Aug. 31, 1943. V. W. LEONARD 2,328,473

ELECTRICAL SYSTEM

Filed Oct. 1, 1940 3 Sheets-Sheet 1

Fig. 1.

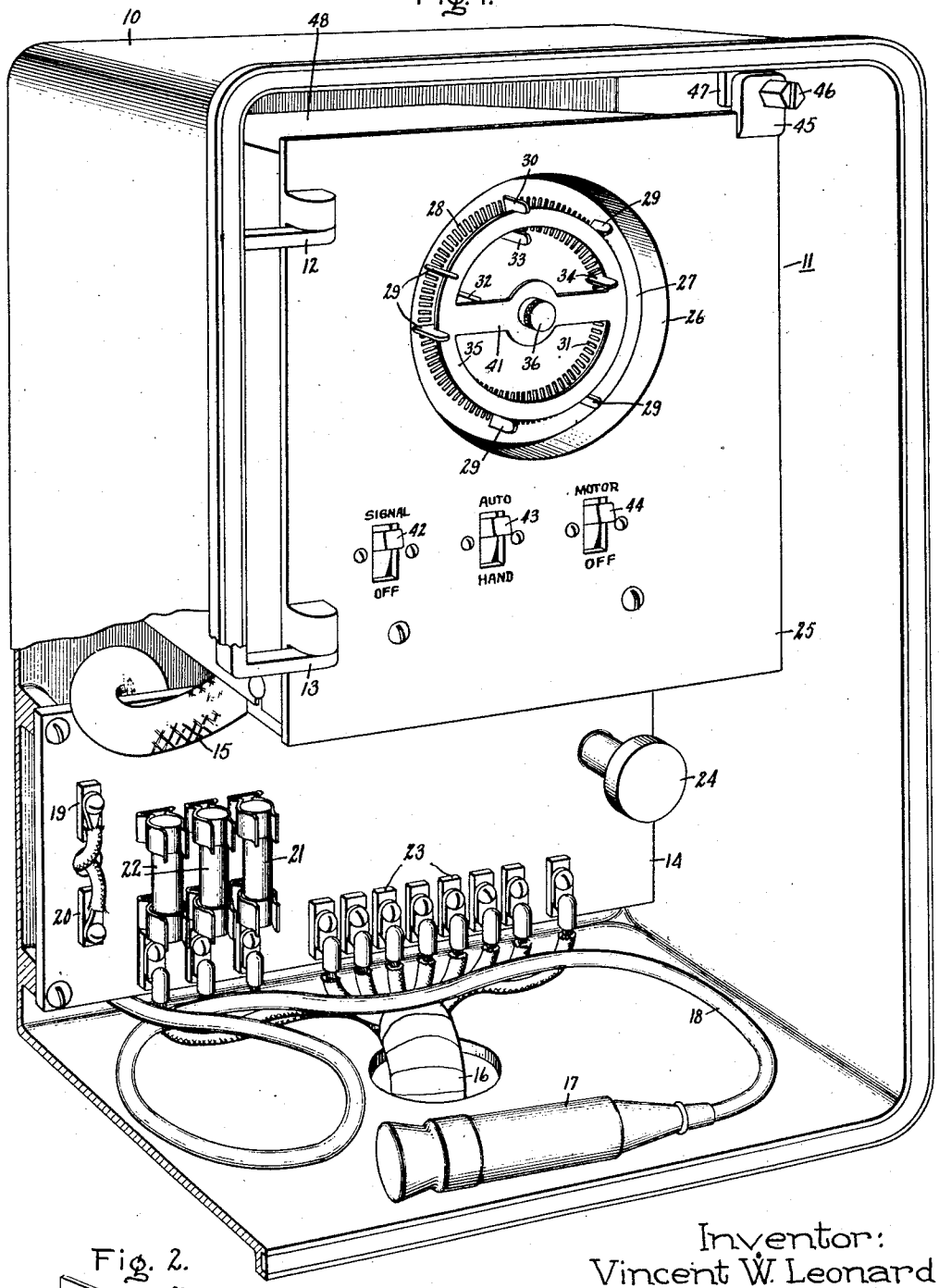
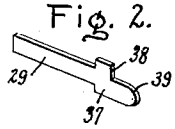


Fig. 2.



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ELECTRICAL SYSTEM

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Fig. 3.

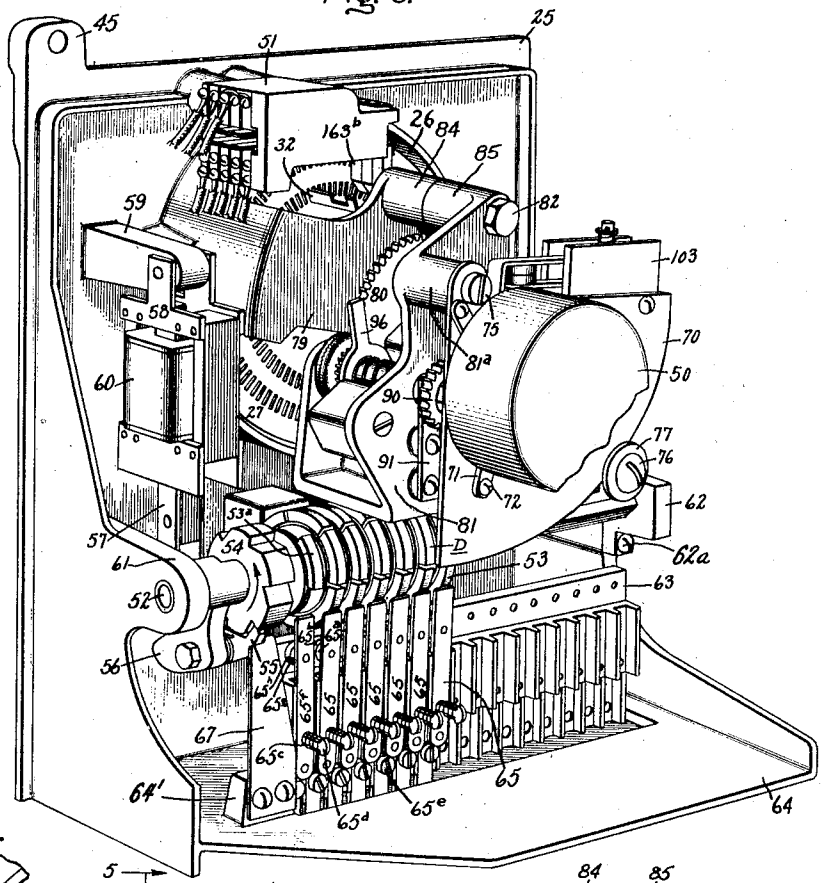
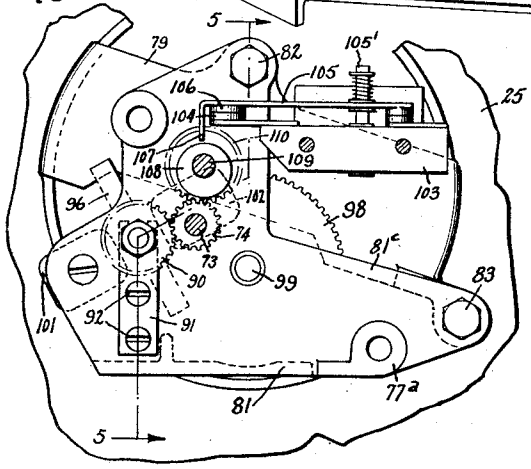


Fig. 4.



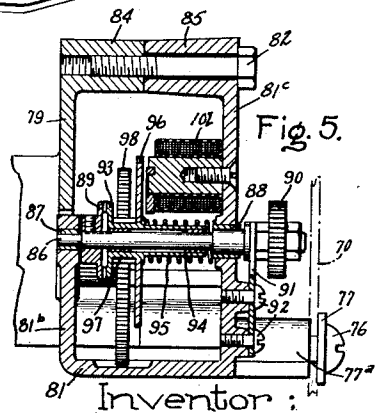


Fig. 5.

