July 7, 1942. M. C. SMITH 2,289,080

SIGNALING SYSTEM

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Fig. 1.

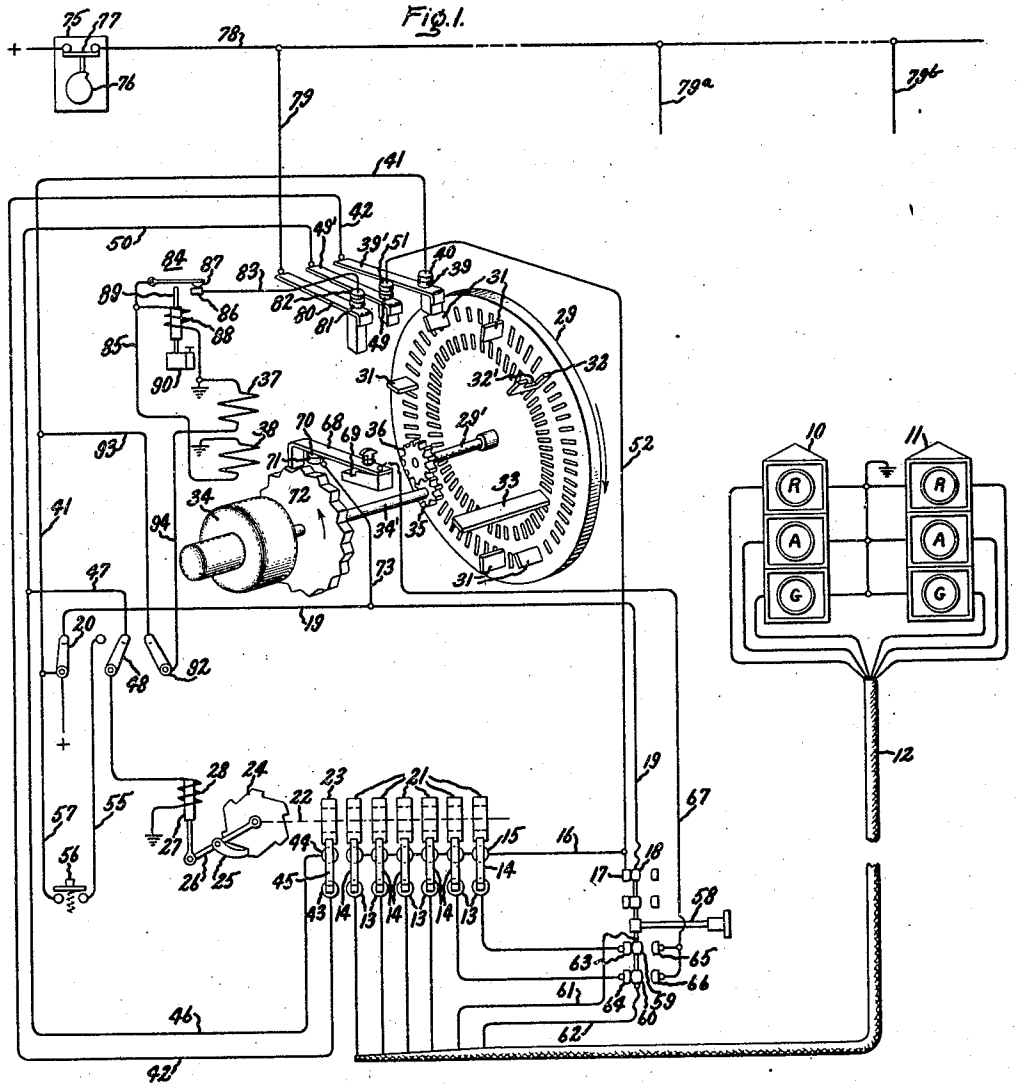
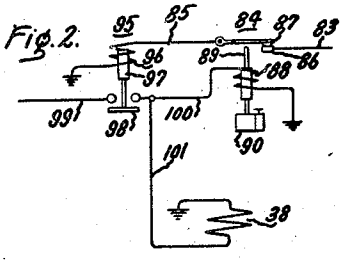


Fig. 2.



