

March 5, 1935.

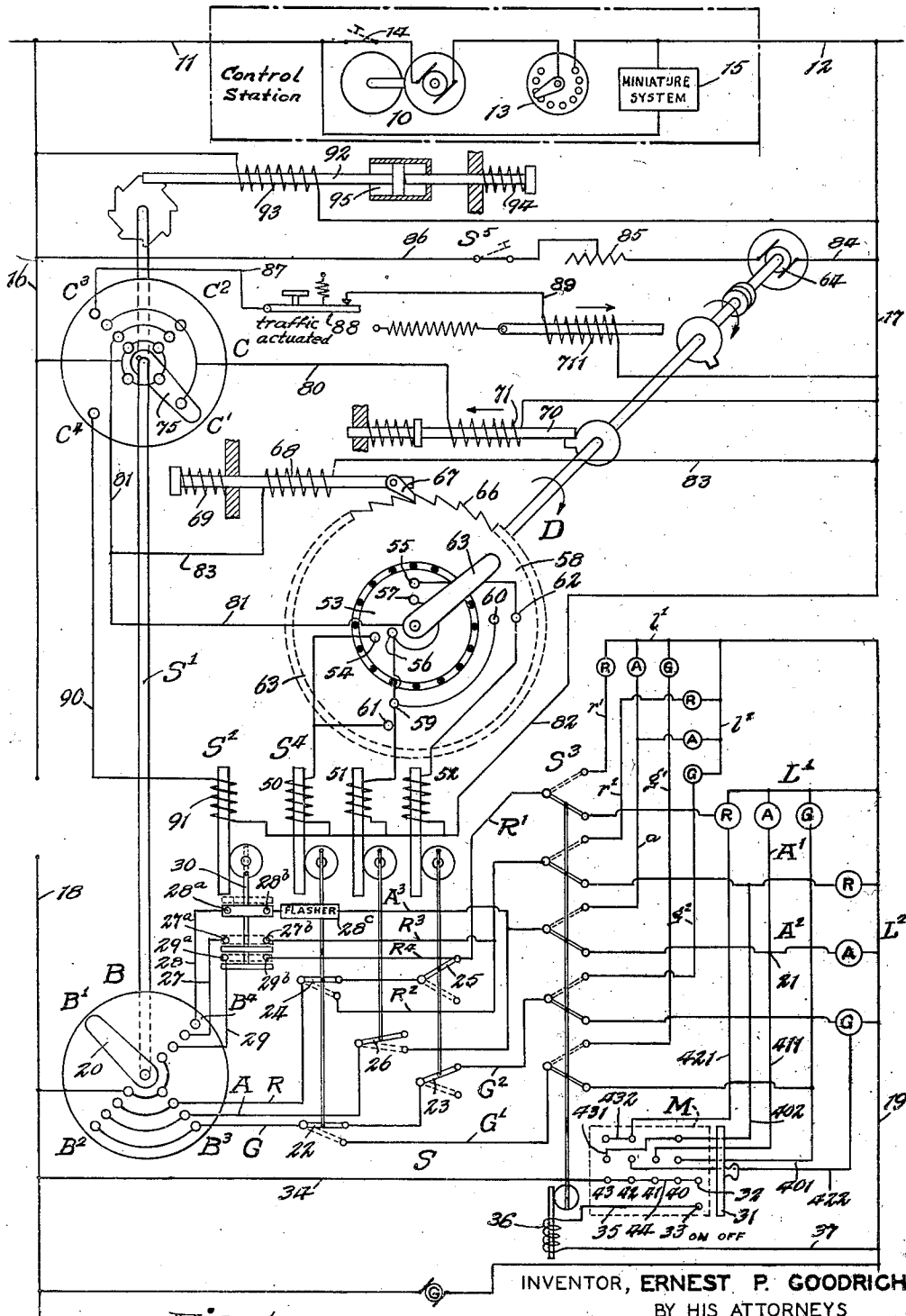
E. P. GOODRICH

1,993,056

SIGNALING SYSTEM

Filed Oct. 12, 1928

3 Sheets-Sheet 1



INVENTOR, **ERNEST P. GOODRICH**
BY HIS ATTORNEYS

Howson and Howson

March 5, 1935.

E. P. GOODRICH

1,993,056

SIGNALING SYSTEM

Filed Oct. 12, 1928

3 Sheets-Sheet 2

Fig. 2.

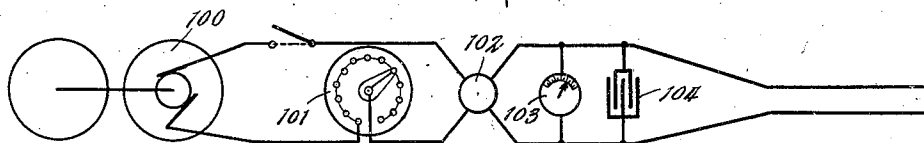


Fig. 3.

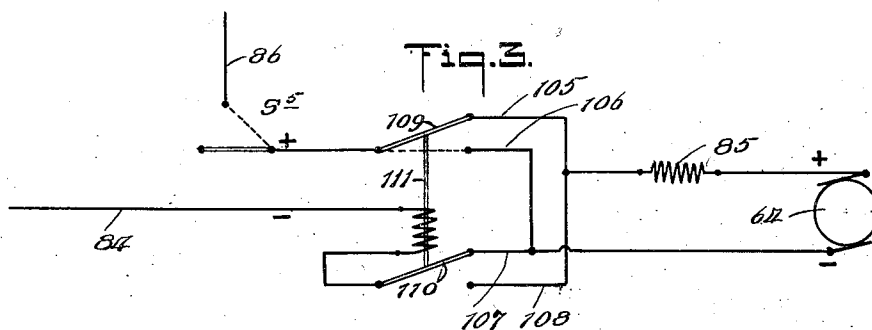


Fig. 4.

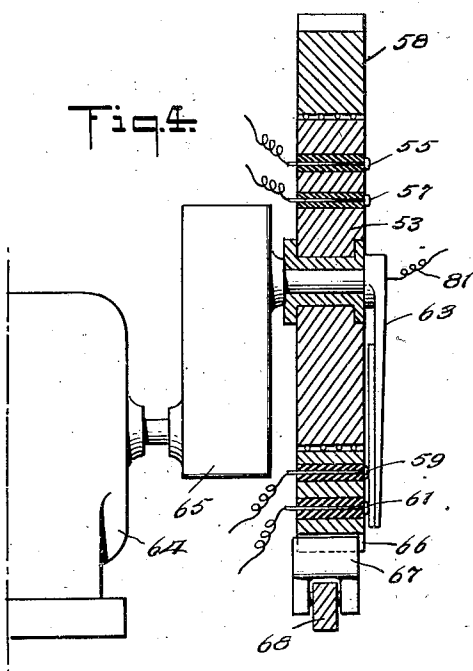
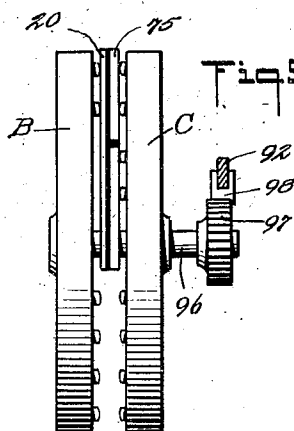


Fig. 5.



