Jan. 6, 1953 F. A. PEARSON 2,624,793

TRAFFIC SIGNALING SYSTEM AND APPARATUS

Filed Feb. 21, 1949 4 Sheets-Sheet 1

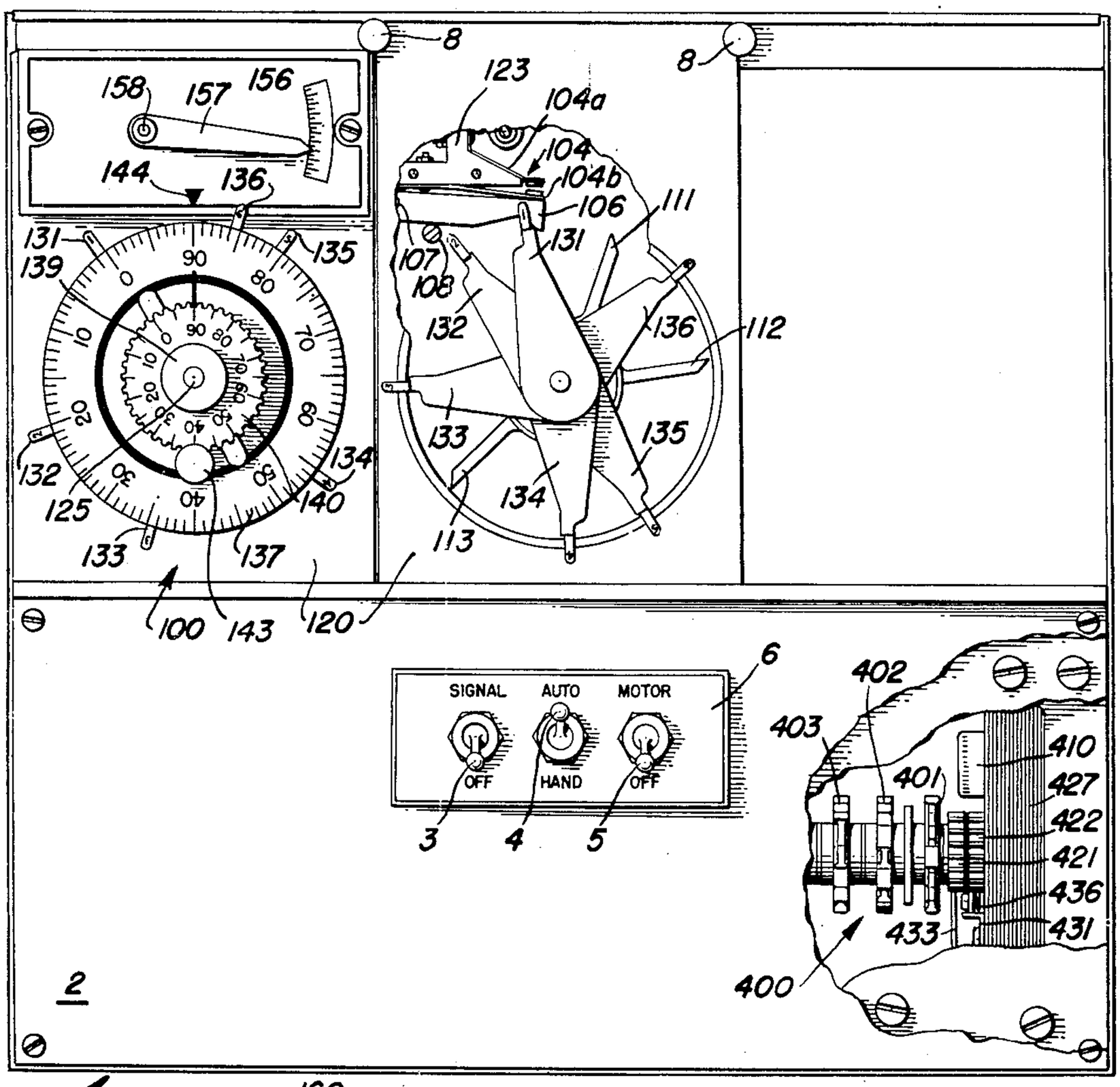

