 70, wires 76, 91, armatures 87, 88, to the stationary contact of switch 80, which is normally open. As the dial 24 is revolved by the motor 27, the arm 83 closes the switch 80 and the circuit then continues through wires 86, 33, bucking coil 31, wire 32, to the common side of the source. It will be remembered that bucking coil 31 previously obtained its energy through the resistance 35 and selector switch 22. In the circuit just described through the synchronizer full voltage is applied to the bucking coil 31, and the coil now creates sufficient opposition to stop the motor 27. Each portion of the resistance 35 is such that it permits operation of the motor 27 through the bucking coil 31 at a speed slightly higher than that of the corresponding cam of the resynchronizer 21 which is selected to go with that resistance. In this instance, the total resistance 35 is such that it will permit the motor 27 to operate at a speed slightly faster than that of the cam 67 which controls the switch 70 of the synchronizer. Normally, the arm 83 of the dial 24 will close the switch 80 just before the cam 67 opens the switch 70. Accordingly, the cycle timer 20 is synchronized once during every revolution of the dials by the synchronizer 21, with the motor 60.

In the circuits just described, it will be observed that because the total resistance 35 is cut in circuit with the braking or bucking coil 31, the motor 27 would run at comparatively high speed. Accordingly, a switch of the synchronizer is selected that is also opened and closed at a comparatively high speed. Accordingly, the cycle timer 20 may be operated at various speeds from headquarters by actuating the push buttons 49, 50, to select the speed desired and simultaneously, a corresponding resynchronizing circuit is selected whereby the cycle timer 20 may be periodically synchronized at the speed selected.

This perhaps would be better illustrated by tracing another circuit. Assume that the switch arm 37 of the selector 22 is rotated in a clockwise direction by the actuation of the push button 50 until the switch arm 37 engages the contacts 100, 101. We will now have only the first step of the resistance 35 cut into circuit with the braking coil 31. In as much as nearly full voltage is impressed across the coil 31, the braking effect will be comparatively great, and the motor 27 will run at a comparatively slow speed. Also, the resynchronizing circuit from contact 100 will be connected through synchronizing switch 68 which is operated by the single lobe cam 65 which opens and closes the switch 68 at comparatively long intervals. As assumed above, if the shaft 62 revolves once every 120 seconds, then the switch 68 will only be opened once every 120 seconds to resynchronize the cycle timer 20 which is now operating at approximately one revolution in 118 seconds.

It will be observed that the dials 24, 25, and 26, are all geared together at a 1 to 1 ratio, and operated at the same speed by the pinion 28 of the motor 27. The arms associated with the dials 25 and 26 open and close associated switches which actuate the circuit controller 23, as hereinafter explained.

Assuming the arms associated with the dials 25, 26, are set in the position shown in the drawings, and rotate in such positions with the dials,

it will be observed that by shifting the arms 83, 84, 85, the operation of the controller 23 and the traffic signals may be varied. To explain further: Assume switch 80 is connected in circuit with the wire 91, as shown in the drawings. If the arm 83 is now adjusted relative to the dial 24 in a clockwise direction, the next time the arm 83 comes into engagement with the movable contact of switch 80, the full voltage circuit will be completed through the braking coil 31, and the motor 27 will be stopped. This condition will prevail until the cam 67 of the synchronizer opens the switch 70.

In other words, the timer 20 will be stalled an amount of time equal to the distance that the arm 83 was advanced. After the cam 67 opens the switch 70, and the motor 27 starts, the timer 20 will then operate at its set speed and will be resynchronized once every revolution of the dial 24. However, the arms associated with the dials 25, 26, will now actuate the circuit controller 23 at a different time relative to the time that they did formerly before the variation of the arm 83.

It will now be observed that by shifting the arm 83, the relationship between the secondary controller and its neighbors will be varied. That is, assuming the secondary controller is at intersection B and normally the green light appeared ten seconds after the appearance of the green light at A intersection, with the adjustment of the arm 83, it may be made to appear five seconds later, or twenty seconds later.