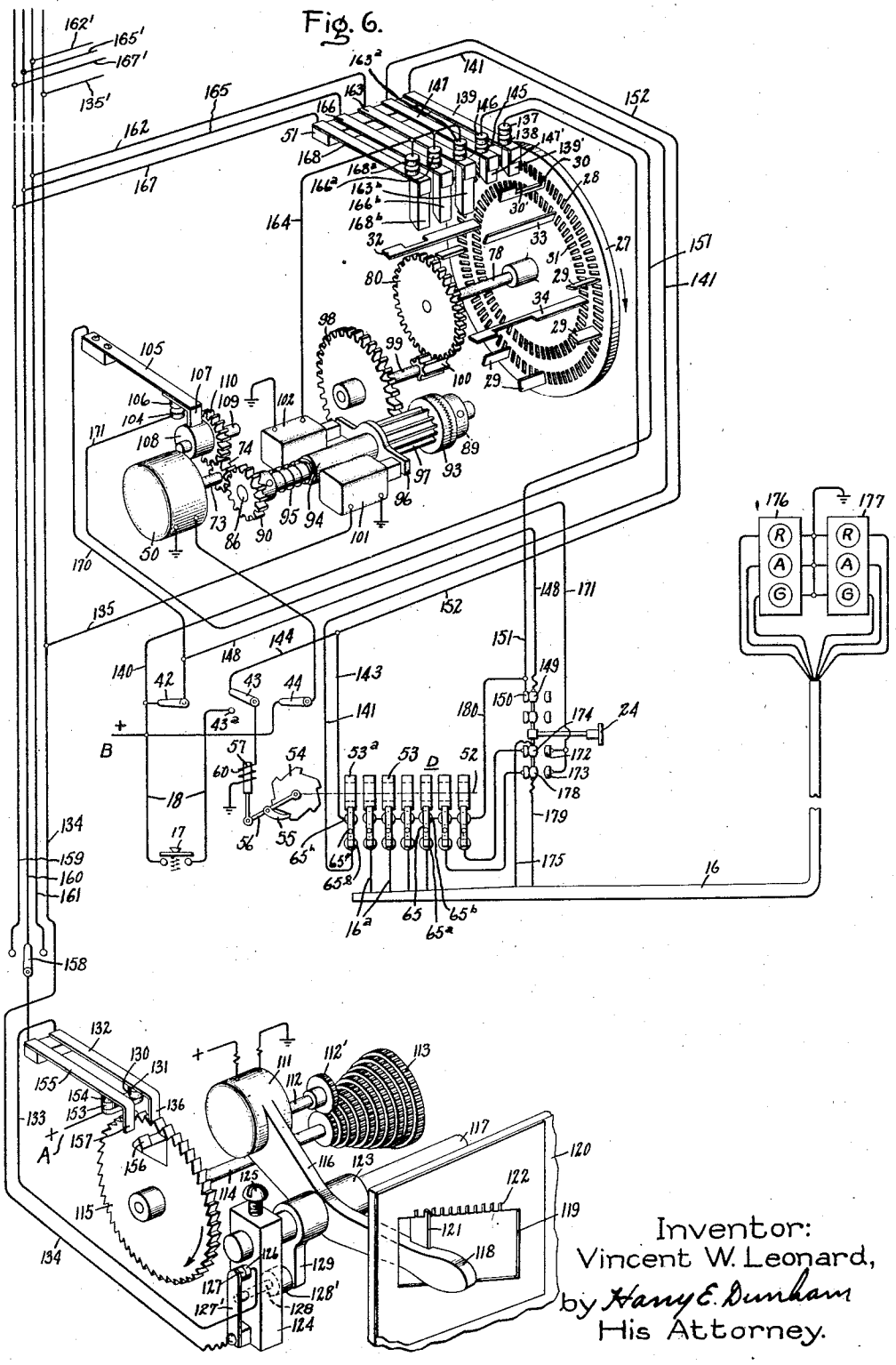
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ELECTRICAL SYSTEM

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Fig. 6.



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Patented Aug. 31, 1943

2,328,473

UNITED STATES PATENT OFFICE

2,328,473

ELECTRICAL SYSTEM

Vincent W. Leonard, Saugus, Mass., assignor to General Electric Company, a corporation of New York

Application October 1, 1940, Serial No. 359,262

17 Claims. (Cl. 177—337)

The present invention relates to electrical systems and particularly to such systems comprising one or a plurality of devices each operated by an electric motor. In such systems the operated device may be in the form either of an indicating device or a control device.

One object of my invention is to provide in such a system an improved construction and arrangement for varying from a remote point, such as a central control point or station, the period of time required for a motor to effect a complete cycle of operations of the device which it drives.

Another object of my invention is to provide in such a system an improved construction and arrangement for maintaining one or a plurality of operated devices in synchronous operating relation with a control device located at a central point or station.

A further object of my invention is to provide in such a system an improved construction and arrangement whereby the relationship between a plurality of operated devices may be changed from a central point or station.

Another object of my invention is to provide an improved construction and arrangement of timer apparatus for use in a system embodying my invention.

Other objects and advantages of my invention are pointed out hereinafter, and for a consideration of what I believe to be novel and my invention, attention is directed to the following specification and the claims appended thereto.

My invention is well adapted for use in street traffic signaling systems and as to certain features has special application to such systems. Accordingly, it is this application of it which I have elected specifically to illustrate and describe. It is to be understood, however, that the invention is not limited thereto necessarily except where so specified in the claims, but may be used wherever found applicable.

In the accompanying drawings, Fig. 1 is a front elevation of a traffic signal controller or timer embodying features of my invention and adapted for use in a system embodying my invention; Fig. 2 is a perspective view of an element of the timer shown in Fig. 1; Fig. 3 is a rear perspective view of the timer of Fig. 1; Fig. 4 is a side elevation of the cycle length regulating mechanism; Fig. 5 is a sectional view along lines 5—5 of Fig. 4; and Fig. 6 is a diagrammatic illustration of a system embodying my invention, the figure illustrating diagrammatically the elements of the controller or timer illustrated in Figs. 1 to 5, which may be termed an intersection or secondary controller or timer, a group of traffic signals connected thereto, and a master controller or timer also connected thereto.

Referring to the drawings in detail, Fig. 1 illustrates, in front perspective, a traffic signal controller of the type disclosed and claimed in the U. S. Patent 2,236,298, issued to Ralph A. Reid, March 25, 1941, and assigned to the assignee of the present application. It comprises a casing 10, a timer 11 supported on hinges 12 and 13, and a switchboard 14 mounted on the rear wall of the casing 10 and below the timer 11. A flexible cable 15 connects the timer 11 to terminals 23 on the switchboard 14 and a cable 16 connects the switchboard terminals 23 to the intersection signals. A hand-operated switch 17 with a suitable length cable 18 is connected to the switchboard terminals 19, 20. It is used to manually operate the traffic signals, and when not in use is stored in the bottom of the casing 10. The switchboard has mounted thereon a number of fuses. In the illustrated example there is one line fuse 21 and two fuses 22 which are connected into the system synchronizing conductors. A hand-operated switch 24, for changing the controller operation from normal sequence to flashing amber signal operation, is provided at the right end of the board.

In Fig. 1, only the front of the control panel 25 of the timer 11 is illustrated in detail. It is provided with a circular opening 26 in which a dial 27 is mounted for rotation. The dial 27 is provided with radial slots 28 arranged in a circle about the center of the dial in which keys 29 and 30 are placed. In the present instance there are five keys 29 and one key 30. The positioning of these keys relatively to each other determines and indicates the relative lengths of the individual signal periods or phases within a cycle. Any suitable number of slots 28 may be used. Preferably I use one hundred slots because this enables the lengths of the periods or phases of a total cycle length to be conveniently expressed in percentage of the total cycle length. A second group of radial slots 31 is arranged in a smaller circle about the center of the dial 27 and receives keys 32, 33 and 34. These keys are placed in selected ones of the slots 31 to indicate and to determine, as will appear later in this specification, three distinct relationships of the dial and of the signal time cycle of this controller to the dials and to the signal

time cycles of other controllers in the system. All the keys are held in their respective slots by a locking ring 35. This ring is provided with a supporting bar 41 by means of which it is mounted on the end of the dial shaft. It is locked to the end of the dial shaft by a knurled nut 36.

The panel 25 of the timer 11 is further provided with three control switches mounted in a horizontal row below the timer dial. Switch 42 controls the signal lamp circuits and has a "signal" position and an "off" position. Switch 43 controls the automatic and the hand operation of the signals and has an "automatic" position and a "hand" position. Switch 44 controls the timer motor circuit and has a "motor" position and an "off" position. The circuits which these switches control are illustrated in Fig. 6 and will be described in connection with that figure.

The panel 25 is further provided at its upper right-hand corner with a lug 45 in which a screw 46 is mounted which engages a threaded opening in a lug 47 on the casing 10. By means of this lug and screw arrangement, the timer may be secured in the casing, and if desired, may be released and swung outwardly on its hinges 12 and 13 for inspection.