Fig. 1

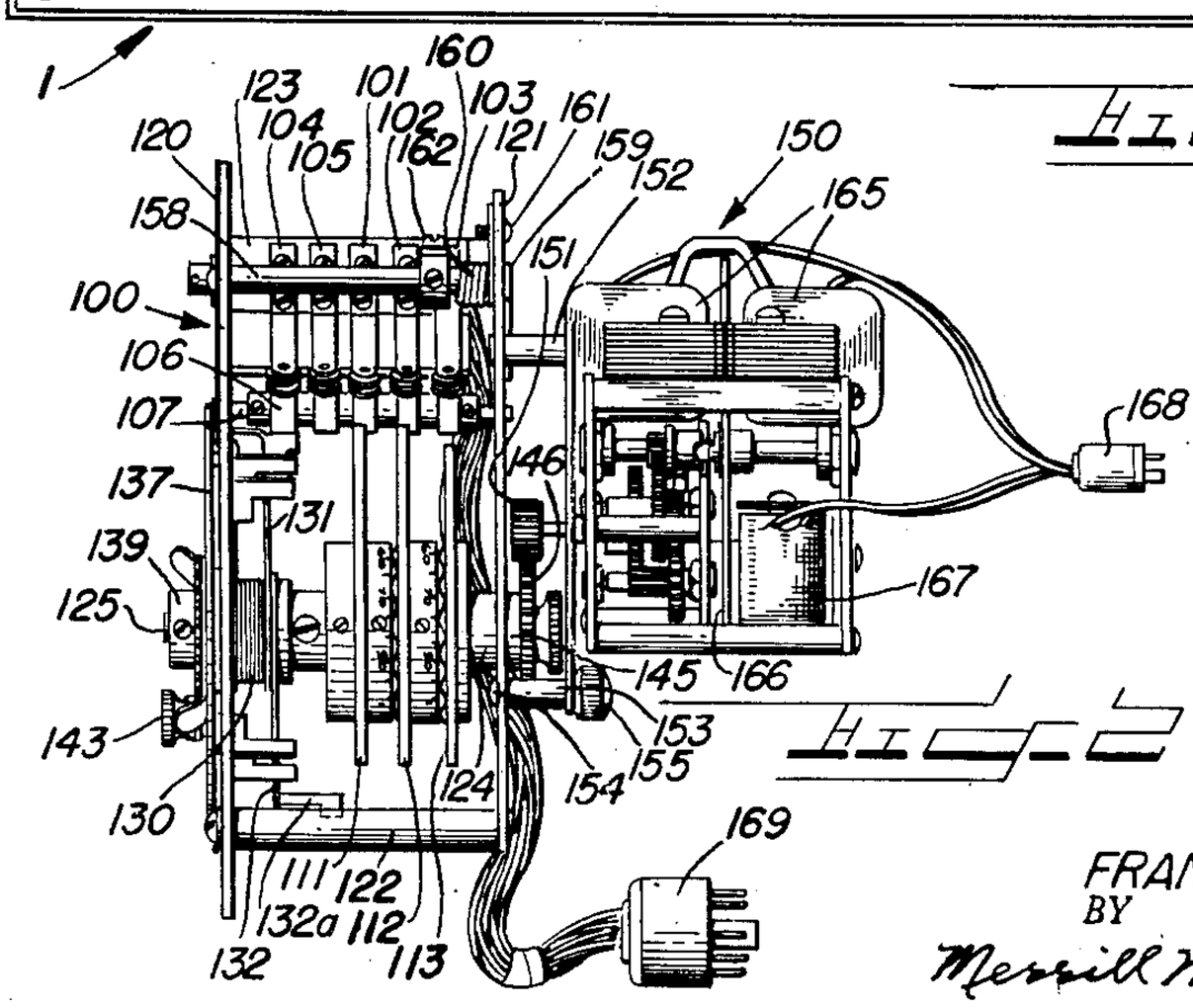

Fig. 2

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TRAFFIC SIGNALING SYSTEM AND APPARATUS