To those familiar with the traffic signal art, this is known as the off-set which might be generally defined as the relative time the green light appears in each succeeding intersection in the system.

Heretofore, as set forth in my Patent No. 1,929,378, the secondary controller has been provided with one offset arm which could only be adjusted by the operator making the adjustment at each secondary controller.

In my present invention, I provide means whereby this offset may be varied from headquarters.

As previously explained, the switch 80 is connected to the wire 91 through armatures 87 and 88 being in engagement with their lower contacts, and the relays 89, 90, not being energized. If the relay 89 is energized, the switch 81 is connected through armature 87, which is then in engagement with its upper contact. When the relay 90 is energized, and its armature is in engagement with its upper contact, switch 82 is connected to the wire 91 through the armatures 88 and 87. Means is provided at headquarters for energizing either of the armatures 89, 90. One side of relay 89 is connected to the contact 105, and the corresponding side of the relay 90 is connected to the contact 106. The contacts 105, 106, are energized by the single pole doublethrow switch 107, the stationary contact of which is connected to the positive source of current. The arm 83 of the dial 24 engages the switch 80. The contact arm 84 only engages the switch 81, and the contact arm 85 engages switch 82.

When the secondary controller is installed at a street intersection, the arms 83, 84, and 85, are initially set to give the three most desired offsets. Obviously, any one offset may be chosen from headquarters by connecting in circuit any one of the switches 80, 81, 82, by operation of the switch 107. For example, the circuit including the switch 80 will produce an equal flow of traffic in both directions, as shown by the graph Figure 3. The selection of the circuit including the switch 81 will favor traffic moving, say to the North, as shown in Figure 4, while selection of the switch 82 and its circuits will favor traffic moving toward the South, as indicated in the graph of Figure 5.

I will now proceed to describe the circuit controller 23. This controller, as here shown, comprises a shaft 110 mounted in suitable bearings, not shown. On one end of the shaft is secured the rotor 111 of a motor which is driven by the coil 112. On the opposite end is an escapement mechanism which may be of any suitable design, or construction. As here shown, it comprises the escapement wheel 113, escapement 114, which is operated in one direction by the solenoid 115, and in the opposite direction by the spring 116. The coil 112 of the motor, and the coil of the solenoid 115 are connected in parallel so that they are both energized at the same moment. This mechanism revolves the shaft 110 one step upon energization of the motor coil 112 and the solenoid 115.

Obviously, any suitable step by step mechanism may be employed to rotate the shaft 110 in the desired manner. The circuit controller 23 may consist of any suitable switching mechanism operated electrically or mechanically.

The shaft 110 is provided with a plurality of cams. These cams operate switches which are connected in circuit with the respective traffic signals.

It is obvious that by substituting different shafts for 110 with different cam arrangements, or substituting different cams for those shown on the shaft 110, any desired sequence of operation may be obtained. For example, the circuit controller 23 is now shown with the amber, or caution, signal displayed in all four directions between signal changes, this because the amber signals of both streets are tied together by the wire 128a. By changing the contour of certain of the cams, or by differently connecting the switches 128, 131, the caution signal may be made to overlap, or appear simultaneously with the green at the end of the green period of duration, or overlap, or follow the red. Cam 120 operates the switch 121, which controls the green signal indication on the main street, through the wire 122. All of the signals are connected to a common return 123. The cam 124 controls the switch 125, which operates the red signal indication on the cross street, through wire 126. The cam 127 controls the switch 128 which in turn operates the amber on the main street through wire 129. The cam 130 controls the switch 131 which controls the amber on the cross street through wire 132. The cam 133 controls the switch 134, which operates the green signal on the cross street, through wire 135, and the cam 136 operates switch 137, which controls the red on the main street, through wire 138.