INVENTOR
ERNEST P. GOODRICH

by his attorneys

Howson and Howson

March 5, 1935.

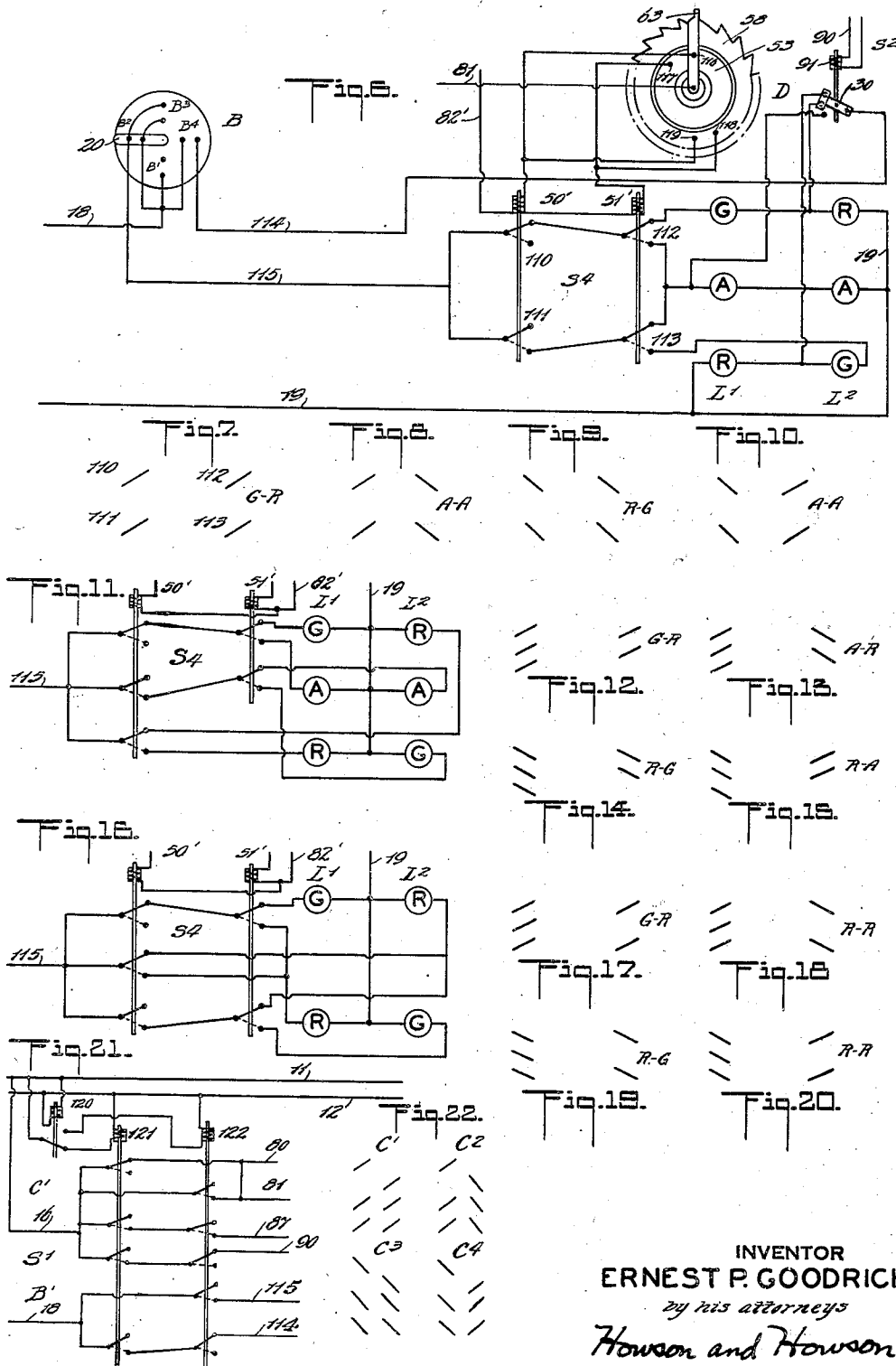
E. P. GOODRICH

1,993,056

SIGNALING SYSTEM

Filed Oct. 12, 1928

3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

1,993,056

SIGNALING SYSTEM

Ernest P. Goodrich, Brooklyn, N. Y.

Application October 12, 1928, Serial No. 312,171

17 Claims. (Cl. 177—337)

This invention relates to signaling systems and in particular it is concerned with signaling systems used for traffic control.

The present application is a continuation in part of my application Serial No. 117,560 filed June 21st, 1926.

One object of this invention is to provide an electrically controlled system capable of giving signals at one or more stations and subject to control from a central station. It is also an object to provide an automatically operating system for giving signals at a number of stations, the system being capable of having each station removed from the central control and subjected to local manual control and capable also of adaptation by control from the central station to suit differing conditions in the area affected by the signals. A further object is to provide a system which will require a minimum of wires and will avoid altogether the use of power circuits other than one main circuit through the signal stations.

It is also an object to adapt such a system to the control of traffic and to make provision therein for variation in the operation to suit the varying conditions of traffic during the day and night.

Finally it is an object to simplify and to render more flexible the control of signaling systems and to improve the construction of certain of the operating parts of such systems.

The invention is described hereinafter as embodied in a preferred type of traffic control system and is so illustrated in the accompanying drawings.

In the drawings—

Figure 1 is a diagram of the main A. C. power line for a unified traffic control system and of a complete signal light operating unit for any one street intersection.

Figure 2 is a diagram of the main power circuit showing a similar system adapted for operation by direct current.

Figure 3 shows a reversing switch to maintain uni-directional current through a direct current motor for use when the system is operated on direct current.

Figure 4 is a view, partly in vertical section, showing a construction of distributor.

Figure 5 is a view showing a construction of the main control switch.

Figure 6 shows a modification of a part of the system to give a different type of signaling from that given by the modification of Figure 1.

Figures 7, 8, 9 and 10 are schematic representations of the successive positions of the unit switches of the alternator shown in Figure 6, during one cycle of signal combinations.

Figure 11 shows another modification of the

alternator to give a different type of signaling.

Figures 12, 13, 14 and 15 are representations of the successive positions of the unit switches of the alternator of Figure 11 during one cycle.

Figure 16 shows another alternator giving still another type of signaling and Figures 17, 18, 19 and 20 represent a cycle of its alternator switch positions.

Figure 21 shows a modified main control switch, an alternative of that shown in Figures 1 and 5, and the manner of connecting it in the system.