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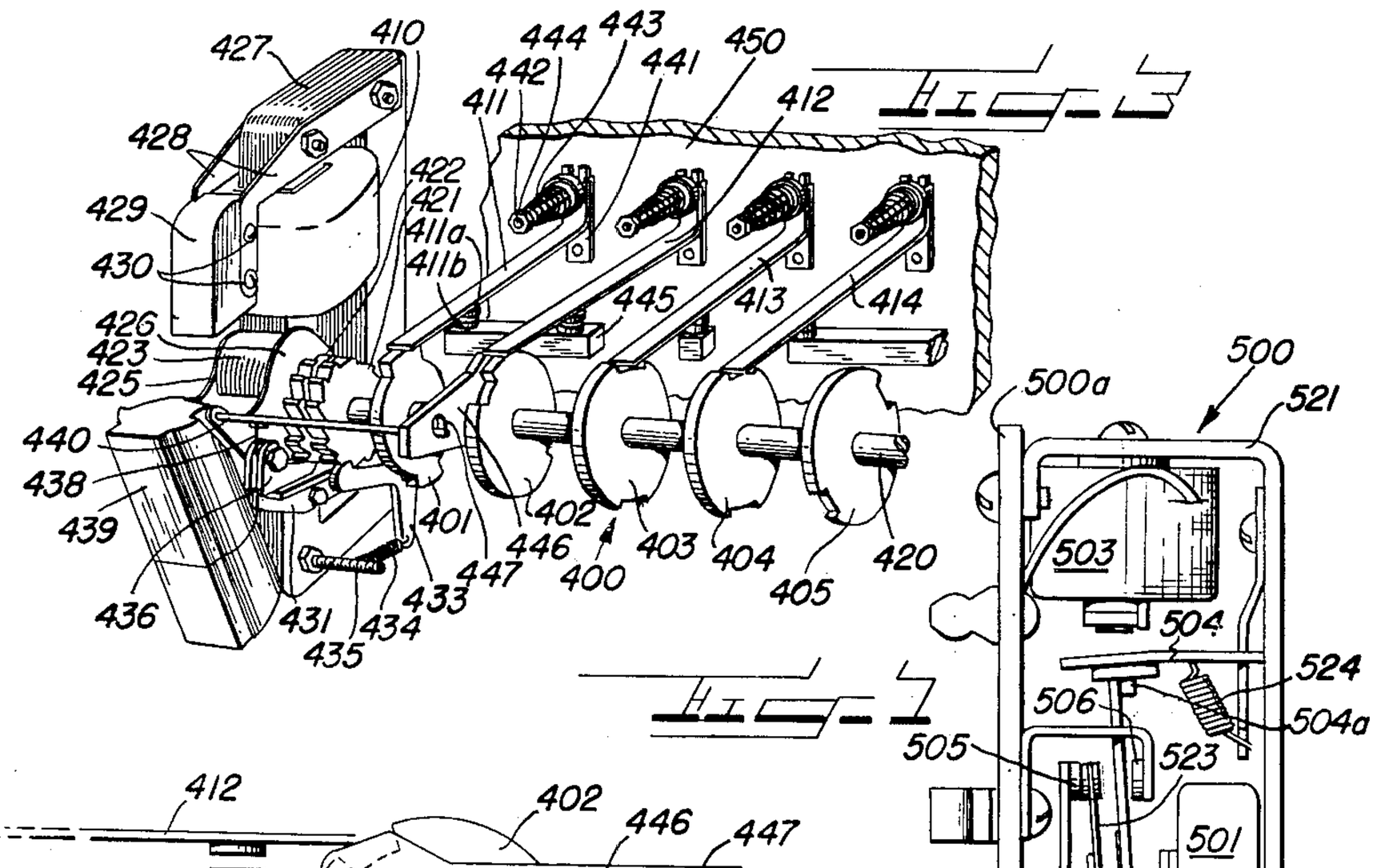