The shaft 110 is shown with the cam 133 closing the switch 134 displaying the green signal to the cross street, and the cam 136 closing the switch 137 which displays the red signal to the main street. Upon the next operation of the shaft 110, the switches 134, 137, will open, and the switch 131 will be closed by the cam 130 displaying amber, or caution, signal to both streets through the wires 132, 128a and 129. Upon the next succeeding operation of the shaft 110, the cams 120, 124, will close the switches 121, 125, displaying go signal to the main street, and red

signal to the cross street. The next succeeding operation will open the switches 121; 125, and close the switch 128, again displaying the amber signal, and the next succeeding operation again closing the switches 134, 137, displaying stop to the main street, and go to the cross street.

As stated previously, the coil 112 of the motor 111, and the solenoid 115, are energized by switches associated with the dials 25, 26, of the cycle timer 20. The dial 25 is provided with adjustable arms 140, 141, 142, and with a fixed pin 143. The pin 143 operates the switch 144, and the arms 140, 141, 142, operate the switch 145.

I will now trace the circuit through the switches 144, 145, and coil 112, and solenoid 115. Starting with the positive source (right center Figure 1) current is fed through the wires 146, 147, armature 148, wire 149, to the stationary contacts of switches 144, 145. These switches are normally open. Assuming now that the arm 140 engages the movable contact of switch 145, and closes the switch, the circuit now continues through wire 150, 151, motor coil 112, wire 152, back to the common side of the source. Current is also conducted through wire 151, solenoid 115, wire 153, to the common side of the source. As the coil 112 and the solenoid 115 of the escapement mechanism are now energized, the shaft 110 will be revolved one step, shifting the cams and operating the respective signal switches.

As previously stated, all of the arms 140, 141, 142, operate a movable contact of the switch 145. The switch 144 is operated only by the fixed pin 143. However, the circuit from switch 144 is carried through wire 154 to the stationary contact of switch 155 associated with the circuit controller 23, which switch is operated by the cam 156. If the cam 156 is in engagement with the switch 155, and the switch accordingly closed, a positive feed is then run to the coil 112, through the wire 158, and to the solenoid through wire 151, and back through wire 153, to the common side of the circuit. In other words, in order for the switch 144 to energize the coil 112 and the solenoid 115, the shaft 110 must be in such position that the cam 156 is closing the switch 155. The reason for this circuit is to keep the controller 23 in step with the cycle timer 20.

It will be observed that the cam 156 is secured to the shaft 110 in the same position as cam 130 which controls the amber signal, and when the shaft 110 is in this position, if the pin 143 operates the switch 144, the shaft 110 will be revolved one step which will close the switches 121, 125, displaying the go signal to the main street, and red to the cross street. In other words, if the controller 23 is in step with the cycle timer 20, actuation of the switch 144 by the pin 143 will close the circuit to the green light on the main street. Or, in other words, the fixed pin 143 controls the commencement of the green signal duration on the main street. If however, for any reason the controller 23 has become out of step with the cycle timer 20, the coil 112 will not be energized, and the controller 23 will miss a beat, and accordingly it will miss a beat once every revolution of the dial 25 until it has again become in step.

As previously stated, the arms 140, 141, 142, are adjustable relative to the dial 25. If the controller 23 is in step with the cycle timer 20, the fixed pin 143 will control the commencement of the green signal to the main street, red to the cross street; the arm 140 will control the commencement of the duration of the amber; the arm 141 will control the commencement of the go period to the cross street and the red to the main street; the arm 142 will again control the commencement of the duration of the amber. Accordingly, the duration of any period of the cycle, or total period, can be readily varied by adjusting the corresponding arm 140, 141, or 142.