Figure 22 represents the selective positions of the two groups of switch units forming one controller which is a part of the main switch shown in Figure 21.

The thought which underlies this invention is the provision of a single main circuit through all the signal stations, the selective establishment at each station, by mechanism controlled from a central station, of feeder circuits for operating the signaling devices to give different types of signaling, and the governing of the respective signal circuits by a motor driven distributor and other control switches at each station, these governing devices being operated from the main supply line and controlled by variation of electrical conditions therein. The governing of the respective signal circuits thus selectively established includes the determining of the frequency and the relative duration of the signals given.

The motor driven distributing switch and similar switches at each station are themselves subject to energization and control from the central station through the main circuit and in like manner the switch for selectively establishing the signal circuits is controlled from the central station. The controlling switch at each station for selecting as between the motor controlled distributor and the other devices whose function is to govern the signal circuits, and also the switch which selectively establishes the signal circuits are synchronized so that for each type of signal circuit established, there will also be established the proper circuits from the main power line through the motor driven distributor and its associated devices to govern that particular signal circuit in the desired manner. Although the several signaling stations are on the same supply line and are thereby subject to simultaneous control from a central station, yet provision is made for individual control of any one signaling station at that station when desired.

By such a system, uniformity and synchronization of operation of signals at a number of stations are obtained, an economy in apparatus, conductors and the like is effected and a flexible system is provided that is capable of being suited to differing conditions in the area affected by the signals and is subject to control from a central station.

The power to operate the controls throughout the traffic control system here described is derived from a variable speed, constant voltage A. C. generator 10 which feeds to the two-wire line 11, 12. In this line, at the central station with the generator, are the rheostat 13 for varying line voltage, the disconnecter switch 14, which may be manual or automatic, and the indicator 15 which may comprise a miniature of the system to show its operation and condition at any instant.

At each street intersection is a set of lights L¹, L², each set being made up of a group of lamps designed to flash red, amber or green, or certain combinations of these colors. The lamps of the two sets are so inter-related that they give different color combinations forming signal units. The group L¹ faces traffic on the main street and the group L² faces cross street traffic. The lamps may have lenses on opposite sides or there may be two identical groups in each set, each two groups being faced oppositely on the street they control.

Two independent controls are provided for each set of lights L¹ and L². There is a manual control M located at each intersection to control the signals at that intersection individually and an automatic control, the mechanism of which is mainly at the intersection, but this automatic mechanism is subject itself to control by the operator at the central station, such control being coincident at all stations in the system.

At each station, there are a number of signal circuits leading to the lights L¹ and L² from a source of power which may be the line 11, 12 or it may be separate as shown here at lines 18 and 19. When a separate source is availed of for the lights at each station, it may be either A. C. or D. C. regardless of which is used in the main power circuit. These feeder circuits for the lights are selectively established and are primarily governed from the central station by the dial B of switch S¹ which determines the type of signaling which is in use at any one time, selecting from among constant one-color light, one-color light subject to flash, and different color combinations alternating at regular intervals. The respective circuits thus selectively established by dial B are subject to secondary control, or government after establishment, by relay switches S², S³ and S⁴. The circuits energizing the relay coils of switches S² and S⁴ are fed and controlled from the main circuit 11, 12 and the relays operating the switches S² and S⁴ are selectively established in circuit by the dial C of the switch S¹. Thus, as each signal circuit means is established by the dial B to effect a predetermined type of signaling by the lamp sets L¹ and L², the appropriate governing means therefor is connected to the main circuit by the dial C.

The switch S⁴ may be termed an alternator switch since, when its operating means is put in the circuit by the dial C, it governs the signal circuits correspondingly established through the light sets L¹ and L² by the dial B, to give alternate red and green with intermediate amber at regular intervals. By varying the details of the switch S⁴ and of its control means, the distributor D, various combinations of red, green and amber or of any of them may be effected. This alternator is operated by relays successively energized by circuits under the control of the motor driven distributor D the circuits for which are established by the dial C of the switch S¹ from the power lines 11, 12.

The system will now be described in greater detail.

The main power line, which preferably is a two-wire line 11, 12, extends the length of the highway and, at each intersection on the highway, lines 16, 17 lead from it to operate the local devices for governing the signal circuits, which themselves are established either from a local source or from the power lines 11, 12 as may be convenient.

The feeders 18, 19 for the light circuits are shown here as for connection to a local source. Feeder 18 is connected to dial B of switch S¹, this dial having four series of contact plugs arranged radially. An arm 20 is turned on the dial B, in a manner to be described, to bridge successively each of the four radial series of plugs designated as positions B¹, B², B³ and B⁴ of the arm. Feeder 18 leads to the inner plug of each of the plug series B², B³ and B⁴, but as shown, not to that of B¹ as that is the "off" position. It may, however, be connected to the inner plug of B¹.

From the outer three plugs of series B² and B³, the wires R, A and G lead to the alternator S⁴, where wires R and G branch. From these, the branches R¹ and R² lead to the red lamps of the sets L¹ and L² respectively and branches G¹ and G² lead to the L¹ and L² green lamps in like manner. Wire A after passing through switch S³ branches at 21 and its branches A¹ and A² lead to the amber lamps of the sets L¹ and L².

At the juncture between these main light feeders and their branches, the alternator S⁴ interposes switches shown diagrammatically. These switches are of known type in which each movement of the actuator element in one direction produces a reversal of the switch arm position, the opposite movement of the actuator being idle. Such a switch is known and, of itself, forms no part of this invention. The actuator, it is noted, moves back to rest position after each operating movement. It will be understood that the drawings in this respect are schematic and not a true depiction of the switch structure but only of its function.

Of the component switches of the alternator S⁴, switches 22 and 23 control the G¹ and G² branches, switches 24 and 25 control the R¹ and R² branches and switch 26 is inserted in the A line. In the positions of the various switch arms shown, the G and G² conductors are connected and also the R and R¹. The manner in which these switches are successively operated to cause the cycle of signal combinations to be displayed and to be repeated regularly as long as may be desired will be described hereinafter.

The parallel lamp circuits are completed by the connection of all of the lamps to the feeder 19.

From the three outer plugs of the B⁴ series on dial B, wires 27, 28 and 29 lead to a two position constant light switch S², wires 27 and 29 connecting to the plugs 27a and 29a respectively on one side of the switch and wire 28 connecting to the plug 28a on the other side. A bridging contact 30 moves between the two switch positions bridging the contacts 27a and 27b and 29a and 29b in one position and 28a and 28b in the other. It does not connect the plugs 29a and 27b as it has an insulating portion between its two conducting portions.

From the plug 27b a line R³ connects with the line R², and from the plug 29b a line R⁴ leads to the line R¹, the two plugs being thereby con-

connected to the red lamps of L^1 and L^2 . With the bridging contact 30 in the position shown in dotted lines a circuit is established in which red shows on both streets. This is used when all traffic is to be stopped, as for instance to make way for fire apparatus.