Fig. 2 illustrates in perspective a key 29. It is an elongated sheet metal member having a body of such cross-section that it may be moved easily through a dial slot 28 and of such length as to engage and operate contacts mounted on the back of the control panel. It is provided with a head 37 which is notched to form a shoulder 38 and a handle 39. The keys 30, 32, 33 and 34 are provided with similarly shaped heads, the bodies thereof being of different lengths and provided with suitable notches as will later appear by reference to Fig. 6. In operation, the keys are placed in pre-selected dial slots until each head 37 engages the surface of the dial and prevents further movement inwardly. The ring 35 is then mounted on the end of the dial shaft and engages the shoulders 38 of the keys in both rows of slots. It is locked in this position by the knurled nut 36. The handle ends of the keys project over the edges of the ring and thereby indicate the respective positions of the keys.

The mechanism of the timer is illustrated in Figs. 3, 4, and 5 and is shown diagrammatically in Fig. 6. Fig. 3 is a perspective rear view of the timer having its cover 48 (partly shown in Fig. 1) removed to expose the mechanism. This mechanism comprises a driving motor 50 connected to drive the dial 27, a block 51 of insulating material which supports contacts actuated by the keys in the dial 27, a signal contact operating drum D, and operating mechanism arranged to operate the drum D step by step in response to actuations of certain of the contacts in block 51 by keys in the dial.

The block 51 is mounted on the back of the panel 25 above the dial 27 and supports contacts which are actuated by the keys in the dial. The contacts mounted in block 51 are only partly visible in Fig. 3. They are arranged in pairs, the contacts of each pair being normally out of contact with each other. When the dial rotates, each key in the dial momentarily raises the lower one of a selected pair to engage the upper contact of that pair, thereby closing a circuit and effecting an operation. The contacts are shown in greater detail, and the circuits are diagrammatically shown, in Fig. 6. Their operation will be described in detail in connection with that figure.

The signal contact operating drum D, as illustrated in Fig. 3, comprises a cam shaft 52 having thereon a plurality of disk cams 53 which control the circuits to the signal, a resynchronizing disk cam 53a and a ratchet wheel 54. It is mounted horizontally below the dial 27 in bearings mounted in lugs 61 and 62 projecting from the side of the panel 25. Lug 61 is integral with the panel and lug 62 is removable, being fastened in place by suitable screws 62a. The shaft with the ratchet wheel and cams is rotated step by step by a pawl 55 mounted on a pawl arm, or crank 56. The pawl arm is pivoted at one end on the shaft 52 and at the other end is pivotally connected to an armature 57 of a solenoid mechanism. This solenoid mechanism includes a magnet frame 58, pivotally supported from a lug 59 projecting from the rear surface of the panel 25, and an operating coil 60. The armature 57 moves axially through the coil and between the poles of the magnet frame. The coil 60 is intermittently energized by a circuit closed by the actuation of certain of the contacts in block 51. When the coil 60 is energized, it lifts its armature 57 and the pawl arm 56 to move the pawl 55 into a new notch in the ratchet wheel. When the coil 60 is deenergized, the armature 57 and pawl arm 56 drop and the pawl 55 turns the ratchet wheel 54 one step to a new position. A spring 67 mounted on the lug 64', integral with shelf 64 projecting horizontally from the lower edge of the panel 25, resiliently engages the pawl 55 at the end of this downward movement and prevents it from being forced out of its notch by any attempted movement of the drum past this position, and thereby prevents the drum from moving beyond this last position responsive to its momentum.

A contact block 63 of suitable insulating material is mounted on the panel 25 above shelf 64 and carries a series of movable contact arms 65, the ends of which ride respectively on the signal circuit controlling cams 53. Contact arms 65 are suitably supported adjacent to their lower ends and carry contacts 65a adjacent to their ends which engage fixed contacts 65b mounted on block 63. The contact arms are biased to a position wherein the contacts on the arms are in engagement with the fixed contacts by springs 65^c located between heads on pins 65^d and the arms. Pins 65^d are suitably attached to block 63 at their inner ends and project through openings in the arms. At 65^e are suitable terminals and terminal screws for connecting electrical wires of the cable 15 (see Fig. 1) to the terminals. The lower ends of the contact arms engage these terminals to receive current from these wires. In the present instance, six signal contact arms 65 are shown, this being the number required for the particular system illustrated. As shown at the right hand side of Fig. 3, however, space is provided for additional contact arms, should additional contact arms be needed for any system. Cooperating with the resynchronizing cam 53^a is a resynchronizing contact arm 65^f similar to contact arms 65 and provided with a contact 65^g which cooperates with a fixed contact 65^h on panel 63.

The cams 53, 53^a comprise disks the rims of which are divided into sections by radial slots, selected sections being broken out to provide cams of the desired contour. Cams of this type are more particularly shown in and comprise the subject matter of the application of Ralph A.

Reid, Serial No. 105,684, filed October 15, 1936, and assigned to the same assignee as this application. As the cams rotate, the contact arms 65 and 65f are held in positions such that the contacts 65a and 65g are out of engagement with cooperating contacts 65b and 65h when riding on the rim section, and are lowered where the rim sections are broken away to bring the contacts into engagement. The circuits connected to and controlled by these contacts are shown in Fig. 6 and will be dealt with in the description of that figure.

The driving motor indicated generally by the numeral 50 is preferably a self-starting synchronous motor of the type disclosed in U. S. Patent 2,105,513 issued to A. F. Welch. It includes a casing attached at one end to a supporting plate 70 by tabs 71 projecting from the casing and by screws 72 projecting through the tabs into the plate. The motor shaft 73, which is not shown in this figure but appears in Figs. 4 and 6, projects through the plate and is provided with a pinion 74.

The plate 70 is pivotally mounted on a frame 81 by a screw 75 projecting through the plate at one corner thereof and threading into a post 81a on the frame. It is held stationary in a selected position about this pivot by a screw 76 and washer 77, which clamp the edge of the plate at a point opposite its pivot against the end of a post 77a on frame 81 (see Fig. 5). The plate is clamped in the position in which the motor pinion 74 engages a gear 90 in the train connected to drive the dial 27. The pivotal mounting of the motor makes possible a readjustment of the position of the motor whenever it is desired to change the size of gear 90.

The dial 27 is mounted upon a shaft 78 (see Fig. 6), which shaft projects through a yoke 79 into the panel opening 26. It carries the dial on one end and a gear 80 on its other end. The yoke 79 projects across the panel opening 26 being attached to the back surface of the panel near the edge of the opening 26. It is sufficiently spaced from the panel opening to provide a clear space for the keys projecting from the back of the dial and to enable them to move with the rotating dial.

Frame 81 is U-shaped having a front wall 81b and a rear wall 81c. It is attached to yoke 79 by screws 82 and 83 and is held in correct spaced relation to yoke 79 by spacing lugs 84 and 85 carried by the yoke and frame respectively through which screw 82 passes and by similar spacing lugs (not shown) through which screw 83 passes. Carried by the walls 81b and 81c of frame 81 is a mechanism operable to control the operating cycle length of the timer. This mechanism comprises a clutch, means for opening and closing the clutch, and gearing through which the clutch is connected to motor pinion 74 and to the dial gear 80. Referring now particularly to Figs. 4, 5 and 6, such mechanism comprises a clutch shaft 86 mounted in suitable bearings 87 and 88 in frame 81. Fixed to shaft 86 at one end is one member 89 of the clutch and fixed to the shaft at the other end is a gear 90 which meshes with motor pinion 74. Clutch shaft 86 is held against axial movement by a plate 91 attached to frame 81 by screws 92 and having a forked end, the tines of which engage a groove in shaft 86.

The second and cooperating clutch member 93 is mounted upon a clutch shaft 94 in the form of a sleeve which surrounds and is suitably journaled on shaft 86 and is axially movable thereon. Clutch member 93 is normally held in closed position against the clutch member 89 by a spring 95 which surrounds clutch shaft 94 and is held under compression between the rear frame wall 81c and a bar armature 96 rigidly mounted on the shaft 94. The bar armature is axially spaced from the clutch member 93 and on the length of shaft 94, between the bar armature and the clutch member, teeth are cut to form a pinion 97 through which clutch shaft 94 is connected by intermediate gears to drive the dial 27. The intermediate gears are shown in Fig. 6 which shows the pinion 97 in engagement with a gear 98 mounted on a shaft 99. Shaft 99 is mounted in the frame 81 (Fig. 4), and carries a pinion 100 which is in engagement with gear 80 on the dial shaft to complete the gear train between clutch shaft 94 and dial 27.

Armature 96 is a bar of magnetic material and is mounted at its center on clutch shaft 94 to provide two ends or pole pieces arranged to rotate past the pole faces of two electromagnets 101 and 102. Electromagnets 101 and 102 are fixed to the inner face of frame wall 81c by suitable screws as shown in Figs. 4 and 5 and are arranged on diametrically opposite sides of clutch shaft 94.