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His Attorney.

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SIGNALING SYSTEM

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9 Claims. (Cl. 172—293)

The present invention relates to signaling systems and particularly to signaling systems such as are used at street or highway intersections for controlling traffic.

In traffic signaling systems, it is known to provide traffic controlling signals at successive street intersections timed relatively to each other and to provide at a central point or station a master timer or controller for keeping the intersection signals in a desired timed relationship. In such systems, the mechanism at each intersection comprises an intersection timer or controller connected with suitable "stop" and "go" signals and is operated to display the "stop" and "go" signals in a desired sequence. In such signaling systems, the arrangement is such, usually, that if the signals at any intersection get out of the desired timed relation relatively to the other signals of the system, the intersection controller or timer which effects the operation of the signals at such intersection is actuated by the master controller to bring the "stop" and "go" signals which it controls back into step with the other signals of the system. One arrangement utilized for this purpose is that of stopping the intersection controller and then starting it up at the correct time again to put the signals at the intersection in step with the other signals of the system.

In the operation of such systems, it may occur that when the signals at an intersection get out of step with other signals in the system, they are so far out of step that it is necessary that the controller at such intersection be caused to effect correction for a major portion of a signaling cycle. Heretofore, as far as I am aware, it has been the practice to make the necessary correction to bring the signals at the intersection back into step during a single signaling cycle. This is undesirable as it means that one signaling period of a cycle is prolonged unduly, a thing which may, especially in the case of heavy traffic along a highway, cause considerable disturbance. For example, it might happen that a major portion or an entire "go" period of a traffic signal cycle would be missed, a thing which in the case of heavy traffic might cause a considerable piling up of traffic on the highway.

The object of the present invention is to provide an improved construction and arrangement in a traffic signaling system, whereby when the traffic signals at an intersection get out of step, they are brought back into step by a certain limited amount at a time, the resynchronizing of the signals being spread over a number of successive signaling cycles, if needs be. For example, should the signals at an intersection be out of step by 25 seconds then, according to my invention, instead of correcting for this entire amount in a single signaling cycle, I correct for it over a number of successive signaling cycles, for example, three, which would mean correcting for 10 seconds on each of two successive traffic signaling cycles and correcting for 5 seconds in the third cycle. An advantageous arrangement where the traffic signals control traffic along a main thoroughfare, in so far as effecting correction with the least disturbance to traffic at the intersection, is to prolong the "go" signal on the main thoroughfare for the number of successive cycles required to bring the signals into step.

My invention is applicable to signaling systems of various types. In the present instance, I have elected to illustrate it in connection with a traffic signaling system as disclosed in U. S. patent to R. A. Reid No. 2,236,298, issued March 25, 1941. It is to be understood, however, that while my invention is well adapted for use in such a system, its use is by no means limited thereto as it may be used in connection with any specific type of signaling system to which it may be found applicable.

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

In the accompanying drawing, Fig. 1 is a diagrammatic view of a traffic control system embodying my invention, and Fig. 2 is a fragmentary diagram illustrating a modification of Fig. 1.

Referring to this drawing in detail, two groups of traffic signals 10 and 11 are indicated, each group of signals comprising three signals marked "G," "A" and "R," being respectively green, amber- and red-colored light signals. The groups are positioned to face intersecting lanes of traffic respectively and the respective signals are recognized as denoting "Go," "Caution" and "Stop." The signals are energized through conductors in a cable 12, the return conductors being connected to a common ground terminal indicated between the two groups of signals. The specific signals herein illustrated comprise colored lenses with electric lamps positioned behind them, these signals being generally accepted by public authorities.

Each conductor of the cable 12 is connected directly or indirectly to a stationary contact 13 of a suitable controller and receives energy through

a movable contact 14 from another stationary contact 15. The circuit for the lights continues to a suitable source through a conductor 16, closed switch contacts 17, 18, a conductor 19 and a suitable power switch 20 to the source indicated merely by a plus sign. The contacts 15 are interconnected to the common supply conductor 16 so that when a movable bridging contact 14 rests on both of its pair of stationary contacts, it closes the circuit to the respective signal lamp in that circuit to energize it.