To effect a flashing on both streets, a line A^3 connects the plug 28b with the line A to establish a circuit through both of the amber lamps when the bridging contact 30 is in position, shown in full lines, bridging the plugs 28a and 28b. There is provided, in line A^3 , a flashing device 28c of known type for automatically making and breaking the circuit through the line A^3 in response to current flow therein. If a constant amber light were desired, a shunt could be provided around the flasher 28c.

The switch S^2 is of the same type as that described as being used in the units of the alternator S^4 . Its actuation and control will be described hereinafter.

Associated with the lamp circuits at each local station is a tell-tale panel of lamps I^1 , I^2 , duplicates of the sets L^1 and L^2 but of miniature size. This panel is connected to a switch S^3 having arms forming a portion of each line, R^1 , R^2 , A, G^1 and G^2 , in such a way that upon shifting of S^3 , each of the component arms of the latter is moved to the dotted line position shown, thus transferring the circuits established by the dial B through the R^1 , R^2 , A, G^1 and G^2 leads to a connection with the tell-tale leads r^1 , r^2 , a, g^1 and g^2 and with the lamps I^1 , I^2 instead of with lamps L^1 and L^2 . Switch S^3 is actuated by a solenoid 36 and is of the same general type as the switches S^2 and S^4 . Upon each energization of solenoid 36 the arms are shifted from one position to the other.

This transfer of the light circuits to the miniature lamps is effected by moving the switch arm 31 of the manual controller M to cover the plugs 32 and 33 on the panel of the controller thus closing a circuit from the feeder 18, through the wires 34, 35, the solenoid 36 and the wire 37 connected to feeder 19, causing the energization of the solenoid 36 and a movement of the actuator arm to shift the arms of the switch S^3 . The panel of lamps I^1 , I^2 , should be mounted in a position in which they are readily visible to the person operating the hand lever 31 by which the local station may be controlled independently of other local stations while the automatic control is transferred to the miniature lamp set.

Wires are also provided to feed the lamps L^1 and L^2 and to give a manual control of them when the automatically governed lamp circuits are transferred to the tell-tale lamps I^1 , I^2 . These wires lead to the panel which carries the plugs 32, 33 and on which also are four sets of contact plugs 40, 41, 42 and 43 each having a plug connected by a bus 44 and to the feeder 34 which leads from the main light feeder 18. The wires 401, 402 form a circuit from the bus 44 through the plugs 40 and through the green L^1 lamp and the red L^2 lamp to feeder 19. In like manner, the wires 421 and 422 connect the red L^1 lamp and the green L^2 lamp through the plugs 42. Wire 411 connects both amber lamps through the plugs 41, and the wires 431 and 432 connect both red lamps to the plugs 43, the latter connection thus duplicating the effect of the wires R^3 and R^4 in the automatic control.

It will be apparent that upon swinging the arm 31, the first operation is to shift the switch S^3 by bridging the contacts 32, 33. The automati-

cally controlled circuits are thereby transferred to the tell-tale panel and the main lamps are left subject only to manual control. Further movement of the arm 31 bridges in turn the plugs 40, 41 and 42 completing the several circuits described just above and giving green, amber and red in succession on the main highway and red, amber and green respectively on the cross street. The operator can see from the tell-tale panel the condition of the automatic system and can suit local signals thereto.

For clearing the intersection for fire apparatus, the arm 31 is put fully over to the right bridging the plugs 43 and establishing a circuit through both of the red lamps.

To put the system back under automatic control, the operator has simply to swing the arm 31 fully back, the bridging of 32, 33 on the way giving an impulse to the relay 36 which will cause it to shift the switch S^3 , and to put its switch arms back in the position shown in full lines. By watching the tell-tale panel, the operator can put the local station back in proper synchronism with the whole system.

Assuming the arm 20 on the dial B of switch S^1 to be in either the B^2 or the B^3 position establishing the R, A, G circuit for normal traffic conditions, the operation of the alternator S^4 will occur as now will be described.

The alternator, as stated above, comprises several switches having relay actuators 50, 51, 52 which shift the switch arms when the actuators are moved in a single direction. The actuators are three in number, one 50 for the switches 22 and 24, one 51 for the switch 26, and the third 52 for the switches 23 and 25. It is to be noted that the switches 22 and 24 have two "on" positions, while the switches 23, 25 and 26 have an "on" and an "off" position. The effect of this upon the signal light sequence will appear hereinafter.

The relays are in circuits connected to the main power feeders 16, 17 and established by the upper dial C of the switch S^1 . These circuits include also the motor driven distributor D designed to cause energization of the three relays in predetermined succession.

The distributor D comprises a fixed ring 53 having concentric circular slots in which contact plugs are adjustably secured. In the outer slot are two mutually insulated plugs 54, 55, and in the inner slot, two other insulated plugs 56, 57.

In like manner, in slots in a movable ratchet toothed ring 58 surrounding ring 53, there are four insulated plugs, those designated 59 and 60 being mutually insulated in the inner slot and those designated 61 and 62 being in an outer slot.

Referring to Figure 4, an arm 63 carrying a contact piece to engage these plugs in passing is rotated by the electric motor 64 through the slip clutch and reduction gearing 65. The contact arm is secured to its drive shaft by a connection permitting relative movement between the two if the arm is arrested but affording sufficient friction so that when not positively arrested the arm will be rotated. The arm is electrically connected to one side (11) of the power circuit by the wire 81 and in bridging the several contact plugs successively completes circuits in which are the relays 50, 51, 52. The latter are connected to the side of the power line (12) of opposite polarity by the wire 82.

The contact plugs 55 and 62 are connected with the relay 52, plugs 54 and 61 with relay 50, and 75

the four plugs 56, 57, 59 and 60 are connected with relay 51 in the manner shown.

As the arm 63, rotating clockwise, passes over the plugs, circuits are successively completed through the several relays causing movement of the switch actuator elements at predetermined intervals. As an example, arm 63 is shown as having just engaged plugs 57 and 55 causing the energization of relays 51 and 52 and the movement of the switch arms 23, 25 and 26 to positions shown. This interrupts the circuit of the amber lamps of the sets L¹ and L² and closes the lines G² and R¹. It may be assumed that at this time the switches 22 and 24 are in the positions shown putting the lines G² and R¹ in circuit giving a red light on the main street and a green light on the cross street.

When the arm 63 has turned further it engages the plugs 60 and 62 and completes the circuits by which the relays 51 and 52 are again energized, this time to open the switches 23 and 25 and to close the switch 26. This causes amber to show on both streets, interrupts the circuits causing red and green to show and gives warning that traffic is to change.

Shortly thereafter, the arm 63 reaches the plugs 59 and 61 and energizes the solenoids 50 and 51, causing the shifting of switches 22, 24 and 26, to cut out the amber circuits because switch 26 is put in open position and to bring the G¹ and R² lines into connection with the main G and R lines through the switches 22 and 24 respectively.