The timer is provided with signal flashing contacts and operating means for the contacts. This mechanism comprises a block 103 of insulating material attached to the upper edge of the plate 70. (See Figs. 3 and 4.) Mounted on block 103 is a stationary contact 104 and cooperating therewith is a movable contact 106 carried at one end of a contact arm 105. The contact arm 105 is supported on the block 103 by a pin 105' and is urged downwardly by a suitable coil spring surrounding the pin, and which serves to bias arm 105 to a position in which contacts 104, 106 are in engagement with each other. At its free end, arm 105 is provided with a nose 107 which rides on the surface of a rotating cam 108 mounted on a shaft 109. Shaft 109 is journaled in frame 81 and has fixed thereon a pinion 110 which meshes with the motor pinion 74. When cam 108 rotates, it intermittently effects movement of contacts 104 and 106 into and out of engagement with each other.

Referring to Fig. 6, the master timer comprises a synchronous motor 111 which may be and is preferably the same type of motor as motor 50 in the secondary controller. The drive shaft 112 of motor 111 is provided with a pinion 112' which is shown in engagement with one gear of a gear cone 113. The gear cone 113 is mounted on a shaft 114 which shaft is parallel to the motor shaft 112. The speed at which this cone shaft is driven is determined by the speed of the motor shaft 112 and by the gear ratio between the motor pinion 112' and the engaged gear on the gear cone. The desired speed for the motor shaft is obtained by suitable speed reduction gearing enclosed in the casing of the motor 111 and a desired gear ratio is obtained by moving the pinion 112' into engagement with the gear of the cone which will give that desired ratio.

The gear cone shaft 114 drives a master dial comprising a toothed wheel 115 having thereon teeth which actuate a contact 131. Contact 131 is mounted on a resilient arm 132 which is rigidly mounted at one end and is provided with a nose 136 at its other end. The contact 131 rests on a stationary contact 130 the position of which may be made slightly adjustable in any suitable manner (not shown) and is so chosen that the

end of nose 136 falls below the path of the tooth ends and, therefore, into the notches between the teeth. When a tooth moves under the end of nose 136, contact 131 is lifted out of engagement with the stationary contact 130 to separate the contacts.

The contacts 130, 131 are connected in an electric circuit which includes the winding of the electromagnet 101 and which may be traced from the source of electrical energy A indicated by the plus sign adjacent to contact 130, through the contact to contact 131, arm 132, conductor 133, normally closed contacts 126, 127 (the function of which is hereinafter explained), arm 127', and conductors 134 and 135 through electromagnet 101 to ground. During operation, this circuit is normally closed so that magnet 101 is normally energized. It is opened each time a tooth on wheel 115 passes under nose 136 to lift contact 131 from engagement with contact 130.

The operation of the master timer to control and regulate the period of time for secondary dial 27 to make one complete revolution, will be now described.

Assume that motor switch 44 is closed, thus closing the operating circuit from the source of electrical energy B, indicated by the plus sign, through motor 50, and that motor 50 is running. Motor 50 will then continuously turn clutch member 89 and will turn amature 96 and dial 27 when clutch member 93 is in engagement with clutch member 89, i. e., whenever the clutch is closed. Also, assume that motor 111 is operating and through the gearing is turning master dial 115. Also, assume that each time the master dial 115 makes one revolution, the secondary dial 27 is to make one revolution and that to this end the gear ratio between the clutch shaft 94 and the dial shaft 78 and secondary dial 27, is 50:1, i. e., it requires 50 revolutions of clutch shaft 94 to turn the dial shaft and dial one revolution, and that there are 100 teeth on master dial 115. Since armature 96 has two pole pieces, a pole piece passes the pole face of magnet 101 each one-half revolution of clutch shaft 94, and since the speed ratio between clutch shaft 94 and secondary dial 27 is 50 to 1, then a pole piece passes the pole face of magnet 101 one hundred times during one revolution of secondary dial 27, a number equal to the number of teeth on dial 115. Further assume that the gear ratios are such that motor 50 through its gears would, if clutch 89—93 were continuously closed turn secondary dial 27 one complete revolution in sixty seconds and that it is desired that it be made to turn such dial one complete revolution each seventy seconds. To do this the master timer is set, as hereinafter explained, to cause the master dial to make one complete revolution in seventy seconds.

Now assume that contacts 130 and 131 are in engagement so that magnet 101 is energized and that a pole piece of armature 96 is held in engagement with the magnet pole face, thus holding open clutch 89—93 which means that dial 27 is stationary. Now, when a tooth of dial 115 moves contact 131 away from contact 130, thereby opening the magnet circuit, armature 96 is released and clutch shaft 94 is moved by spring 95 to close the clutch 89—93 whereupon motor 50 through the clutch starts to rotate the armature and, through the gearing, the dial 27. The arrangement is such that the time required for a tooth on dial 115 to move under nose 136 is such that it holds the magnet circuit open long enough for a pole piece of armature 96 to move away from the pole face of magnet 101, after which the magnet circuit is again closed.

Motor 50 turns clutch shaft 94 until the other pole piece reaches the pole face of magnet 101 whereupon it is attracted to the magnet pole face to again open clutch 89—93 and stop rotation of secondary dial 27. Since motor 50 drives shaft 86 and clutch member 89 at a speed such that shaft 86 makes a one-half turn before master dial 115 makes one-one hundredth of a turn, the pole piece will reach the magnet pole face and be attracted by it to open the clutch and stop rotation of dial 27 before the next tooth on dial 115 engages nose 136 and moves it to an extent sufficient to again open the magnet circuit. As soon as the next tooth on dial 115 does open the magnet circuit, the armature 96 is released to permit the armature to make another one-half turn after which it will be again stopped; and then released when the next tooth on dial 115 opens the magnet circuit. Thus there is imparted to the clutch shaft 94 and dial 27 a series of successive intermittent or step by step turning movements, one hundred such intermittent or step by step movements being required under the assumed conditions to impart one complete turn to dial 27. Since in the illustrated example, it has been assumed that motor 50 tends to turn dial 27 one complete turn in sixty seconds, this means that on each actuation dial 27 is turned for sixty-one hundredths of a second and is stopped for ten-one hundredths of a second. Or, viewed from another aspect, motor 50 through clutch 89—93 tends to turn dial 27 one complete revolution in sixty seconds and in order to increase the time for one complete revolution to seventy seconds, the dial is during its turning movement stopped for a total period of ten seconds, the ten seconds being divided up among one hundred separate stops, each one-tenth second in duration.

In a similar manner, secondary dial 27 can be made to make one complete revolution in a different period of time by operating master dial 115 at a different speed, the only limitation being that the speed be such that the time for one revolution of dial 115 is greater than the time in which motor 50 tends to turn dial 27 one complete revolution. In other words, secondary dial 27 can be made to make one complete revolution in any period of time greater than that in which motor 50 tends to turn dial 27 one complete revolution by suitably setting the driving means for master dial 115. Accordingly, in laying out the apparatus, it is so arranged that the desired minimum time for one complete revolution of the driven or secondary dial will be that at which the driving motor 50 drives the dial with clutch 89—93 continuously closed. This may be termed the basic cycle length. Then to effect a revolution of the driven or secondary dial in the minimum time, it is only necessary that the magnet circuit 101 be held continuously open so that clutch 89—93 remains closed.

It is to be understood that the specific figures given in the foregoing description of the operation of the apparatus are only by way of example and are not to be taken as in any way limiting the invention. However, in actual practice, I prefer to deal in hundredths since, as already stated, this enables the divisions or phases of a cycle of dial 27 to be expressed readily in percentages.

The nose 136 is so adjusted relatively to the teeth on the dial 115 that the contacts 130 and

131 are opened for a time period at least long enough for a pole piece of bar armature 96 to move away from the pole face of the electromagnet at all operating speeds of the master dial 115 and that the contacts 130 and 131 be reclosed before the other pole piece of the bar armature reaches the pole face of the electromagnet.

The speed of the master dial 115 is changed by changing the gear ratio between the motor pinion 112' and the gear cone 113. To facilitate this change in gear ratio, the motor 111 is supported on the end of a lever 116 pivoted by a sleeve 123 upon a shaft 117. The other end of this lever is provided with a handle 118 and projects through an opening 119 in a panel 120. A knife edge 121 is provided on the handle end of the lever to cooperate with notches 122 in a side of the opening 119. To slide the motor along the shaft 117, which is parallel to the cone axis, it is necessary to first move the lever 116 about its pivot. This movement disengages the pinion from the gear cone and releases the knife edge 121 from a slot 122. The lever may then be moved along the shaft 117 until the pinion 112' is in line with the selected cone gear. The lever then may again be moved about the shaft 117 until the pinion 112' engages the gear and the knife edge 121 simultaneously engages the corresponding notch 122. The notches 122 are arranged to take into account the size of the gears in the gear cone so as to effect proper meshing of pinion 112' with the gears of the cone.