Insofar as I am aware, in previous controller apparatus for progressive traffic signaling systems, the variation of the sub-periods, or what is known to those skilled in the art, as the change of split, was accomplished by making the necessary change at each secondary controller. In my present invention, I provide means for adopting any one of a plurality of splits from headquarters. As shown in the drawings, my circuit controller is provided with means for selecting one of two different splits. This is accomplished by utilizing either dial 25, or dial 26. Obviously, any number of additional dials might be employed as the particular traffic situation demanded. The dial 26 is provided with arms 160, 161, 162, which are similar to the arms 140, 141, 142, associated with dial 25. The dial 26 is also provided with a fixed pin 163 and associated with dial 26 are two switches 164, 165. The arms 160, 161, 162, operate the switch 165, and the pin 163 operates the switch 164 in the same manner as the arms and switches associated with dial 25. The arms 160, 161, 162, are initially adjusted relatively to each other in a different manner than the corresponding arms 140, 141, 142, of dial 25, so that by shifting from the switches 144, 145, to the switches 164, 165, a different split is obtained.

The means employed for switching from one set of switches to the other comprises a relay 166 which controls the armature 148. As shown, the relay 166 is not energized, and the armature 148 is in engagement with contact of the wire 149. The relay 166 is energized from headquarters by the switch 167, the movable contact of which is connected to positive side of the circuit, and when the switch 167 is closed, a circuit is made through the wire 168, to relay 166, and back through the common return 54. When the relay 166 is energized, the armature 148 is in engagement with a contact connected to wire 169 which disconnects the switches 144, 145, and connects the switches 164, 165 in circuit.

From the above description, it will be obvious that with my circuit controller, as here shown, it is possible to select from headquarters, one of three offsets, one of two splits, and one of several total periods. Generally speaking, changing the offsets has a tendency to increase, or decrease, the speed of operation of the progressive system in one direction. This is sometimes a material aid in handling a larger volume of traffic moving in one direction through the system. However, it is to be observed that the duration of the signals at each intersection is not affected. However, there is a practical disadvantage which sometimes renders such a change of little value. That is, the reduction in the width of the band of traffic. This will be understood by those skilled in the art. When the speed of the system is increased, say from twenty to thirty miles per hour, the useable portion of the green, or go, signal is shortened, or in other words, the length of the traffic platoons moved by the system is shortened. Where greater speed alone is desired, the adjustment of the offset is satisfactory. However, if in addition to increasing the speed of the regular flow of traffic, there is

also additional traffic at that time, for example, the traffic flow on the main street may be increased by heavy traffic turning in on the main street from one of the cross streets, then the adjustment of the offset does not solve the problem.

I have found that my control apparatus is very flexible and with it any traffic problem, of which I am aware, can be readily handled from headquarters. For example, the above situation can be taken care of by what is known as the extension of the green on the main street. By this is meant, leaving the previously allotted time to the cross street the same, and adding to the time allotted to the main street. This situation, I accomplish in the following manner: Assume that the arms 140, 141, 142 on dial 25 are set so as to effect a fifty-fifty split at a particular intersection, and the arms 160, 161, 162, are so relatively arranged that the split is sixty-fifty, favoring the main street. By operation of the push buttons 49, 50, at headquarters, a new total period is selected which is ten seconds longer than the period usually used with the dial 25. The switch 167 is then closed to switch over to the control switch associated with dial 26. By this means, I have increased the green on the main street ten seconds, and have not detracted from the red, or amber, period. It is understood that in this combination of operations, I obtain a result different from shifting from dial 25 to dial 26, or from changing the total period. The effect of changing the total period, or changing the splits, or changing the offsets, or a combination of any of these, can be observed with the aid of graphs, Figures 3 to 9 inclusive.

Figure 6 illustrates the flow of traffic with the green period increased at the intersections of 3rd Avenue, 5th Avenue, 8th Avenue and 10th Avenue, with the offset remaining the same, as shown in graph Figure 4.

Figure 7 is a graph showing the flow of traffic with the green on the main street increased at the intersections of 2nd Avenue, 4th Avenue, 6th Avenue, and 11th Avenue, with the same offset as shown in graph Figure 5.