When the arm 63 passes the plugs 54 and 56, the relays 50 and 51 are energized to shift the switches 22, 24 and 26. By this, the lines G¹ and R² are cut out by the change of position of the switches 22 and 24 and the A circuit is closed by the closing of the switch 26.

Then, when the arm 63 bridges the plugs 55 and 57, the switch 26 is opened and the switches 23 and 25 are put in position to encircuit the lines G² and R¹ as described above.

It will be seen that this cycle as described involves a period of red light on the main street with green on the cross street, followed by a period of amber light alone on both, and following that, a period of green light on the main street with red on the cross street. In the succeeding period, there is amber light alone on both streets just preceding the change to red on the main street with green on the cross street.

At this point, it will be observed that the arrangement of circuits from the panel of the manual control M is such that as the arm 31 is moved from left to right, a cycle of signals is given corresponding to that caused by one rotation of the arm 63 from its position bridging contact plugs 59 and 61.

The above cycle of changes may continue to be repeated as long as traffic conditions warrant. At certain times, it is desirable to give a longer period of permitted traffic movement on one street than on the other. The present system provides for this by a ratio changer for varying the relative duration of the red and the green light. The variation is effected by changing the angular spacing of the plugs in the distributor D.

The outer ratchet toothed ring 58 carrying the contact plugs 59, 60, 61 and 62, which determine the ending of the period of green light on the main street, is rotatable with respect to the inner ring 53 to vary the angular spacing between the said plugs and the other plugs on the ring 53. To effect the rotation, the ring 58 has its outer edge toothed, as at 66, and with it is associated a pawl 67, driven by a relay actuator rod 68 in

one direction and by a spring 69, in the other. The relay is in a shunt between the feed line 17 and the wire 81 which leads through the dial C to feed line 16 and is adapted to be operated by a momentary drop in voltage in the main circuit 11, 12.

The distributor D is provided with an interrupter dog 70 normally held radially outward by a relay but it is adapted to be moved inwardly into the path of the arm 63 by a spring whenever a drop occurs in the voltage of the current in the relay. Since the arm 63 is connected to the drive shaft by a slip connection, when the dog arrests the arm the drive shaft continues to turn.

Each arrester unit comprising a dog 70 and a relay 71 is adjustably mounted on an annular member outside the ring 58 so that by having the dogs on the several local units along the highway at predetermined positions with respect to their respective contact plugs, the whole system may be synchronized by arresting all the arms and then releasing them simultaneously. On the other hand, if the angular spacing between the arrester dog and the contact plugs is varied progressively from station to station, then when all of the arms are released simultaneously, the arms start in different parts of the cycle. Rotating at uniform speed the arms maintain this difference and cause the cycles of signals at the several stations to differ in phase. The system thus may be made to give progressive signals of the "wave" type, so-called, now in vogue.

The circuits through the distributor D and the relays 50, 51 and 52 are established by the upper dial C of the switch S¹. This dial has four radial series of contact plugs giving four positions for the movable contact arm 75.

In position C¹, the arm 75 bridges two plugs and forms a circuit from the power line 16 through the wire 80 and the relay operated arrester 71 to the power line 17, thus bringing the arrester under control and holding it outward, free of the arm 63. In this C¹ position, no power is supplied to any other part of the local system except to the motor 64 thru lines 84, 86 which are independent of the dial C.

After having shut off the power in wires 11, 12, as may occur during night hours, for repairs or for any other reason, the switch 14 can be opened, generator 10 brought into full operation, resistance thrown into the line by rheostat 13 and switch 14 closed. The low voltage thereby maintained in wires 11, 12 by the rheostat 13 will not actuate the relays 71 at the several stations to move the arrester dogs outward though the motors 64 are operating normally. Operation of the rheostat 13 so as to cut out the resistance and raise the voltage in wires 11, 12 will then simultaneously operate the relays 71 in all the local systems so that the distributor arms 63 will start to operate simultaneously in proper phase relation. In this first position, however, no signals are given because C¹ on dial C corresponds to B¹ on dial B. It is merely a preparatory stage.

In position C² three plugs are bridged and a circuit is established from the line 16 through the wire 81 and thence to the centre of the distributor arm 63. Depending on the position of the arm 63, the current passes through some or others of the plugs on rings 53 and 58 or it is interrupted while the arm 63 is moving between plugs. When closed, however, by engagement of the arm and the plugs, the circuit includes, one, two or all, as the case may be, of the solenoids 50, 51, 52 and is completed to the power line 17 by the wire 82.

The C² position also establishes a circuit from line 16 through the innermost plug on the dial C, through the line 80 and the arrester relay 71 to the line 17 thus keeping the arrester under control. With normal current and voltage, the relay 71 holds the arrester dog outward, but upon drop of voltage, the dog is urged inward by its spring to arrest the arm 63 at the predetermined point in the signal cycle.

In a shunt 83 from the line 81 to the power line 17, is the low voltage relay 68 for the ratio changer.

The motor 64 is in a circuit not controlled by the dial C but consisting of a wire 84 from the line 17 through a wire to the motor windings and thence through a resistance 85, a hand switch S⁵ and the wire 86 connected to the line 11. Thus, the motor 64 at each station is energized whenever the generator 10 is operating, unless the switch S⁵ is opened to cut out the motor at that particular local station. The resistance 85 is variable to maintain uniform voltage across all of the motors in the system by compensating at the stations near the source of power for the drop in impressed voltage through the system.

In the C³ position of arm 75, the circuit through the distributor is established as in the C² position and, in addition, a circuit is established from the line 16 through the wire 87, the highway crossing switch 88, and the wire 89 to the relay of a second arrester 711 and to the power line 17.

The highway crossing switch 88 in the circuit is placed in the cross street in a position to be operated by a passing autoist by reaching from his car or in any other suitable manner. This switch is held closed by a spring, and so returns to closed position automatically after being opened by a passing autoist.

Upon opening of the circuit by opening the switch 88, the dog of the arrester unit 711 is momentarily withdrawn by the spring and the arm 63 is released to be turned one revolution giving one cycle of lights. The switch 88 is closed again in the meantime by its spring, thus giving effect again to the current through the relay 711 which causes the dog to be inserted again in the path of the distributor arm. Thus the red signal is given on the main street and the green on the cross street, giving the person a chance to cross the main street in safety. The relay 711 is to be so located with respect to the contact plugs that except when someone so operates switch 88, the system is static with green showing on the main street and red on the cross street.

In the C⁴ position of the arm 75 on the dial C, a circuit is established from the line 16 through the wire 90 and the relay 91 of the low-voltage relay switch S² and thence to the line 17, thus bringing the switch S² under control from the central station. Normally, when in the C⁴ position, the switch S² will be in the dotted position, giving red lights on both streets. If a flashing light is desired, the central station operator merely throws resistance into the power lines 11, 12 by means of the rheostat 13 and the low-voltage relay 91 moves the arm 30 to the position bridging the plugs 28a, 28b. A second drop in voltage created by operation of the rheostat will actuate the relay to return the bridging contact to the position in which it bridges the plugs 27a, 27b and 29a, 29b.