The gears in the gear cone are chosen to provide a desired full range of speeds for the dial 115, the largest of the gears being chosen to give the longest desired operating cycle and the smallest being chosen to give an operating cycle longer than the basic cycle length of the secondary controller. This is necessary because, as above pointed out, the master controller functions only to increase the secondary controller cycle length over its basic cycle length. Stating this in terms of cycle length, the master controller may be made to function to maintain, for example, a 60 second or longer cycle length if the basic cycle length for the secondary controller, as determined by the gear ratio between motor 50 and dial 27, is less than 60 seconds.

The gear 90 of the secondary controller which determines the basic cycle length of the controller is arranged to be removed and another gear giving a different basic cycle length substituted. The master controller, on the other hand, is equipped with a gear cone which permits speed settings for a complete range of speeds and is not arranged to be changed should the range of control be limited by changing the gear 90 in the secondary controller. It is, therefore, desirable to provide means in the master controller to prevent the use of those gears on the gear cone which would tend to produce a revolution of dial 115 in a period of time less than the basic cycle length of the secondary dial. This means should be readily adjustable and should provide for a disconnection of the master controller if any attempt be made to adjust its speed so that it makes a complete revolution in a period of time less than that of the secondary controller basic cycle length. Such a means, which in the present instance is in the form of a cut-off switch, is provided on shaft 117.

The cut-off switch, or gear ratio limiting device, comprises a block of insulating material 124 slidably mounted on the shaft 117. It is arranged to be locked into any position to which it may be moved by a screw 125 projecting through the block into engagement with the shaft 117. The block has attached to it a stationary contact 126 and a movable contact 127 mounted on a resilient contact arm 127'. The contact arm is attached to the block at one end and normally holds the contact 127 in engagement with the contact 126, thereby holding closed at this point the circuit of magnet 101 to which these contacts are connected. A plunger 128 provided with a head 128' projects through the block and engages the contact arm 127'. When the contact arm is in closed contact position, the head 128' of the plunger is spaced from the side of the block. The sleeve 123 which carries the motor arm is provided with a lug 129 so that when the sleeve is moved close to the block 124, the lug 129 engages the head 128' of the plunger and moves the plunger to separate the contacts. Any further attempt to move the sleeve along the shaft 117 is then prevented by the block 124. In operation, therefore, it is first determined which of the gears at the small end of the cone are not usable because of the basic cycle length of the secondary controller, and the block 124 is moved accordingly and positioned to prevent the movement of arm 116 beyond the smallest gear which may be used. The block is moved into a position such that the lug 129 will just touch the plunger head 128' when pinion 112' is positioned to engage the smallest permissible gear on the gear cone and the block is locked in this position. The arm 116 may then be moved into position for putting pinion 112' into engagement with any one of the larger gears on the cone but any attempt to move it to put pinion 112' into engagement with a smaller gear on the cone, than is permissible, will first open the contacts 126 and 127 and then will be stopped by the block 124. In operation, when arm 116 is moved to a position in which contacts 127 and 128 are separated, the circuit of magnet 101 is opened so that clutch 89—93 remains closed and dial 27 is operated by motor 50 at its shortest or basic cycle length.

In actual practice, in the case of a traffic signaling system, the notches 122 in the master timer and the corresponding gears of cone 113 may be arranged to represent definite cycle lengths and be so marked. For example, the first notch at the left may represent a cycle length of 30 seconds and successive notches toward the right increase in cycle length by 5 seconds up to the maximum provided for. In setting up the system, the intersection timer may be provided with a gear 90 to give the desired basic cycle length, i. e., the cycle length at which the timer normally operates. For example, if the basic cycle length is to be 40 seconds, then a gear 90 is placed on shaft 86 of a size to give this basic cycle length with the clutch 89, 93 closed continuously. When the desired size of gear 90 has been placed in the intersection timer, knife edge 121 is placed in notch 122 corresponding to such basic cycle length which means that gear 112' is brought into engagement with the cone gear 113 corresponding to such basic cycle length. After this has been done, block 124 is adjusted along shaft 126 to a position in which contacts 126, 127 are separated by bringing head 128' into engagement with lug 129. Thus, the master timer is readily adjusted to correspond with the basic cycle length desired for the intersection timer.

The member which carries the keys or actua-

tors 29, 30 and the member which carries the circuit closer move relatively to each other to effect a cycle of operations, in the present instance a cycle of operation of the traffic signals. Normally, with clutch 89, 93 closed, motor 50 moves the movable member, in the present example dial 27, through its cycle in a predetermined definite period of time determined by the gear ratio between motor 50 and dial 27 which gear ratio, as already pointed out, may be changed readily by changing the size of gear 90. To increase this cycle length or time period, motor 50 moves the movable member through its cycle in a predetermined number of definite steps. The length of the period of time required for a complete cycle is then varied by varying the length of the period of time between steps, the number of steps remaining always the same.

Viewed from another aspect, it may be considered that electromagnet 101 is normally energized to hold the clutch open and that it is deenergized at definite intervals of time to permit the clutch to close and turn dial 27 one step of predetermined extent. A definite number of steps is required for dial 27 to make a complete revolution and the time required for a complete revolution is varied by varying the period of time between steps.

In the illustrated embodiment of my invention, magnet 101 and the clutch 89, 93 are shown so arranged that energization of the magnet opens the clutch. However, if desired, the reverse arrangement may be used and a form of clutch other than that illustrated may be used.

The rotation of secondary timer dial 27 effects successive energizations of magnet winding 60 to impart step by step turning movement to the signal contact operating drum D which in turn controls the operation of the traffic signals which are indicated diagrammatically at 176 and 177.

Carried by block 51 is a stationary contact 137 adapted to be engaged by a movable contact 138 fixed on the free end of a resilient arm 139, the other end of which arm is fixed on the block 51. Attached to the free end of arm 139 is an actuating block 139' having a sloping underside adapted to be engaged by keys 29. Dial 27 rotates in the direction indicated by the arrow and a key 29 in passing under actuating block 139' lifts contact 138 into engagement with contact 137, contact 138 dropping down out of engagement with contact 137 again as soon as the key passes beyond the block. When contact 138 engages contact 137, a circuit is closed through magnet winding 60 as follows: From source of energy B, indicated by the plus sign, conductor 140, contacts 137, 138, arm 139, conductor 141, contacts 65^g, 65^h (assumed to be closed), conductors 143 and 144, switch 43 and winding 60 to ground.

When this circuit, which may be termed the normal operating circuit for winding 60, is closed, armature 57 is lifted thereby lifting pawl 55 bringing it into engagement with the next tooth or notch on ratchet wheel 54; and when the circuit is opened again, armature 54 drops down to effect a turning movement of ratchet wheel 54 a distance equal to the distance between two teeth or notches. This turns the signal contact operating drum D a similar amount. In the present instance, the contact operating drum has six signal operating cams 53 and a resynchronizing cam 53^a. In Fig. 6, for purposes of illustration, the stationary contacts 65^b and 65^h and movable contacts 65^a and 65^g which are controlled by the cams on the drum D are shown as being spaced and bridged by the contact arms 65 and 65^f. The stationary contacts 65^a are connected by the conductors of cable 16 to traffic signals 176, 177 which are indicated diagrammatically as being in the form of the usual red, amber and green lights. The two right hand pairs of contacts 65^a, 65^b in the present instance control the amber lights and are connected thereto through contacts 174, 178 in switch 24. The other four pairs of contacts 65^a, 65^b control the green and red lights and are connected directly thereto. Cams 53 are shaped to operate contact arms 65 to give the desired signal sequences or signal cycle phases as the cams are turned step by step by pawl 55. All the signal lights are connected to source of supply B through contacts 149, 150 in switch 24. The circuits for the signal lights may be traced as follows: Source of supply B, switch 42, conductor 148, contacts 149, 150, and conductor 180 to the row of stationary contacts 65^b; then through the two right hand contacts 65^b to switch contacts 174, 178 in switch 24, and conductors 175 and 179 to the amber lights and through the other four contacts 65^b directly to the four conductors 16^a of cable 16. In the present instance, ratchet wheel 54 has six notches or teeth so that six operations of pawl 55 are required to turn the cams one complete revolution and thus operate the signals through one complete cycle. Resynchronizing cam 53^a is so shaped that in five of the six positions of the cams, the contacts 65^g, 65^h are in engagement while in the sixth position, which may be termed the resynchronizing position, they are separated. It will be noted that the normal operating circuit for magnet winding 60 includes the resynchronizing contacts 65^f, 65^g. Accordingly, a key 29 can effect energization of magnet winding 60 and a turning movement of the cams only when resynchronizing cam 53^a is in a position such that contacts 65^f, 65^g are closed.