FIG 3

FIG 7

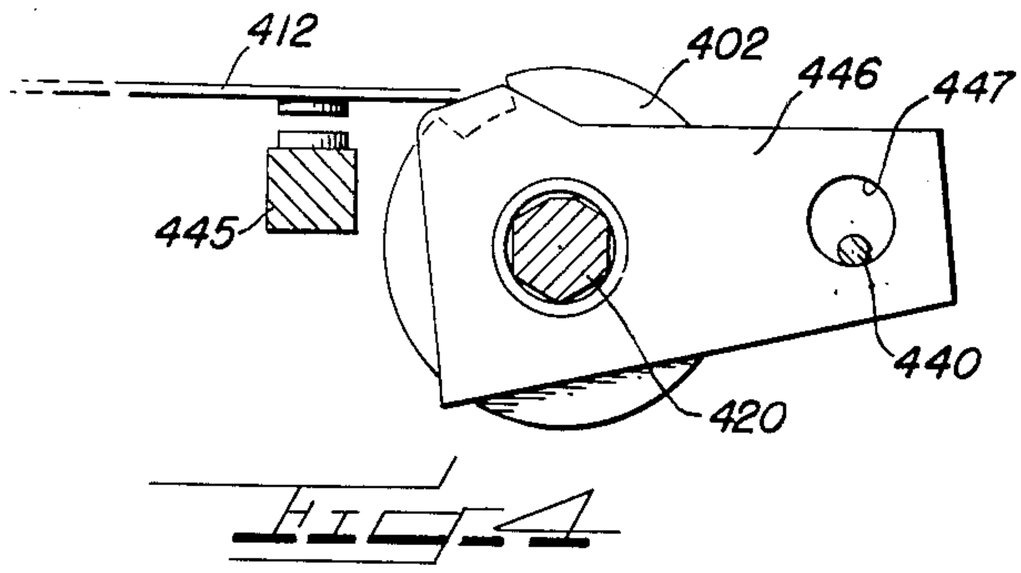

FIG 4

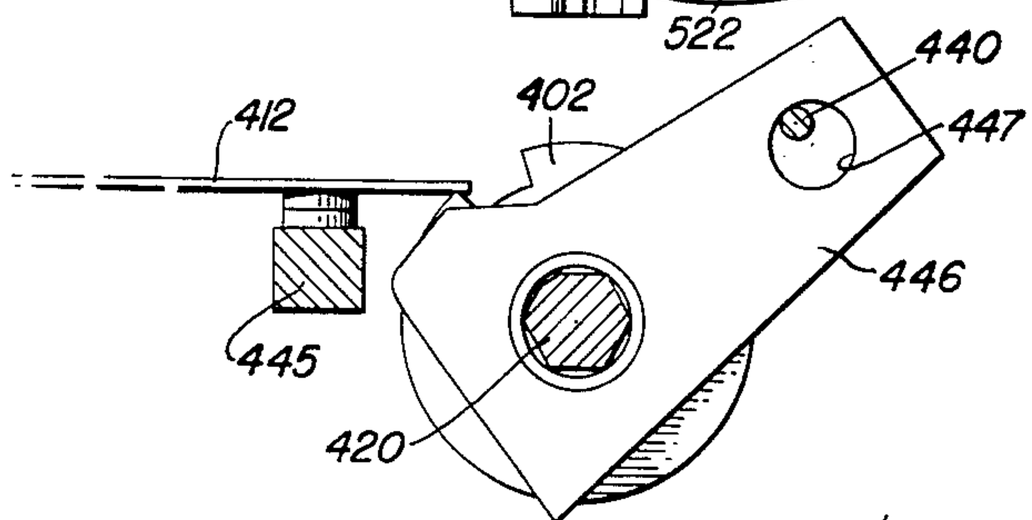

FIG 5