The two dials B and C are actuated in synchronism so that their four positions correspond each to each as numbered, B¹ to C¹ etc. The common actuator is similar to that for the other

relay switches described, consisting of an arm 92 adapted to move the contact arms 20 and 75 from one position to another upon each impulse given to the solenoid 93 of a no-voltage relay. The non-driving return movement of rod 92 is effected by a spring 94. If desired both movements may be retarded by a dash pot 95 so that a low voltage delayed action relay may be used without being affected by the operation of the quick acting relays 68, 71, 711 and 91.

The following summary shows the effect of the several positions of the switch S¹ upon both the control circuits established by the dial C and the signal circuits established by the dial B. It will be recalled that the motors 64 at all of the stations are operating whenever the main circuit 11, 12 is energized, assuming that the switch S⁵ at each station is closed, and that the corresponding switches at all the stations operate simultaneously.

Position I

B. No light circuits are established.

C. With the rheostat 13 causing reduced voltage and current, the dogs 70 in the arrester units at the various stations are pressed downward by their springs as shown in Fig. 1 to arrest the distributor arms 63, and to bring all of the stations to the proper point for starting a series of signal cycles. When normal voltage is restored in the main circuit 11, 12, the arrester dogs are held outward and the distributor arms 63 at the several stations are left free to rotate in the predetermined phase relation. This C¹ position may be maintained while the motors 64, if synchronous or single phase A. C. motors, may be brought to speed by known mechanical means. In the C¹ position of the dog of the relay 711 is withdrawn so that it can not interrupt the operation of the distributor D.

Position II

B. The R, G, A, circuits are established for giving alternating signal combinations on both the main and the cross streets in a regularly repeating cycle.

C. At each station, the arrester dog 70 is withdrawn. The ratio changer is in circuit so that it can be operated upon momentary drop in voltage. The circuit is established through the distributor arm 63 and the relays 50, 51, 52 which operate the unit switches of the alternator S⁴. The motor rotates the distributor arm 63 and causes the succession of signal combinations on the main and cross streets. This is the normal day time operating position and is the one for which the switches are shown set in the drawings.

Position III

B. The same signal light circuits are established as in position II.

C. This is the position for night traffic or for times when the amount of traffic on the cross streets is very slight. The motor is running but the circuit through the arrester unit 711 has been brought in and thus the distributor arm is held in a position to cause green to show on the main street and red on the cross street. The highway crossing switch 88 is in circuit so that an autoist wishing to cross the main street can open it and thereby momentarily allow the arrester dog to be withdrawn by a spring or other device and release the distributor arm for one revolution giving one cycle of alternating lights at that intersection.

Position IV

B. The circuits for alternating lights are cut out and the circuits 27, 28, 29 for one-color light, red in both directions or flashing amber in both directions are established through the switch S^2 . If the arm 30 of the switch S^2 is in the position indicated diagrammatically in the solid lines, a flashing amber light is given due to the flasher 28c. If the arm 30 is in the other position, a constant red light appears on each street.

C. All of the control circuits are cut out except the circuit through the relay 91 of the switch S^2 . Then upon operating rheostat 13 at the central station, the low-voltage relay 91 actuates the switch arm 30 in S^2 to complete either the circuit through the red lamps or the one through the amber lamps.

For operation by direct current, little change is necessary. Figure 2 shows those parts of the main current supply 11, 12 requiring modification. At the central station, a variable speed direct current generator 100 is provided and with it a rheostat 101, a reversing switch 102, an indicator 103 and a condenser 104.

A direct current motor must be provided for each distributor D and with it a polarized relay to make certain that the current through the motor shall always be in one direction. Such a relay is shown in Fig. 3 as it would be inserted in the system across the motor leads 84 and 86. The relay includes two sets of leads 105, 106 and 107, 108 and two switches 109, 110 having a common relay actuator 111 energized by the lead 84. Upon reversal of current, the switches 109, 110 are shifted. In one position they put the leads 105 and 107 in circuit and in the other, the leads 106 and 108, but in either case the direction of the current through the motor 64 is the same.

The occasion for providing the polarized relay is to make it possible to operate certain of the relays in the system by reversal of current as well as by no-voltage, low voltage and the like. These various ways of selectively operating electrical devices in a large system are known *per se* and are included here under the phrase "definition of devices responsive to a variation of the characteristics of the source of power".

An advantage of the A. C. system is in the possibility of using synchronous motors but these can not readily be started and stopped. The D. C. system, however, has the merit of requiring fewer turns in the relay windings, of giving a wider range of control by the variation of conditions in the main circuit and of affording the possibility of stopping and starting the motors at will.

Whether the system is arranged for operation by direct or by alternating current, it is possible to vary the duration of a cycle of the signal combinations, when alternating red, green or amber lights are being used, by varying the speed of the distributor motors. In the A. C. system this is effected by varying the frequency. In the D. C. system a variation of impressed voltage causes a change of motor speed. The D. C. apparatus must be so arranged that drop in voltage for the purpose of lowering the speed will not interfere with the selective operation of the low voltage relays. This may be done by having the relays operate at a lower voltage than the minimum used for speed variation, or preferably by using no-voltage and reverse current relays.

The system, whether operated from a D. C. or

from an A. C. main circuit may be modified as shown on the third sheet of drawings. The several modifications there shown have in common the thought of operating the unit switches of the alternator switch S^4 by means of two relays instead of three as in Figure 1, and further there is shown in Figure 21 an arrangement by which the dials B and C of the main switch S^1 are replaced by controllers made up of groups of relay actuated switches. This arrangement of the switch S^1 may be used equally well with the alternator S^4 as shown in Figure 1 or with any one of the alternators shown in Figures 6, 11 and 16.

In Figure 6, the dial B for selectively establishing the signal circuits and the distributor D for controlling the alternator S^4 are connected to the other parts of the system in the manner shown in Figure 1. In the B^1 position of the arm 20 no signal circuit is established. In the B^2 and B^3 positions, current is fed through the wire 115 to the signal lamps of the sets L^1 and L^2 by way of the alternator S^4 which here consists of four switch units of the type used in the Figure 1 arrangement. Two of these switch units, 110 and 111, are simultaneously operated by the relay 50' while the other two 112 and 113 are simultaneously operated by the relay 51'. It will be evident that the single wire 115 branched before connection to the unit switches of the alternator S^4 is equivalent to the three wires R, A, G, in Figure 1 leading from three plugs on dial B. So with the wire 114 in comparison with the wires 27, 28 and 29.