Fixed at one end to block 51, adjacent to contact arm 139, is a contact arm 147 having at its free end a contact 145 adapted to engage a fixed contact 146 on the block. Also, on the free end of contact arm 147 is an actuating block 147' similar to actuating block 139'. Actuating block 147' stands in the path of movement of key 30 and as dial 27 rotates, block 147' is engaged by key 30 to lift contact arm 147 to bring contact 145 into engagement with contact 146, contact 145 dropping out of engagement with contact 146 again as soon as the key passes beyond the block. Key 30 is provided with a notch 30' so that it does not engage operating block 139'.

When contact 145 engages contact 146, a circuit is closed through magnet winding 60 as follows: From source of energy B through switch 42, conductor 148, normally closed contacts 149, 150 in switch 24, conductor 151, contacts 146, 145, contact arm 147, conductors 152, 144, switch 43, and winding 60 to ground. When this circuit, which may be termed the resynchronizing circuit, is closed, armature 57 is raised and when the circuit is opened again, the armature falls to effect turning of the signal operating drum one step as already explained. It will be noted this resynchronizing circuit does not include the contacts controlled by resynchronizing cam 53^a. Also, it will be noted that there are five keys 29 and one key 30, a total of six keys, and that there are six notches or teeth on ratchet wheel 54. Accordingly, for a complete revolution of drum D to effect a complete operating cycle of the traffic

signals, there are required six actuations, one by each of the five keys 29 and one by key 30.

Assume now that an intersection timer is operating, dial 27 rotating in the direction of the arrow, that the various switches are in the positions shown in Fig. 6, and that dial 27 is in correct synchronous relation with drum D. It will be seen that key 30 has just actuated contacts 145, 146 and moved beyond the same which means that the last actuation of drum D was through the resynchronizing circuit. Accordingly, resynchronizing cam 53a has been moved to the first position beyond the resynchronizing position and contacts 65e, 65h are closed. As dial 27 continues to rotate, keys 29 are brought successively into engagement with block 139' to successively close the normal operating circuit for magnet 60 and thus effect step by step turning movement of drum D. Upon actuation by the fifth key 29, i. e., key 29 just in advance of key 30 as regards the direction of rotation of dial 27, resynchronizing cam 53a will have reached a position in which it opens the resynchronizing contacts 65f, 65g. The next actuation will be by means of the resynchronizing key 30 engaging the block 147' to close the resynchronizing circuit. As long as dial 27 and drum D are in correct synchronous relation with each other, the operation just described will continue.

Assume now that dial 27 is not in correct synchronous relation with drum D. This may happen, for example, when the signals have been temporarily operated by hand control by moving switch 43 into position to close the circuit through hand switch 17 and the signals have been put back for operation by the controller by moving switch 43 back to the automatic position shown in the drawings. If the controller is started into operation with the drum and dial not in correct relationship relatively to each other, then if it so happens that the drum is in the position in which contacts 65e, 65h are in open circuit position, no energization of coil 60 and operation of the drum will occur until resynchronizing key 30 actuates contacts 145, 146 to close the resynchronizing circuit, keys 29 being ineffective to close the normal operating circuit since this circuit is open at the resynchronizing contacts 65f, 65g; and when this occurs, dial 27 and drum D will start operation in correct synchronous relation relatively to each other. On the other hand, if the controller is started into operation with the dial 27 and drum D not in correct relationship but at a time when resynchronizing cam 53a is in position such that resynchronizing contacts 65f, 65g are in closed circuit position, then keys 29 will effect operation of the drum until resynchronizing cam 53a is moved to a position in which the resynchronizing contacts 65f, 65g are opened after which no further operation of the drum can occur until resynchronizing key 30 actuates its contacts 145, 146 whereupon the dial 27 and drum D will start operation in correct synchronous relation relatively to each other. Thus, it will be seen that if at any time a controller is started up when the drum and dial are not in correct relationship relatively to each other, or if at any time during operation the drum and dial should for any reason get out of such correct relationship, they will be quickly brought back into correct relationship.

The keys 29 and 30 are placed around dial 27 to give the desired periods of time between successive actuations of the signal lights and as will be clear, the keys may be changed readily at any time to give the set-up desired. The key 30 is preferably placed at the end of the main street green period. The drum D being stopped at the corresponding position maintains the main street green period until it is advanced by the operation of the key 30. As a result of such positioning of the key 30, the heavy main street traffic is kept moving and the relatively light cross street traffic is held up for the period necessary to resynchronize the drum with the dial.

In a traffic signaling system comprising traffic signals at a plurality of successive intersections, it is desirable often to maintain a predetermined relationship between the signal cycles of successive intersections and also to change such predetermined relationship. For example, it may be desirable during the morning hours to favor the traffic coming into the city, during the evening hours to favor outgoing traffic, and during the day, to operate the signals for average traffic conditions. To accomplish this, there is provided in the system an improved form of reset mechanism.

In the master controller, there is provided a pair of resetting contacts 153, 154, the contact 153 being stationary and the contact 154 being fixed on the free end of a contact arm 155 which is fixed at its other end on a stationary support. The free end of contact arm 155 is provided with a downturned nose 157 adapted to be engaged by a tooth 156 carried by master dial 115. When tooth 156 moves under nose 157, it lifts contact arm 155 to move contact 154 out of engagement with contact 153; and when it moves beyond the nose, the contact 154 drops back into engagement with contact 153. Contact arm 155 is connected to a switch arm 158 by means of which it may be connected to any one of a plurality of conductors which extend from the master timer to the intersection timer, three conductors 159, 160 and 161 being illustrated in the present instance. Conductors 159, 160 and 161 are connected by conductors 162, 165 and 167 respectively to spring contact arms 163, 166 and 168. Contact arms 163, 166 and 168 are fixed at one end to block 51 and at their free ends are provided with contacts adapted to engage fixed contacts 163a, 166a and 168a. Also, at their free ends, they are provided with actuating blocks 163b, 166b and 168b similar to actuating blocks 139', 147'. The keys 32, 33 and 34 in dial openings 31 are adapted to engage actuating blocks 166b, 163b and 168b respectively, key 32 being provided with a notch so that it will not engage block 163b and key 34 being provided with a wider notch so that it will not engage either blocks 163b or 166b. When a key 32, 33, or 34 passes under the corresponding actuating block, the corresponding contact arm is raised to bring its contact into engagement with the corresponding fixed contact 163a, 166a or 168a, the arm dropping again to separate the contacts when the key passes beyond the actuating block. Fixed contacts 163a, 166a and 168a are connected by a conductor 164 to one terminal of electromagnet 102, the other terminal being connected to ground.

Assuming that switch 158 is connected to conductor 160, as shown in Fig. 6, the electromagnet 102 is in a circuit as follows: Source of electrical energy A, contacts 153, 154, contact arm 155, switch 158, conductor 160, conductor 165, contact arm 166, contact 166a, conductor 164, and through the electromagnet to ground. Contacts 153, 154 are normally closed. The contact on contact arm

166 and contact 166a are normally open. If secondary dial 27 is in correct synchronous relation with master dial 115, then when key 32 reaches actuating block 166b and raises it to close the circuit through magnet 102 at contact 166a, tooth 156 will have simultaneously reached nose 157 on contact arm 155 and raised the contact arm to open such circuit at contact 153, 154. As a result, nothing happens and dial 27 continues rotating. On the other hand, if secondary dial 27 is not in correct synchronous relation with master dial 115, then key 32 will reach actuating block 166b to close the circuit through magnet 102 at contact 166a at a time when tooth 156 on master dial 115 is not at nose 157. As a result, the circuit through electromagnet 102 will be closed, thus energizing the electromagnet 102 and when a pole piece 96 passes in front of the pole face of electromagnet 102, it will be attracted to open the clutch 89—93 and stop rotation of dial 27. The parts will then remain in this position until tooth 156 reaches nose 157 and moves contact 154 out of engagement with contact 153, thus opening the circuit through electromagnet 102. When the circuit through electromagnet 102 is opened, armature 96 is released to permit the clutch to close so that dial 27 is again driven by motor 50. Thus, it will be seen that dial 27 after being stopped due to energization of electromagnet 102 is started off again in correct synchronous relation with the master timer dial 115. If it is desired to change the synchronous relation between secondary dial 27 and master dial 115, switch 158 is moved to place electromagnet 102 in circuit with either conductor 159 or 161. If switch 158 is connected to conductor 159, then the circuit controlled by key 34 will be put into operation and when key 34 reaches actuating block 168b, it will close the circuit at contact 168a, thus closing the circuit through electromagnet 102 and stopping rotation of dial 27. Then when tooth 156 reaches nose 157, it will open the circuit at contacts 153, 154 and permit dial 27 to start operation in the new synchronous relation with the master timer. Likewise, by connecting switch 158 to conductor 161, the dial 27 can be placed in the synchronous relation to master dial 115 determined by the position of key 33.