The respective movable contacts 14 are moved by cams 21, one cam being provided for each movable contact. The cams are mounted on a common shaft 22 so that they may rotate in unison and their shapes are so arranged that certain ones of the contacts remain closed and certain ones of the contacts are opened in each of several predetermined positions of the shaft, a complete cycle of operations being performed in each revolution of the shaft.

The shaft 22 may contain cams for operating contacts in circuits other than the signal circuits. The shaft 22 carries one cam 23 used, for example, for operating contacts in a circuit arranged to maintain the shaft 22 in synchronism with a control dial. This circuit and its function will be explained later in the specification.

The shaft 22 with its group of cams is rotated step by step by a mechanism including a ratchet wheel 24 rigidly attached to the end of the shaft 22, a pawl 25 pivotally mounted on a pawl arm 26 and in operating relation with the ratchet wheel, an armature 27 and a coil 28. The pawl arm 26 is pivoted at one end on the shaft 22 and at the other end to the armature 27. The armature and pawl arm are raised to an upper position when the coil 28 is energized and the pawl 25 then engages a new notch in the ratchet wheel. When the coil 28 becomes deenergized the armature drops to its first position and the pawl, being carried by the pivoted pawl arm, rotates the ratchet wheel 24, with the shaft 22 and the cams, to a new position. The ratchet wheel illustrated has six notches whereby six energizations of the coil 28 and the corresponding movements of the pawl will effect a complete revolution of the shaft and cams. It is evident, however, that any other desired number of notches may be used and any desired combination of the contact operations may be had in each position by suitably shaping the cams to effect the opening and closing of the circuits at these shaft positions.

The intermittent energization of the coil 28 is effected and timed by contacts actuated by a rotating dial 29 having two rows of slots near its periphery. Keys 31, and 32 are placed in certain ones of the outer row of these slots so that at the proper instances during the rotation of the dial, they will actuate suitably positioned contacts to close the circuit to the coil 28 momentarily, each actuation effecting a movement of the shaft 22 to a succeeding position.

The dial 29 is mounted on a shaft 29' driven by a motor 34 through the motor shaft 34' and a pair of gears 35, 36. The motor is preferably a synchronous motor whose armature speed is proportional to the frequency of the alternating current supplied to its operating field whereby the speed of the dial remains constant as long as the frequency of the supply current remains constant. The motor is provided with two opposing fields 37, 38, the first being used for normal operation and the second being energized only when it is desired to stop the motor.