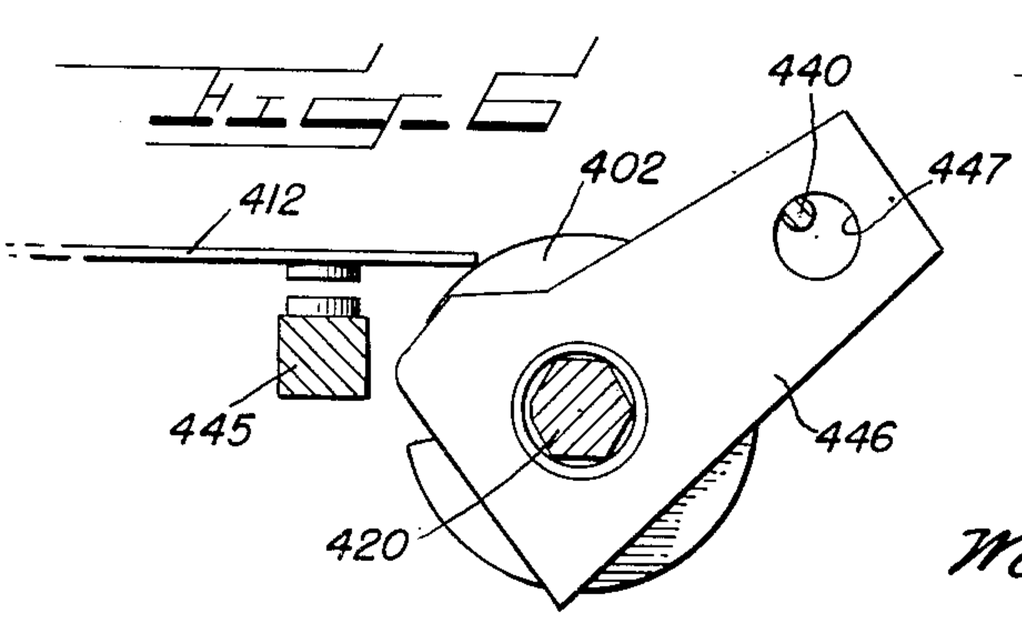

FIG 6

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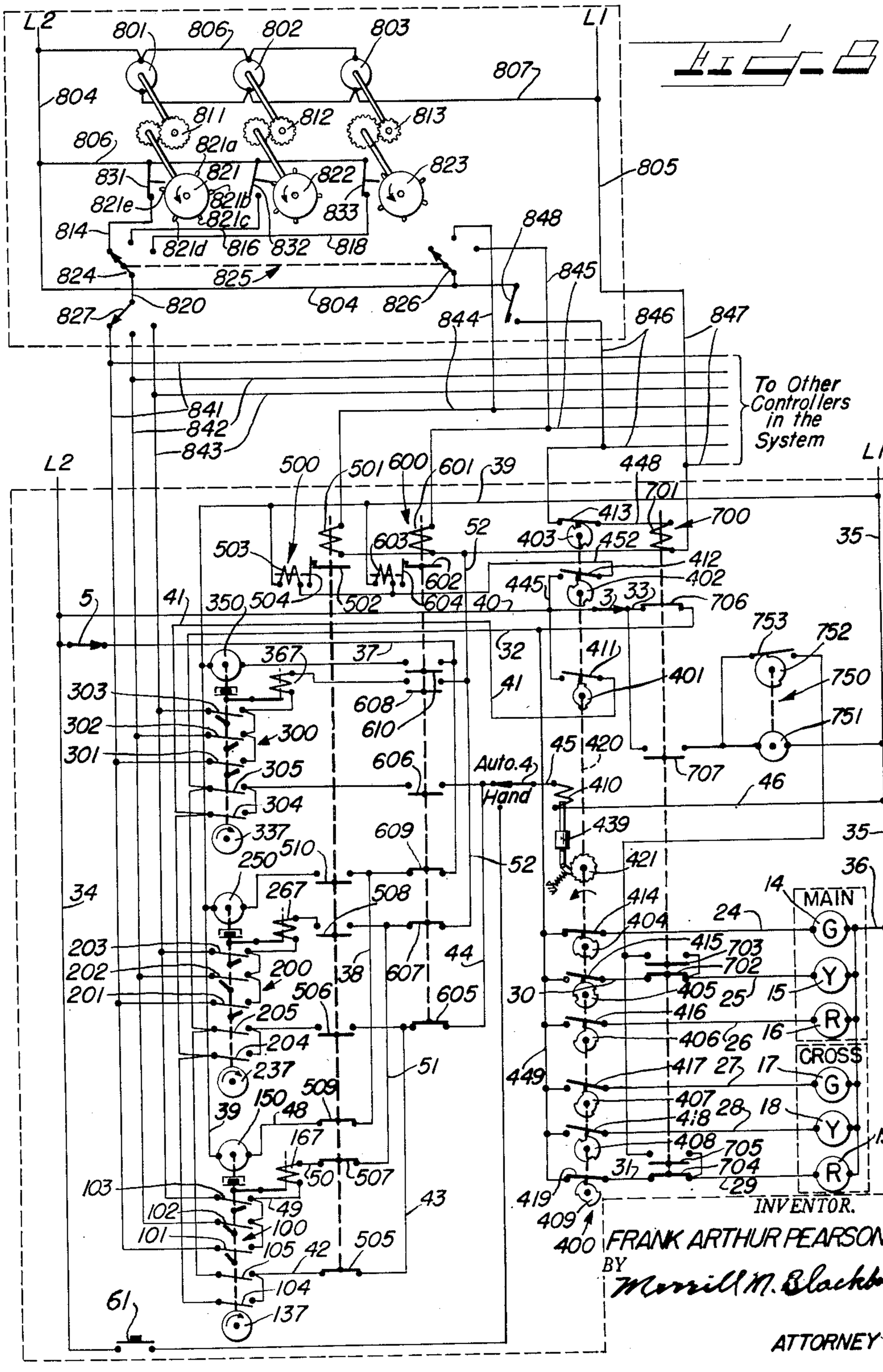