The conductors 134, 159, 160 and 161 are line conductors which extend from the master timer, which may be located at a desired central point, to all the intersection timers of the system. In Fig. 6, these conductors are indicated as extending beyond the intersection timer illustrated and 135', 162', 165' and 167' indicate branch conductors corresponding to conductors 135, 162, 165, 167 leading to another intersection timer similar to the one illustrated. In actual practice, as many secondary timers as found desirable may be connected to conductors 134, 159, 160, 161, all controlled by the one master timer.

In such a system, the keys 32 of all the secondary or intersection timers would be located in their respective dials 27 so as to give one desired relationship of the signal cycles of the intersection timers of the system, and likewise the keys 33 and 34 would be located in their respective dials 27 to give two other desired relationships. Then by moving switch 158, the timers at all intersections can be changed from one signal cycle relationship to another; and having been so changed such new cycle relationship will be maintained automatically by the master timer. Also, when changing the signal cycle of relationship, or at any other time, the signal cycle length of all the intersection timers may be changed by changing the time of rotation of master dial 115 by means of the gearing 112', 113.

In the present instance, three resets are provided by the three conductors 159, 160, 161 but a greater or lesser number may be provided as found desirable. In this connection, it will be noted that the reset electromagnet 102 operates through the same mechanism in the intersection timer, i. e., the armature 96 and clutch 89, 93, as does the cycle length maintaining arrangement. This serves to simplify the construction and to make it possible to provide the reset arrangement at minimum cost. Also, it enables me to provide an intersection timer which without appreciable additional cost is arranged to have the multiple reset feature added to it since the timer may be built provided with the set of dial openings 31, the block 51 arranged to receive the additional contact arms 163, 166 and 168 and the contacts 163a, 166a and 168a, at negligible added cost. Then the timer may be sold as a complete apparatus without the parts required for the reset; and when reset is wanted, the needed additional parts may be added.

Also, it will be noted that the motor 50 and the mechanism between it and gear 80 which drives dial 27 are all carried by the frame 81 which in turn is attached to yoke 79 by the screws 82. By removing screws 82, the frame 81 and all the parts carried by it may be removed as a unit. This is advantageous in case of repair. Also, in case a simple timer is required without either cycle length adjustment or reset, frame 81 and the parts carried by it may be replaced by a similar frame having on it only a motor and gearing for direct connection to gear 89.

My cycle length adjusting mechanism whereby the total cycle length is increased by steps distributed uniformly throughout the cycle is of particular utility in a system wherein the cycle of the timer is made up of a number of different phases occurring one after another and wherein the length of time of the phases are to be adjusted relatively to each other, a condition met with in the case of traffic signals where the cycle is divided into "green," "red" and "amber" phases for example, since any increase or decrease in the cycle length will be uniformly distributed among the several phases. In the present instance, for example, there has been illustrated a construction wherein the dial 27 has one hundred slots 28 for keys 29, the master dial 115 has one hundred teeth, and a pole piece of armature 96 passes the pole face of electromagnet 101 one hundred times each cycle. Accordingly, any increase or decrease in the total cycle length is divided up proportionately among the cycle phases of the total cycle as determined by the location of keys 29 and 30 and this is true irrespective of how such keys are adjusted relatively to each other since there is a time adjustment for each key. Accordingly, in carrying out my invention, I prefer for best results to provide a number of increments of time adjustments equal to the number of cycle adjustment divisions, that is, in the present embodiment of my invention, a number of teeth on master dial 115 equal to the number of slots 28 in secondary dial 27. However, this is not essential necessarily, as sufficiently accurate results may be obtained in many cases by using a lesser number of increments of time adjustments. In the illustrated example, for instance, I might provide only fifty

teeth on master dial 115 in which case there would be an increment of time adjustment for every other slot 28 which would be sufficiently accurate in many instances. The important thing is that the total stopped period of the dial 27 during a cycle shall be divided among the successive phases of the cycle with a degree of accuracy satisfactory in the particular instance.

Another important advantage of my arrangement is that the dials of several controllers, after being brought into synchronism, are maintained in synchronism with each other and with the master controller throughout the operating cycle. It has been pointed out in the specification that each dial is moved by its respective motor for a predetermined distance, in the illustrated example 1/100 of its revolution, and then is stopped for a predetermined time period depending upon the increase desired over the basic time cycle. To carry out this operation, the armature is attracted to the pole face of the actuating magnet at the end of each half-revolution and is thereby positively held until the magnet coil is deenergized. One member of the clutch is attached to the armature shaft and the attraction of the armature operates this clutch member to open the clutch. The operation of the clutch magnet is such that the armature is substantially centered over the pole face during the attraction movement and through the train of gears connecting the armature shaft to the dial, the armature accurately and positively holds the dial at its predetermined corresponding position. As a result of this operation any discrepancies that may occur due to the difference in operating speeds of the several controllers are eliminated at the instant that the armatures reach their respective pole faces and are thereby held stationary. The clutch coils are thereafter simultaneously deenergized and the movement of each dial simultaneously starts and continues for another half-revolution of the clutch shaft, or 1/100 of a revolution of the dial.

In apparatus of the type used to illustrate my invention, the dials are driven by synchronous motors the speeds of which are exactly alike. It would be still possible for the dials to drift out of synchronism, however, if they were not positively stopped at each predetermined position, i. e., at the end of each half-revolution of the clutch shaft. With the apparatus built in accordance with my invention the dials are positively stopped at the end of each half-revolution of the clutch shaft. It is, therefore, possible to hold the dials in substantial synchronism throughout the moving and stopping periods if the dials are driven by synchronous motors, and to resynchronize the dials at the end of each step or one hundredth revolution, if other types of motors are used and there should be any asynchronous relationship caused by a variation in the speeds between these motors and the respective dials during that preceding step. It is of considerable advantage to use synchronous motors, however, because in case of central power failure the timer motors remain in step, also the timers may operate initially in a non-interconnected system subject to further interconnection without auxiliary control devices.

When it is desired to discontinue normal operation of the signals and have flashing amber operation, used often as a caution signal, switch 24 is moved to separate contacts 149, 150, thus disconnecting source of supply B from the drum contacts 65^b and to bring contacts 174, 178 to engagement with contacts 172, 173. This connects the amber lights to the flasher contacts 104, 106 by a circuit which may be traced as follows: Source of supply B, switch 42, conductor 170, contact arm 105, contacts 106, 104, conductor 171, contacts 172, 174, and 173, 178 to conductors 175 and 179 respectively and thence through the amber signal lights to ground. Now with the motor 50 running, contact 106 will be moved intermittently into engagement with contact 104 by cam 108 to continuously flash the amber signal. The cam 108 is driven directly from the motor pinion 74 and therefore provides a constant rate of flash regardless of the operating cycle length of the timer.

During operation of the amber signals as flashing signals, dial 27 will continue rotation. It will be noted that contacts 149, 150 are in the resynchronizing circuit which includes contacts 145, 146 so that when switch 24 is moved to "flashing amber" position, the resynchronizing circuit is opened at contacts 149, 150. As a result, keys 29 will effect step by step movement of drum D until the resynchronizing position of the drum is reached, that is, the position in which contact arm 65^f if moved by cam 53^a to separate contact 65^g from contact 65^h. This opens the normal operating circuit for drum D so that the drum will remain continuously in resynchronizing position. When switch 24 is moved back to normal operating position, it closes the resynchronizing circuit at contacts 149, 150 so that the first time the resynchronizing key 30 closes contacts 145, 146, the drum D will be started off in correct synchronous relation with dial 27 which is the green main signal position in the described controller.

To operate the signals manually, switch 43 is moved from the position shown in Fig. 6 to a position where it engages switch contact 43^a, thus connecting solenoid winding 60 directly to source of supply B through hand switch 17 and conductors 18. The drum controller can now be moved step by step as desired by closing hand switch 17. To put the timer back on automatic operation after it has been on hand operation, it is necessary merely to move the switch 43 from engagement with switch button 43^a back to the position shown in Fig. 6; and when moved back to this position, during the first cycle of operation of dial 27, such dial will be resynchronized with drum D as already explained.

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

1. In a traffic signaling system, the combination of a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which the circuit closer and the circuit closer actuators are respectively mounted, a motor, means including a clutch which connects the motor to one of said members for rotating it relatively to the other member to effect actuation of the circuit closer by the circuit closer actuators, said clutch being normally closed, and means for intermittently opening the clutch at uniformly spaced time intervals for a uniform selected time period during each revolution of said rotating member thereby intermittently to stop said rotating member to lengthen the period of time required for one revolution of such member beyond that at which the motor tends to operate such member with the clutch continuously closed and to distribute

uniformly throughout the rotation of said dial the increments of said additional time period.