The keys 31, 32 are placed in selected ones of the row of slots near the periphery of the dial. Five keys 31 and one key 32 are used. The keys 31 actuate a contact 39 mounted on a resilient supporting arm 39'. The arm 39' is rigidly mounted at one end and is provided on the underside of its free end with a suitable block which is positioned in the path of movement of the keys 31. As the keys rotate, they successively engage the end of the block, momentarily raise it and the contact 39 which is mounted on the arm 39' directly above the block, until the contact 39 engages a contact 40. The key 31 continues to rotate and passes beyond the block, after the two contacts have engaged, and the resilient arm returns the contact 39 to its original position thereby separating the contacts 39, 40 and breaking the circuit therethrough. The circuit closed by the engagement of the two contacts 39, 40 may be traced from the source at power switch 20, through a conductor 41 to the contacts 40, 39 through the resilient arm 39' to a conductor 42, to stationary contacts 43, 44, through a movable contact 45, conductors 46, 47, switch 48 to coil 28 and to ground. There are five keys 31 in the dial 29 which provide for five energizations of the coil 28 during a single rotation of the dial 29. It is desirable, however to have the dial 29 make one complete revolution for each complete revolution of the shaft 22 and cams 21, and it is further desirable to maintain a synchronous relationship between these two rotating bodies so that the dial may thereby become an indicator for the position of the cam shaft and the relative spacings between keys will be a criterion for the desired period lengths of a cycle. For effecting a sixth energization of the coil 28 in each revolution of the dial, the key 32 is provided. The key 32 is provided with a notch 32' so that this key will not actuate the contact 39. It will, however, actuate a second contact 49 to close a circuit to the coil 28. This contact 49 is mounted on a contact arm 49' which is in turn connected to the coil 28 through conductors 50, 47 and switch 48. The key 32 raises contact 49 into engagement with a stationary contact 51 which is connected to the current source at the power switch 20 through conductor 52, contacts 17, 18, conductor 19 and power switch 20. Only one key 32 is used in the dial and there is, therefore, only one position of the dial at which this operation takes place. At the corresponding position of the cam shaft, the keys 31 are made ineffective to advance the cam shaft. The cam 23 on the shaft 22, provided for this purpose, opens the circuit through contacts 43, 44 at this position by lifting the movable contact 45. The normal circuit, through which the keys 31 advance the cam shaft, is thereby opened and the cam shaft 22 remains stationary until the key 32 is advanced by the dial to close the contacts 49, 51. In this way, the cam shaft is advanced by keys 31 until it reaches this position at which the cam 23 opens this circuit. It then remains stationary until the dial moves key 32 into position to actuate the contacts 49, 51. The dial and cam shaft are then in the proper operating relationship. This relationship exists during normal operation and involves no unnecessary delay in the advance of the cam shaft because key 32 being placed in a desired slot between two keys 31 functions exactly as a key 31 to

advance the cam shaft to its next position at the proper instant of the operating cycle.

It is at times desirable to advance the cam shaft by a hand-operated switch independently of the dial. If such operation is desired, the switch 48 is moved from its illustrated position to a second position in which it connects the coil 28 to a conductor 55. This conductor may be connected to the common current supply source by a hand-operated switch 56 and a conductor 57. When switch 48 is in this second position, therefore, the intermittent actuation of the switch 56 will advance the cam shaft 22.

It is also desirable at times to operate the signals simply to indicate caution. For this purpose, the switch 58 is provided having control of the contacts 17, 18 through which the current normally flows to the signals. When these contacts are separated, the common circuit to all the signals is interrupted and the normal sequential operation of the signals ceases. The switch 58 is further provided with movable contacts 59, 60. These contacts are respectively connected to the caution signals through conductors 61, 62 and for normal operation are in position to engage contacts 63, 64 connected to contacts 13 on the cam switch for sequential operation by cams on the shaft 22. For operating the caution signals alone, the switch 58 may be moved to a second position, thereby to move the contact 59 into engagement with a contact 65 and to move the contact 60 into engagement with a contact 66. Contacts 65, 66 are connected by a conductor 67 to a contact arm 68 pivotally mounted on a stationary block 69 and operable intermittently to open and close a pair of contacts 70, 71. A star wheel 72 mounted on the motor shaft 34' actuates the contact arm 68. The contact 71 is connected to the common current source through a conductor 73, conductor 19 and power switch 20. When switch 58 is therefore moved to its second position, the signals of both groups 10 and 11 are deenergized by the separation of contacts 17, 18 and only the amber or caution signals are energized through the newly closed contacts 59, 65 and 60, 66 and through the flashing device just described. When switch 58 is moved to its second position, the contacts 17, 18 being separated, the key 32, upon actuation of the contact 49, cannot establish the circuit to the coil 28. The keys 31, however, will continue to close the circuit to coil 28 until the cam shaft reaches the position at which this circuit is opened by contact 45.