The relays 50' and 51' are alternately energized by the distributor D. On the distributor are four contact plugs, two of which, 116 and 117, are on the inner ring 53 while two others, 118 and 119, are on the outer ring 58 which is movable about the ring 53. As the arm 63 is rotated, a circuit is completed each time the arm 63 contacts with one of the four plugs. Contacting with the plug 116, the arm 63 closes a circuit through the relay 50' and in like manner, upon contact with the plugs 118, 119, 117, in succession, circuits are closed respectively through the relay 51' then through the relay 50' and again through the relay 51'.

The alternate energization of the two relays causes the alternate reversal of the positions of the two groups of simultaneously operated switch units. With the circuits as shown in Figure 6, this causes a cycle of signals known as the "double amber" and consisting first of green on the main street with red on the cross street, second, amber on both streets, then red on the main street with green on the cross street followed by amber on both streets. This cycle is repeated as long as the distributor arm 63 continues to rotate with the arm 20 of dial B in either the B^2 or the B^3 position.

It will be noted that the amber light shows only for a short interval while the arm 63 is travelling in one case from the contact plug 118 to the plug 119 and in the other case from the plug 117 to the plug 116. The relay switch S^2 operates in the same manner as in the Figure 1 modification when the arm 20 of dial B is in its B^4 position and is connected to the lamps in the manner shown.

The cycle is the same as that of Figure 1.

Figures 7, 8, 9 and 10 represent diagrammatically the successive reversals of the positions of the switch arms during one cycle and the alternate operation caused by the alternate energization of the relays 50' and 51'. Opposite each figure

are two letters showing the color of the light appearing on the main street and on the cross street respectively when the switch units are in the relative positions indicated in that figure. Figure 7 represents the position of the switches shown in Figure 6. By reference to it, the circuits formed in each of the succeeding switch positions represented by Figures 8, 9 and 10 may be traced out with no difficulty.

In Figure 11 is shown an arrangement of switch units in the alternator S^4 by means of which a different type of signaling is effected. This sequence is termed the "single amber" and consists first of a green light on the main street with a red on the cross street, second, an amber light on the main street with the red continuing on the cross street, then a red on the main street with green on the cross street, followed by a red continuing on the main street, but with amber on the cross street. The successive positions of the switch units of the alternator shown in Figure 11 are schematically represented in Figures 12 to 15 inclusive. This arrangement involves the use of five switch units in the alternator S^4 , three of these units being actuated by the relay 50' and two of them by the relay 51'. The relays are alternately energized by circuits established by the distributor D in the same manner as shown in Figure 6.

In Figure 16 is shown still another modification to effect a different sequence of signals. In this arrangement no amber light is used, the sequence consisting first of green on the main street with red on the cross street, then red on both streets followed by red on the main street with green on the cross street, and then again red on both streets. This arrangement likewise involves the use of five switch units in the alternator S^4 , the operation of the switch units being the same as in the arrangement shown in Figure 11. The whole difference is in the different number of lamps used and in the different connection of the lamps to the switch units. It will be understood that the constant light switch S^2 may be connected to the lamps in either of the arrangements shown in Figure 11 and Figure 16.

Instead of using a rotary switch arm turning between two dials as shown in Figures 1 and 5, the main control switch S^1 may be made up of relay switches. In Figure 21 is shown an arrangement of switch units for this purpose. A quick-acting low voltage relay switch 120 is connected across the main circuit 11, 12. Associated with this switch are two delayed action relays 121, 122 each operating a group of switch units of the two controllers C^1 and B^1 . These controllers correspond in function to the dials C and B shown in Figure 1. Simultaneous operation of the two controllers is caused by the fact that certain switch units of each are operated by the same relays 121 and 122.

The successive establishment of different control circuits by the controller C^1 and of the different signal circuits by the controller B^1 is effected by the alternate energization of the two relays 121 and 122. The two relays are in circuit from the main feeder 12 through opposite sides of the relay switch 120 to the feeder 11 and are thus brought under control from the central station, being operable upon reduction of voltage in the main circuit.

Due to the fact that the relay 120 is quick-acting while the relays 121 and 122 are slow-acting, a reduction in voltage in the main circuit causes the relay 120 to operate before the relay 121 or

the relay 122. Each energization of the switch relay 120 causes a reversal of the position of its switch arm and, depending upon the position to which the switch arm is thrown thereby, either the relay 121 or the relay 122 is energized. In this manner the relays 121 and 122 are alternately energized by successive reductions of voltage in the main circuit to cause alternate operation of the two groups of switch units in the controllers C^1 and B^1 .

In Figure 22 are schematically shown the four successive positions of the two groups of switch units in the controller C^1 , these positions corresponding to the four positions of the arm 75 on the dial C in Figure 1. The sequence is apparent upon tracing the circuits established in these four positions beginning with the C^1 position which corresponds to that shown in Figure 21 and following through the changes caused by an operation first of the relay 122, then of the relay 121, then of the relay 122 again, and following that a second operation of the relay 121, the latter being effective to return the switch units from the C^4 position to the C^1 position.

In the C^1 position a circuit is established from the feeder 16 to the wire 80 and thence to the interrupter 71 as in Figure 1. In the C^2 position circuits are established from the feeder 16 to the wires 80 and 81 and, the other parts of the system being connected in the same manner as in Figure 1, the same result will be effected as by the C^2 position of the arm 75 in Figure 1. So also with the C^3 position in which the wire 87 is connected to the feeder 16, and with the C^4 position in which the wire 90 is connected to the feeder 16 to encircuit the relay 91 of the constant light switch S^2 .

The position of the switch units of the controller B^1 have not been represented as they are readily understood. The position shown in Figure 21 is the B^1 or "off" position. The actuation of relay 122 connects the wire 115 with the feeder 18. The actuation thereafter of the relay 121 does not change this but still does not encircuit the wire 114. Upon the following actuation of the relay 122, however, to give the B^4 position, the wire 115 is disconnected and the wire 114 leading to the signal lamps through the switch S^2 is connected to the feeder 18.

The whole system has not been set out in showing the modification of the alternator and of the main control switch but the connection of the modified forms to the rest of the system has been indicated by giving to the connecting wires the reference characters of the corresponding wires in Figure 1.

It will be clear from the foregoing that many variations of the component parts of the system are possible, many of them being inventions in themselves although still utilizing the underlying thought of the system. For instance, the arrangement of plugs on the distributor D and the connections to the alternator switch units may be varied to give different signal cycles. Other than motor operated distributors may be used and I wish to include within the broader claims these other distributing means.

I claim—

1. In a signaling system, a series of signal stations each provided with visual signal means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations to the control station, means at each signal station to give a flashing signal, means at each signal station to give a constant signal, means at each station operable by traffic to cause

said signal means to give routine control of traffic for a predetermined time, and means operable from the control station through said main circuit for determining which of the foregoing means shall be operative.

2. In a signaling system, a series of signal stations each provided with visual signal means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations to the control stations, means for giving a sequence of signals for the routine control of traffic, means at each station operable by traffic to cause said signal means to give routine control of traffic for a predetermined time, and means operable from the control station through said main circuit to determine which of the aforesaid means shall be operative.