2. In a traffic signaling system, the combination of a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which the circuit closer and the circuit closer actuators are respectively mounted, a motor, means including a clutch which connects the motor to one of said members for rotating it relatively to the other member to effect actuation of the circuit closer by the circuit closer actuators, said clutch being normally closed, and means for intermittently opening the clutch at spaced time intervals during a revolution of said rotating member thereby to stop intermittently said rotating member to lengthen the period of time required for one revolution of such member beyond that in which the motor tends to operate such member with the clutch continuously closed, and means operating through said clutch for maintaining a predetermined phase relationship between said last named means and said rotated member.

3. In a traffic signaling system, the combination of a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which the circuit closer and the circuit closer actuators are respectively mounted, a motor, means including a clutch which connects the motor to one of said members for rotating it relatively to the other member to effect actuation of the circuit closer by the circuit closer actuators, said clutch being normally closed, means for intermittently opening the clutch at spaced time intervals during a revolution of said rotating member thereby to stop intermittently said rotating member to lengthen the period of time required for one revolution of such member beyond that in which the motor tends to operate such member with the clutch continuously closed, means operating through said clutch for maintaining a predetermined phase relationship between said last named means and said rotated member, and means operating through said clutch for changing the phase relationship between said penultimate means and said rotated member.

4. In a traffic signaling system, the combination of a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which the circuit closer and the circuit closer actuators are respectively mounted, a motor, means including a clutch which connects the motor to one of said members for rotating it relatively to the other to effect actuation of the circuit closer by the circuit closer actuators, said clutch being normally closed, an electromagnet for opening the clutch, a circuit for the electromagnet, means for varying said circuit to cause the electromagnet to open intermittently the clutch at spaced time intervals during a revolution of said rotating member thereby to stop intermittently said rotating member to lengthen the period of time required for one revolution of such member beyond that in which the motor tends to operate such member with the clutch continuously closed, and means comprising a second electromagnet operating through said clutch for maintaining said rotated member in a predetermined phase relationship with said circuit varying means.

5. In a traffic signaling system, the combination of a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which the circuit closer and the circuit closer actuators are respectively mounted, a motor, means including a clutch which connects the motor to one of said members for rotating it relatively to the other to effect actuation of the circuit closer by the circuit closer actuators, said clutch being normally closed, an electromagnet for opening the clutch, a circuit for the electromagnet, means for varying said circuit to cause the electromagnet to open intermittently the clutch at spaced time intervals during a revolution of said rotating member thereby to stop intermittently said rotating member to lengthen the period of time required for one revolution of such member beyond that in which the motor tends to operate such member with the clutch continuously closed, means comprising a second electromagnet operating through said clutch for maintaining said rotated member in a predetermined phase relationship with said circuit varying means, and means operating through said second electromagnet and said clutch for changing the phase relationship between said rotated member and said circuit varying means.

6. In combination, a rotating member, a motor, means connecting the motor to the member including rotating clutch members, an armature rotating with one of the clutch members, an electromagnet having a pole face adjacent the path of movement of the armature, an electric circuit for electromagnet, means for varying said circuit to cause the electromagnet through said armature to open the clutch a predetermined number of times during a revolution of said member, and means for varying the length of the period of time between clutch openings to vary the period of time required for a revolution of said member.

7. In combination, a dial, a plurality of spaced actuators carried by the dial, said actuators being adjustable on the dial relatively to each other, means operated through a cycle by said actuators, means for imparting to said dial step-by-step turning movements of predetermined extent, means for varying the period of time between steps to vary the time required for a cycle of operation of said first mentioned means, and means for maintaining said dial in a predetermined phase relation with said period varying means.

8. In combination, a rotating secondary dial, a motor, a master dial, means controlled by the master dial for effecting turning of the secondary dial by the motor one complete revolution in a predetermined number of steps, means for varying the period of time between steps to vary the time for a complete revolution of the secondary dial, and means for changing the phase relation between said secondary dial and said period varying means.

9. In combination, a rotating member, a motor, means connecting the motor to the member including rotating clutch members, an armature rotating with one of the clutch members, electromagnet means for moving said armature to open the clutch and thereby stop movement of the rotating member, and means electrically connected with said electromagnet means for opening the clutch a predetermined number of times during a revolution of said member and maintaining it open each time for a predetermined period of time to effect a revolution of said member in a predetermined period of time and for maintaining said rotating member in a definite phase relation with said last named means.

10. In combination, a rotatable dial, actuators on the dial adjustable thereon relatively to each other to a predetermined number of definite positions, a shaft, gearing connecting the shaft to the dial requiring that the shaft make a number of turns commensurate with said number of positions to turn the dial one complete revolution, means for successively imparting to the shaft said number of turns, and means for varying the interval of time between turns to increase the period of time required for the dial to make a complete revolution.

11. In a traffic signaling system, the combination of a plurality of secondary timers connected in parallel, each comprising a rotating member controlling the operation of traffic signals, switch means operated by the rotating member, a motor, a clutch through which the motor drives the rotating member, and means for opening the clutch, a master timer, switch means operated by the master timer, a synchronizing circuit including said last named switch means and the first mentioned switch means and the clutch operating means of each secondary timer, said two switch means being operable to effect opening of the clutch and stopping of the rotating members of all the secondary timers in a predetermined phase relation relatively to each other and then to effect closing of all the clutches to start the rotating members operating in such phase relationship.

12. In a traffic signaling system, the combination of a plurality of secondary timers connected in parallel, each comprising a rotating member controlling the operation of traffic signals, a motor, a clutch through which the motor drives the rotating member, and means for opening the clutch; a master timer, a plurality of circuits, switch means for connecting the master timer to any one of said circuits, switch means for each circuit in each secondary timer controlled by the rotating member of such timer, and through which each circuit is connected to the clutch opening means, a switch means common to all said circuits, and means in the master timer for operating said last named switch, said last named switch means and the switch means in each secondary timer of a selected circuit being operable to effect opening of the clutches and stopping of the rotating members of all the secondary timers in a predetermined phase relation to each other and then to effect closing of all the clutches to start the rotating member operating in such phase relationship.

13. For use in a system of the character described, a timer comprising a circuit closer for controlling signal circuits, a plurality of circuit closer actuators, members on which said circuit closer and said circuit closer actuators are respectively mounted, one of said members being rotatable relatively to the other, a motor, gearing connecting the motor to the rotatable member comprising clutch members and driving and driven clutch shafts movable axially relatively to each other on which the clutch members are mounted, an armature mounted to rotate with the axially movable shaft, and an electromagnet mounted adjacent to the path of movement of the armature and having a pole face past which the armature moves, said electromagnet when energized being adapted to move said armature to operate the clutch.

14. For use in a system of the character described, a timer comprising a rotatable dial, a motor means including a movable clutch member for connecting the motor to the dial, an armature which rotates with said connecting means and is connected to said clutch member, and an electromagnet having a pole face past which the armature rotates and which when energized moves the armature to actuate said clutch member.

15. In a signal control system the combination of a motor, a signal control dial, means including a clutch connecting said motor to said dial, means for opening said clutch at predetermined positions during its revolution, and a master controller connected to operate said last-mentioned means to delay said dial at the predetermined positions corresponding to said clutch opening positions.

16. In a timer for use in a system of the character described, the combination of a signal control dial, a motor, a clutch connected between said motor and said dial, said clutch having a clutch member connected to said motor and a second clutch member connected to said dial, and an electric current responsive device arranged to operate said second clutch member to disconnect said motor from said dial at a predetermined position of the clutch and to hold said clutch member and said dial stationary.

17. In combination a rotatable dial, a continuously rotating motor, means for connecting the motor to the dial comprising a clutch, means for normally closing said clutch, means for opening said clutch comprising a bar armature connected to the clutch member which is in driving connection with the dial, an electromagnet having a pole face substantially equal to the width of the bar armature and positioned along the path of movement of said armature and means for periodically energizing said electromagnet during a revolution of said dial whereby said clutch is opened and said armature with the said dial connected thereto are periodically stopped at predetermined positions corresponding to the timing of the excitation of said electromagnet and corresponding to the positioning of said electromagnet along the path of movement of said armature.

VINCENT W. LEONARD.

CERTIFICATE OF CORRECTION.

Patent No. 2,328,473. August 31, 1943.

VINCENT W. LEONARD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 30, for "egainst" read --against--; page 9, first column, line 69, for "further" read --future--; page 10, second column, line 30, after "for" first occurrence, insert --the--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

CERTIFICATE OF CORRECTION.

Patent No. 2,328,473. August 31, 1943.

VINCENT W. LEONARD.

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