In accordance with my invention, the controller above described may be brought into synchronism with a master controller and with other similar controllers within a system by delaying the movement of the controller for small periods during several successive cycles of operation if the time required to place it into synchronism exceeds a predetermined value. The master controller 75 used in this system is provided with a rotating cam 76 which rotates at the speed at which the secondary dials are intended to operate and is caused momentarily to actuate a switch 77 once during each revolution. The switch 77 is connected between a current source and a common conductor 78. When the switch 77 is closed, current is fed to the respective controllers through conductor 78 and branch conductors 73, 79*a*, 79*b*, etc. Branch conductors 79*a*, 79*b*, etc., lead to controllers at other intersections which controllers are in parallel with the one illustrated in detail and operate in a similar manner. Conductor 79 in the described controller is connected to a resilient contact arm 80 having a contact 81 operable by a key 33 placed in the second row of slots in the dial 29. The arm 80 is placed next to the arm 49' and the key 33 is made longer than either key 31 or 32 so that it may engage the extended block on the underside of the contact arm. At a predetermined position of the dial, the contact 81 is raised into engagement with a contact 82 and a circuit is established to the braking field 38 on the motor 35 through a conductor 83, a switch 84 and a conductor 85. Only one key 33 is used so that one actuation of the contact 81 is obtained at each revolution of the dial 29. If at the instant at which the contact 81 engages the contact 82 the master controller switch 77 is closed and current is fed to the braking field 38, the motor stops until such time as the master cam 76 opens the switch 77. At that instant, the braking coil 38 becomes deenergized. The key 33 moves beyond the actuating block of the contact 85 and the circuit is opened.

As previously stated, it is possible for the secondary controller to be out of step with the master timer by a period equalling the greater portion of an operating cycle. To bring the controller into synchronism, it would be necessary in the systems heretofore used, to hold it stationary for this comparatively long period of time and that would result in an undesirable delay of traffic. A time limiting switch is, therefore, provided in the braking coil circuit to release the timer after a predetermined short period of time, thereby enabling it to operate for one complete cycle before it is again stopped due to its being out of synchronism. The timer is stopped through successive cycles, for this period of time as determined by the time limiting switch, until the timer is brought into synchronism. In the latter case, the braking coil circuit is opened by the master timer at the instant at which synchronism is reached and the time limiting switch merely returns to normal condition ready for an operation at a subsequent period. To carry out this operation, any suitable time delay switch may be used. In the present case, a simple dash-pot delayed switch is illustrated. When current flows to the braking field 38, it flows through the switch 84, which preferably comprises a stationary contact 86 and a cooperating switch element 87. Current also flows through a coil 88 provided with a switch actuating armature 89 and connected between the conductor 85 and ground. Current flows through this switch coil only when the master controller switch 77 and the contacts 81, 82 are closed. If current flows through the coil 88 for a predetermined time, it raises the armature 89 against the action of a dash-pot delay mechanism 90 to open the switch 84 and thereby break the circuit between conductors 83 and 85. This operation deenergizes the field 38 and permits the motor 34 to rotate the dial sufficiently to break the circuit at the contacts 81, 82. The dial will then rotate for another complete revolution, still out of synchronism with the other controllers but by a smaller amount, until its key 33 again closes the circuit through contacts 81, 82. If the master switch 77 is then opened within the period set for the switch 84, there will be no operation of the time delay switch 84, the dial will continue operation in synchronism with the master timer and the armature 89 will merely return to its starting position.

In operation of the above system, each traffic

signal controller is set into motion by energizing the motor field 37. A switch 92 is provided, for this purpose, which closes a circuit from the common source at switch 20 through conductor 41, conductor 93, switch 92 and conductor 94. A closure of the switch 20 then provides current for the signaling circuits and a movement of switch 48, to the position shown, prepares the controller for automatic operation. The motor then drives the dial 29 and the keys 31 actuate the contact 39 thereby effecting a rotation of the shaft 22 up to the position at which cam 23 opens the circuit established by the keys 31 and contact 39. The drum will then remain stationary until the dial moves to the position at which the key 32 actuates the contact 49. The shaft 22 and the dial 29 are then in synchronism with each other. During this operation the key 33 also moves with the dial and in each revolution of the dial it closes the circuit to the braking field 38 by the closure of contacts 81, 82. If the dial is in synchronism with the master timer, the switch 77 will be opened at that same instant and nothing happens. If the dial is out of synchronism with the master, the dial will be stopped or at least slowed down until it is released either by the opening of the master controller switch 77 or by the opening of the time delay switch 84.