3. In a signaling system, a series of signal stations each provided with a plurality of visual signaling means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations to said control station, means at each signal station to give automatically a predetermined sequence of signals of predetermined durations for the routine control of traffic, means at each signal station for giving more than two variations of the ratio of durations of signals in the sequence, and means at the control station for actuating said last mentioned means through said main circuit.

4. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations with said control station, a plurality of means at the signal station to cause a display of a plurality of types of signaling for regulating traffic of different sorts such as routine traffic, light traffic, or emergency traffic, means at the signal stations for selecting the type of signaling it is desired to display, means at the control station for operating said selecting means through the main circuit, and means at the signal station operable from the control station through said main circuit when said selecting means has selected a certain type of signaling to change to a certain other type.

5. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations with said control station, a plurality of means at the signal station to cause a display of a plurality of types of signaling, said last named means including means giving a cyclical display for the routine control of traffic, means to continuously display a desired one of said signaling means, and means to continuously flash a desired one of said signaling means, in combination with means at the signaling stations for selecting the type of signal it is desired to display, means at the control station for operating said selecting means through the main circuit and means at the signal station operable from the control station through said main circuit, when said said selecting means has selected a certain type of signaling to change to a certain other type.

6. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to the control station, means at each signal station to give a plurality of types of sig-

nalizing comprising means to give an intermittent signal, means to give a constantly displayed signal, and means to give a sequence of different signals for the routine control of traffic, in combination with means at the signal station responsive to variation of the characteristics of the source of power for determining which of said types of signaling, shall be operative, said variation being transmitted through said main circuit from said control station.

7. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, means at each signal station to give automatically a predetermined sequence of signals of predetermined durations for the routine control of traffic, means responsive to a change in the characteristics of the source of power for giving more than two variations of the ratio of durations of signals in the sequence, said change in characteristics being transmitted through said main circuit from said control station.

8. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, means at each station to give a plurality of types of signaling, one of said types being a sequential display of signals of predetermined durations for routine control of traffic, means operable from the central station over said main circuit and responsive to a change in characteristics of the source of power for selecting the type of signaling, a plurality of independent means for controlling the signals of the given types of signaling, and means at the signal station operable upon a different change in the characteristics of the source of power for varying the ratio of durations in said sequential display, said changes in characteristics being transmitted through said main circuit from said control station.

9. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, means at each station to give a plurality of types of signaling comprising means to give an intermittent signal, means to give a constantly displayed signal, and means to give a sequence of signals of predetermined durations for the routine control of traffic, in combination with means operable from the control station over said main circuit and responsive to a change in characteristics of the source of power for selecting the type of signaling, and means at the signal stations operable upon a different change in the characteristics of the source of power for varying the ratio of durations of signals in said sequence, said changes in characteristics being transmitted through said main circuit from said control station.

10. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, means at each station to give a plurality of types of signaling comprising means to give an intermittent signal,

means to give a constantly displayed signal, and means to give a sequence of signals of predetermined durations for the routine control of traffic, in combination with means at each signal station responsive to a change in characteristics of the source of power in said main circuit to select the type of signaling, means at the control station to change the characteristics of the source of power in said main circuit to change the type of signaling.

11. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, means at each signal station to cause a sequential display of signals of predetermined durations for the routine control of traffic, said means being rendered operative or inoperative upon a change in the characteristics of the source of power, means responsive to a different variation in the characteristics of the source of power to vary the ratio of the durations of signals in said display, said changes in characteristics being transmitted through said main circuit from said control station.

12. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, a plurality of means at each signal station to give a cyclical type of signaling for routine control of traffic or a constant type of signaling for light traffic conditions, means at each signal station for selecting the type of signaling to be displayed, said selecting means being responsive to a change in the characteristics of the source of power transmitted through said single circuit, means operable by traffic passing a signal station to render said periodic means operative for one cycle when and while said selecting means is in position to give the constant type of signaling, said traffic operated means being inoperative while said selecting means is in position for routine control of traffic.

13. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, a plurality of means at the signal station to give a plurality of types of signaling for regulating traffic of different sorts such as routine traffic, light traffic or emergency traffic, means at each signal station for selecting the type of signaling it is desired to display, said selecting means being responsive to a change in the characteristics of the source of power transmitted through said single circuit, means at the signal station responsive to a different change in the characteristics of the source of power and operable from the control station through said single circuit to change a certain type of the signaling to a certain other type when and while said selecting means has selected a certain other type.

14. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said sig-

nal stations to said control station, a plurality of means at the signal stations to give a plurality of types of signaling for regulating different sorts of traffic, one of said types being a sequential display of signals of predetermined durations for the routine control of traffic, means for selecting the type of signaling it is desired to display, means to vary the ratio of durations of signals given in said sequential display, said ratio-varying means being responsive to a change in the characteristics of the source of power transmitted through said single circuit.

15. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, a plurality of means at each signal station to give a plurality of types of signaling for regulating different sorts of traffic, one of said last named means operating periodically to give a sequence of signals of predetermined durations, means at each signal station operable from said control station over said main circuit for selecting the type of signaling, means for giving more than two variations of the ratio of durations of signals in the sequence, said ratio-varying means being responsive to a change in the characteristics of the source of power transmitted through said single circuit.

16. In a signaling system, a series of signal stations each provided with a plurality of visual signaling means, a control station, a single main circuit including a source of power for controlling the system, said circuit connecting said signal stations to said control station, plurality of means at each signal station for giving different types of signaling for regulating different sorts of traffic conditions, means at each signal station for selecting the type of signaling, said plurality of means including means at each signal station to give a sequence of signals of predetermined durations, means to render said sequential means operative or inoperative upon a change in the characteristics of the source of power, and means to vary the ratio of the durations of signals in the sequence, said ratio-varying means being responsive to a different change in the characteristics of the source of power, said changes in characteristics being transmitted through said main circuit from said control station.

17. In a signaling system, a series of signal stations, each provided with a plurality of visual signaling means, a control station, a single main circuit for controlling the system, said circuit connecting said signal stations to said control station, a plurality of means at the signal station to give a plurality of types of signaling, including a sequential display for routine control of traffic and a type for light traffic, said type for light traffic comprising means at each signal station to permit traffic passing by a station to control the signal at that station, means at each signal station to select the type of signaling it is desired to display, means at each station to stop said sequential display at a predetermined point thereof, means at the control station to determine which of the foregoing means shall be operative, all of the aforesaid means being controlled from said control station through said single circuit.

ERNEST P. GOODRICH.

CERTIFICATE OF CORRECTION.

Patent No. 1,993,056.

March 5, 1935.

ERNEST P. GOODRICH.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 56, strike out the words "mutually insulated" and insert the same after "being" in line 57; and page 8, first column, line 60-61, claim 5, for "signaling read signal; and in same line 61, for "signal" read signaling; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 18th day of June, A. D. 1935.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.