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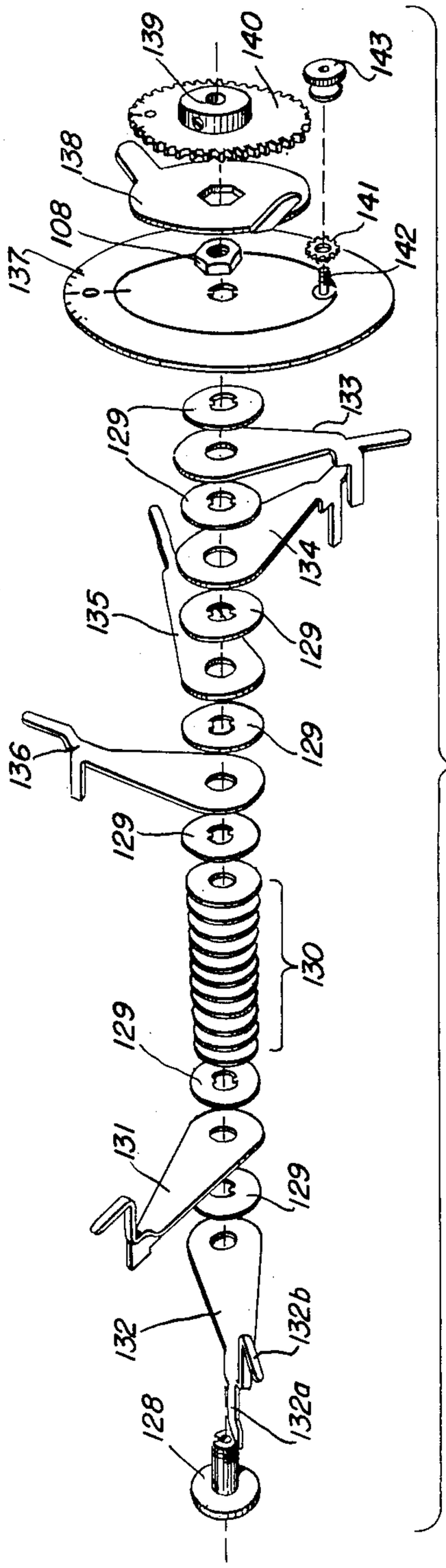