If the time period required to place this dial in synchronism with the master timer is greater than the time limit for which the switch 84 is set, the switch 84 will open the circuit to the braking coil 38, the dial will begin to move and will open the braking coil circuit at the contacts 81, 82. The dial will then continue for a complete revolution during which the switch 84 returns to normal closed position. At the next actuation of the contacts 81, 82, the braking coil will again be energized and the time delay switch 84 will again begin its timing. If the dial 29 comes into synchronous relationship with the master timer before the switch 84 operates, the master switch 77 will be opened, the braking coil 38 will be deenergized and the dial 29 will again begin to rotate. The key 33 again opens the braking coil circuit at contacts 81, 82 so that upon a reclosure of the master switch 77, the braking coil 38 remains deenergized. The number of cycles over which this operation is distributed is dependent upon the time for which the time delay switch 84 is set and upon the period by which the controller is out of step with the master controller. A period of ten seconds has been found satisfactory in one installation but any other period may be used, dependent upon the traffic conditions existing at an intersection.

The position of the key 33 in the dial is determined by the progression timing of the controller relative to the other controllers in the system. Because of this timing requirement it may happen that the dial is held up during a signal period other than the main street green period. It has been found in practice however that in practically all cases there is better than an even chance that the resynchronizing key 33 will be in the main street green period. The short delay periods distributed over several cycles become practically unnoticed when they fall into the main street green period and cause little disturbance in traffic flow when they fall in signal periods other than the main street green period.

Fig. 2 is a fragmentary diagram disclosing a modification of the diagram of Fig. 1. The modification is essentially the provision of a local source of current for the energization of the time delay relay and the motor brake coils. Referring to this diagram in detail, a relay 95 provided with a coil 96, an armature 97 and a movable contact 98 is connected into the circuit of the synchronizing conductor 83. When energy flows through this conductor 83 in accordance with the operations described in connection with Fig. 1, current also flows through the contacts 86, 87, conductor 85, through the coil 96 to ground. The relay contact 98 is thereby operated to close a circuit between a conductor 99 and a conductor 100. The conductor 99 is connected to a local source of current at the location of the specific intersection controller which is to be synchronized. The conductor 100 is connected to the brake coil 38. Another conductor 101 leads from conductor 100 to the time delay relay coil 88 and from there to ground. In operation, therefore, the circuit between conductors 99 and 100 is closed immediately upon energization of the conductor 83. The brake coil 38 is thereby energized, and the time delay coil, being energized, immediately tends to lift its armature 89 against the delaying action imposed upon it by the dash-pot 90. If the period of energization of the conductor 83 is longer than the time period for which the dash-pot 90 is set, the circuit to the relay coil 96 is broken by the separation of contacts 86, 87. The brake coil 38 is thereby momentarily deenergized and the motor 34 moves the key 33 so as to open the circuit to conductor 83. The relay coil 96 is thereupon deenergized and opens the circuit to both coils 38 and 88. The time delay relay coil 88 being deenergized, the armature 89 returns to initial position and the contacts 86 and 87 reclose to be in position for a succeeding operation at the next resynchronizing instant in the succeeding operating cycle of the traffic signal controller.

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

1. In a signal system, the combination of a master controller operating upon a predetermined cycle of operations, a secondary controller, means for continuously operating said secondary controller through a predetermined cycle of operations corresponding to the master controller operating cycle, braking means in said secondary controller operable to delay said controller, means operated by said secondary controller at a predetermined position during its cyclic operation to actuate said braking means, means operated by said master controller for releasing said braking means when it reaches synchronism with said secondary controller, and means operated to effect the release of said braking means ahead of said master controller release operation if the time period of said brake actuation exceeds a predetermined period.

2. In a traffic signal system, the combination of a master controller, a secondary controller, means for continuously operating said master and secondary controllers through predetermined corresponding cycles of operations, braking means in said secondary controller, means operated by said secondary controller at a predetermined instant during its operating cycle to energize said braking means, means operated by said master controller at a predetermined corresponding instant in its operating cycle for deenergizing said braking means, and means in said secondary controller operated to deenergize said braking means ahead of said master controller

operation if the time of energization of said braking means is greater than a predetermined period.