From the above, the desirability of both increasing the speed of the system and broadening the respective traffic bands is at once apparent, and the desirability of effecting these changes from a central point is obvious. It is to be understood that the circuit controller 10 is not a necessity. Its function is to check the synchronizer 21, or in other words, to make a double check on the secondary controllers. The shaft 62 of the synchronizer 21 is provided with an additional single lobe cam 170 which operates switch 171 which is normally open. This switch is connected in circuit with an electromagnet 172 which operates an armature 173 which in turn, when operated, engages a stop 174 on the motor 60. A positive source of current at headquarters is taken from the wire 51 through switch 16 which is normally closed by the cam 13, wire 175, through switch 171, when closed, electromagnet 172, wire 176, to the common return 54. Both of the motors 11 and 60 are synchronous motors, and as they operate on the same frequency, they normally will remain in step with each other. However, if for any reason the motor 60 becomes out of step with the motor 11, the circuit will be completed through the electromagnet 172 by operation of the switch 171 by the cam 170. This will pull the armature 173 into engagement with the stop 174 and stop the motor 60 until the circuit is broken by the movable contact of the switch 16 dropping into the valley of the cam 13. This provides an additional check on all the synchronizers. However, as all of the motors 60 of the synchronizers 21 are synchronous motors, there is very little likelihood of their becoming out of step, and for this reason the system will continue to operate in step if for any reason the circuits running from any of the secondary controllers become open, or out of order. In such instance, the secondary controller will operate on the split determined at the time such circuits become open. The offset would be that determined by the arm 23. In other words, the same as if switch 107 was in the position shown (open), relays 89, 90 being deenergized.

For convenience, an indicating device may be also added at headquarters to indicate, at any instance, the position of the selector 22 and therefore indicate the total period at which the system is at that instance operating. Such a device is indicated at 201, and may be of any suitable design or construction. For example, it could be of the same construction as the selector 22, except the switch arm 37 would be replaced with the pointer 202. This indicating device 201 is connected in circuit with the wires 52, and upon operation of the push buttons 49, 50, the pointer 202 will indicate the position assumed by the switch 37 of the selector 22.

What I claim is:

1. In a synchronizing system, a first constant speed motor, a second motor, a circuit for energizing said second motor including an impedance for controlling the speed of said second motor, means to vary said impedance to select the speed of operation of said second motor, circuit means to synchronize the two said motors to rotate at each of a plurality of predetermined speed ratios at a particular phase relation, said last means including switches capable of selective connection in said circuit means and means operated by said first motor for cyclically operating said switches, each at predetermined periods, means operated by said impedance varying means to connect in said circuit means the one of said switches that maintains said motors in synchronism at the speed ratio corresponding to the amount of impedance simultaneously connected in said circuit by the impedance varying means.

2. In a traffic control system having a central station for flexibly controlling progressive traffic through a plurality of intersections and also having at each intersection: stop and go traffic signals, a first constant speed motor, a second motor, a circuit for energizing said second motor including an impedance for controlling the speed of said second motor, means to vary said impedance to select the speed of operation of said second motor, circuit means to synchronize the two said motors to rotate at each of a plurality of predetermined speed ratios at a particular phase relation, said last means including switches capable of selective connection in said circuit means and means operated by said first motor for cyclically operating said switches, each at predetermined periods, means operated by said impedance varying means to connect in said circuit means the one of said switches that maintains said motors in synchronism at the speed ratio corresponding to the amount of impedance simultaneously connected in said circuit by the impedance varying means, and means operated by a predetermined number of revolutions of said second motor regardless of its speed

for alternately displaying in a predetermined ratio said stop and go signals in a single cycle whereby variations of speed of said second motor vary the total period of said cycle.