FIG. 5

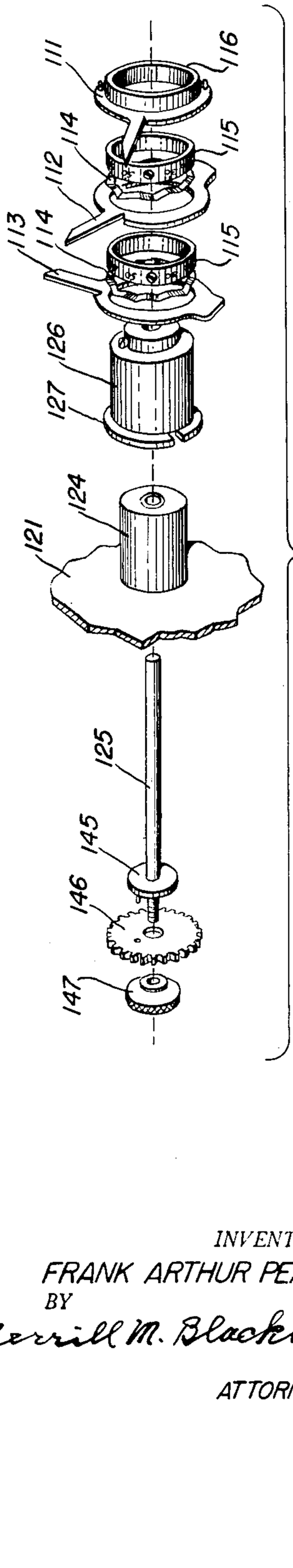

FIG. 10

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UNITED STATES PATENT OFFICE

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TRAFFIC SIGNALING SYSTEM AND APPARATUS

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Application February 21, 1949, Serial No. 77,528

14 Claims. (Cl. 177—337)

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This invention relates to signaling systems and apparatus and more particularly to apparatus for providing different schedules of traffic control at different times of the day.

On main thoroughfares, it is desirable to provide a traffic control system that will permit a car starting at one end of the main street to travel at a designated speed and be given a green "Go" signal at each intersection. This is termed a progressive traffic control system as the main street green signals at each intersection are timed to come "On" as the vehicle progresses down the street at a specified speed.

The equipment used to provide this type of traffic control normally consists of a local controller at each street intersection which is synchronized with a single master timer. The local controller has a step switch which operates the signals in the proper sequence. A motor driven cycle dial with adjustable levers operates a set of switches momentarily to advance the step switch from one position to the next. The time that the signals remain in each condition is determined by the positioning of the dial levers. The signals go through a complete cycle in the time required for the cycle dial to make one revolution. The cycle dial on each controller is synchronized by the master timer so that the cycle dial at each intersection rotates according to a predetermined phase relation with each other and thus provides progressive movement of traffic along the main street.

This invention pertains mainly to above mentioned type of traffic controllers except having multiple cycle dials any one of which may be selected to advance the step switch. Multiple cycle dials permit setting a different timing program on each to handle different traffic conditions most efficiently.

For each traffic condition, the time cycle and percentage of red and green indications required for each intersection can be determined by making a time-space chart. The intersections are located on the chart according to their spacing in feet. A group of vehicles progressing down the street is represented by two parallel lines drawn diagonally across the chart. The slope of the line represents the speed of vehicles in feet per second. This chart determines the number of seconds which must occur from a given reference point to the start of the green period at each intersection. A convenient reference point is the synchronizing point of the master controller. The term "offset" is used herein as the percentage of the total cycle that the start

2

of the main street green at the intersection is shifted from a "0" reference point in the master controller cycle.

For average conditions, traffic will be approximately the same in each direction along the main street, and the cross street traffic will be an appreciable percentage of the total. For these conditions it is advantageous to use a short signal cycle to eliminate long waiting periods on either street. To allow for progression of an equal volume of traffic in each direction, the offsets should be determined from the time-space chart. The time cycle, percentage division and offset are set on dial #1 of the controllers at each intersection.

Heavy inbound traffic occurs during certain times of the day such as the hours just before the stores and offices open. This traffic moves more slowly because many are seeking parking places or turning off into side streets. A time-space graph made for this condition is based upon a slower speed and a wider inbound traffic band. A slower time cycle and larger percentage of the cycle for main street green would be used. The schedule thus determined is set on a second cycle dial of each controller which would be operative at periods of heavy inbound traffic. The time cycle, percentage division, and offset may all be different than the schedule on dial #1. Similarly, outbound traffic will be heavy just after the stores and offices close. The schedule determined by a time-space graph can be set on a dial #3.

In many cases where the intersections are evenly spaced, the same percentage division of a cycle for outgoing and ingoing traffic can be used, except a different offset may be required. My controller provides a selection of offsets for each dial. The same dial can be used for both outgoing and ingoing traffic in these cases. The other dial can then be used to provide a greater percentage green for the cross street traffic and used during periods when cross traffic is heavier than normal.