3. In a traffic signaling system, the combination of a master controller and a secondary controller each of said controllers being operable through predetermined and corresponding cyclic operations, means for stopping said secondary controller, means operated by said secondary controller for effecting an operation of said stopping means at a predetermined instant in each cycle of operation, means in said master controller for effecting a release operation of said stopping means at a predetermined corresponding instant in its cycle of operation, and means in said secondary controller operated to effect a release operation of said stopping means if said master controller does not effect a release operation of said stopping means within a predetermined period of time.

4. In a traffic signaling system, the combination of a master controller and a secondary controller, each of said controllers being operable through corresponding cyclic operations, means for stopping said secondary controller, means operated by said secondary controller for energizing said stopping means at a predetermined instant in its cycle of operation, means in said master controller for deenergizing said stopping means at a predetermined instant in its corresponding cycle of operation, and means in said secondary controller operated to deenergize said stopping means if said master controller does not deenergize said stopping means within a predetermined maximum period of time.

5. In a traffic signal control system, the combination of a master controller, a series of secondary controllers each of said secondary controllers being provided with a braking coil arranged to be energized at a predetermined point in its respective operating cycle, a common conductor normally energized and connected to said secondary controllers to energize said braking coils when the circuits thereto are closed by said controllers respectively, means in said master controller for momentarily deenergizing said common conductor when it comes into synchronism with the secondary controllers thereby deenergizing said braking coils and effecting an operation of said controllers to break their respective connections to said common conductor, and a time-limiting switch connected between said common conductor and said braking coil in each of said controllers to deenergize said braking coil within a predetermined time interval whereby the secondary controller operates through another cycle and is again stopped, this operation being repeated until synchronous relationship with the master controller is established.

6. In a traffic signal system, the combination of a master controller operating at a predetermined cycle, a secondary controller, means for continuously operating said secondary controller through a predetermined cycle of operations corresponding to the master controller cycle, braking means in said secondary controller, means operated by said secondary controller at predetermined positions during its operation to energize said braking means, means operated by said master controller for deenergizing said braking means at a predetermined instant during its own operating cycle, and a dash-pot relay in the circuit of said braking means in said secondary controller operable to deenergize said braking means within a predetermined time period after the operation of said brake energizing means in said secondary controller thereby superseding said master controller when the time between the energization of said braking means and the release operation of said master controller exceeds a predetermined time period.

7. In a traffic signal system, the combination of a master controller, a secondary controller, means for continuously operating said secondary controller through a predetermined cycle of operations, braking means in said secondary controller, means including a local source of current and an instantly actuating relay operated by said secondary controller at predetermined positions during its operation to energize said braking means, means for operating said master controller through a cycle of operations corresponding to the cycle of operations of said secondary controller, means operated by said master controller for deenergizing said braking means when said master controller comes into synchronism with said secondary controller, and a time delay switch in the circuit of said braking means in said secondary controller operable to deenergize said instantaneously operating relay and thereby to deenergize said braking means within a predetermined time period after the operation of said brake energizing means in said secondary controller.

8. In a signal system, the combination of a master controller and a secondary controller operable respectively through signal cycles of corresponding lengths, means operated by said secondary controller at a predetermined instant in each operating cycle to stop said secondary controller, means in said master controller to restart said secondary controller at a corresponding instant in its operating cycle, and means in said secondary controller to restart said secondary controller prior to the restarting instant of said master controller if the time period between said stopping instant and said master restart instant exceeds a predetermined maximum.

9. In a signal system, the combination of a master controller and a secondary controller operable through corresponding signal cycles, means operated by said secondary controller at a predetermined instant in each operating cycle to stop said secondary controller, means in said master controller to restart said secondary controller at the instant at which the master controller comes into synchronism with the secondary controller, and means in said secondary controller to restart it prior to the restarting instant of said master controller if the time period between said stopping instant and said instant of synchronization exceeds a predetermined maximum.

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