3. In a traffic control system having a central station for flexibly controlling progressive traffic through a plurality of intersections and also having at each intersection: stop and go traffic signals, a first constant speed motor, a second motor, a circuit for energizing said second motor including an impedance for controlling the speed of said second motor, means to vary said impedance to select the speed of operation of said second motor, circuit means to synchronize the two said motors to rotate at each of a plurality of predetermined speed ratios at a particular phase relation, said last means including switches capable of selective connection in said circuit means and means operated by said first motor for cyclically operating said switches, each at predetermined periods, means operated by said impedance varying means to connect in said circuit means the one of said switches that maintains said motors in synchronism at the speed ratio corresponding to the amount of impedance simultaneously connected in said circuit by the impedance varying means, and means operated by a predetermined number of revolutions of said second motor regardless of its speed for alternately displaying in a predetermined ratio said stop and go signals in a single cycle whereby variations of speed of said second motor vary the total period of said cycle, said circuit means also includes switches periodically operated by said second motor and selectively connected in said circuit means to determine the particular phase at which the said motors will be synchronized, means to connect selectively the last said switches in said circuit closers whereby the signal offset at a plurality of intersections can be controlled.

4. In a traffic control system having a central station for flexibly controlling progressive traffic through a plurality of intersections and also having at each intersection: stop and go traffic signals, a first constant speed motor, a second motor, a circuit for energizing said second motor including an impedance for controlling the speed of said second motor, means to vary said impedance to select the speed of operation of said second motor, circuit means to synchronize the two said motors to rotate at each of a plurality of predetermined speed ratios at a particular phase relation, said last means including switches capable of selective connection in said circuit means and means operated by said first motor for cyclically operating said switches, each at predetermined periods, means operated by said impedance varying means to connect in said circuit means the one of said switches that maintains said motors in synchronism at the speed ratio corresponding to the amount of impedance simultaneously connected in said circuit by the impedance varying means, and means operated by a predetermined number of revolutions of said second motor regardless of its speed for alternately displaying in a predetermined ratio said stop and go signals in a single cycle whereby variations of speed of said second motor vary the total period of said cycle, said circuit means also includes switches periodically operated by said second motor and selectively connected in said circuit means to determine the particular phase at which the said motors will be synchronized, means to connect selectively the last said switches in said circuit closers whereby the signal offset at a plurality of intersections can be controlled, means for selecting the said ratio of stop and go signals in said cycle whereby the signal split is controlled, and means at said central station for operating said impedance varying means, offset varying means and split varying means for the various intersections.

5. A traffic control system for flexibly controlling progressive traffic through a plurality of intersections and having at each intersection: stop and go signals, a variable speed motor, a power circuit for controlling said motor including a plurality of means, each of which is effective to operate said motor at a different rate of speed, a constant speed motor, a plurality of switches operated by said constant speed motor, each of said switches being operated at a different rate of speed, a control circuit, means operable to render any predetermined one of said means in the power circuit of the variable speed motor operable and to simultaneously connect any predetermined one of said switches in said control circuit, said control circuit also including means operable to periodically synchronize said variable speed motor with said switch connected in said circuit, and a timer operated by said variable speed motor for cyclically displaying said stop and go traffic signals.

6. A traffic control system having a central station for flexibly controlling progressive traffic through a plurality of intersections and also having at each intersection: stop and go traffic signals, a variable speed motor, a power circuit for controlling said motor including a plurality of means, each of which is effective to operate said motor at a different rate of speed, and said means being capable of selective connection in said circuit, a constant speed motor, a plurality of switches operated by said constant speed motor, each at a different rate of speed, a control circuit, means operable to connect any predetermined one of said means in the power circuit of the variable speed motor and to simultaneously connect any predetermined one of said switches in said control circuit, said control circuit also including a plurality of switches periodically operated by said variable speed motor and each being selectively connected in said control circuit and operable to periodically synchronize said variable speed motor with said switch operated by the constant speed motor and connected in the control circuit at a predetermined phase relation therewith, means operable at the central station for connecting any one of said switches operated by the variable speed motor in said control circuit, and a timer operated by said variable speed motor for cyclically displaying said stop and go traffic signals.

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