Previous types of multi-dial controllers have not been provided with a satisfactory means of transferring the step switch control from one dial to the other. If this transfer is made without proper synchronization, the signals may remain in one position for an extended period which may be under some circumstances as long as the main street green interval. This causes confusion and unnecessary interruption of traffic.

One object is to provide means whereby a minimum disturbance will result in the move-

ment of traffic at an intersection when transferring from one schedule to another. This makes the transfer possible only when the cycle dials and step switch are in a selected position.

Another object of my invention is to provide an improved system of traffic control in which each dial of a multi-dial controller is driven by a separate motor at a selected speed, anyone of which may be selected to control the signal cycle.

Another object is to keep the signal control step switch in synchronism with the cycle dial when transferring from one cycle dial to another.

Another object is to provide a selection of offsets for each cycle dial and a simple method of selection from a remote point.

Another object is to provide a step switch mechanism with a switch to provide a momentary impulse for effecting transfer from one dial to another when the step switch is in a predetermined position.

Another object is to transfer from normal "Stop" and "Go" indications to flashing night light only when the signals are in a predetermined position.

Reference is made to the following description and the accompanying drawings for a better understanding of my invention together with other and further objects thereof.

Referring to the drawings,

Fig. 1 illustrates a front view of the controller built in accordance with my invention. The second dial is removed and part of the front plate cut away to show the contact mechanism. Space for the third dial is shown. Part of the bottom panel is cut away to show the location of the step switch.

Fig. 2 is a side view of a cycle dial unit.

Fig. 3 is a schematic view of the step switch.

Figs. 4, 5, 6, are detail views of the transfer cam and contact on the step switch.

Fig. 7 is a side view of the transfer relay.

Fig. 8 is a schematic across-the-line diagram of the electrical circuit of the master timer and a local intersection controller.

Fig. 9 is an exploded view of the cycle dial.

Fig. 10 is an exploded view of the cycle dial cam shaft and offset levers.

Referring to the drawings in detail, Fig. 1 illustrates a front view of the controller housing 1 having a front panel 2 on which are mounted toggle switches 3, 4, and 5, with a legend plate 6. A suitable ledge is provided on the top edge of plate 2 to support three cycle dial units which are held in position by thumb screws 8. Step switch 400 is mounted behind the front panel 2 under the cycle dial units.

The three cycle dial units are identical to each other. Figs. 1, 2, 9 and 10 illustrate the construction in detail with the parts numbered in the 100 series. To distinguish between the three cycle dial units in Fig. 8, all parts marked with a number in the 100 series in this figure are a part of the first cycle dial unit. All parts marked with a number in the 200 and 300 series belong to the second and the third cycle dial units respectively. The last two digits of all numbers in the 200 and 300 series refer to the same parts in Figs. 1, 2, 9 and 10 having the same last two digits. The cycle dial units may also be termed timers as they provide impulses according to a preset timed schedule to advance shaft 420.

The cycle dial unit shown in Fig. 2 consists of a front plate 120 and a back plate 121 held parallel by posts 122 and an insulating contact block 123. A flexible contact leaf 104*a* is mounted

on the top of contact block 123. Another flexible contact leaf 104*b* is mounted on the bottom of contact block 123. Each of the above contact leaves has a contact point attached to one end. The leaves are formed so the contacts on each spring are normally separated from each other. The above pair of contact leaves comprise a switch hereinafter termed switch 104. An insulating finger 106 pivoted at one end on shaft 107 is located under leaf 104*b*. Shaft 107 is carried by bearing holes in plates 120 and 121. Finger 106 is held in proper alignment with the contact leaf 104*b* by suitable spacers and collars assembled on the shaft 107. Pressing upward on finger 106 causes it to press bottom contact leaf 104*b* upward to make contact with a top leaf 104*a* thus completing a circuit through the switch. The weight of finger 106 causes it to drop back to its normal position where it lays against a post 108 between plates 120 and 121. Four additional pairs of leaves mounted on block 123 comprise switches 101, 102, 103, and 105 each actuated by a finger 106.

Plate 121 has a long sleeve bearing 124, best shown in Fig. 10, riveted thereto which carries a dial shaft 125. Attached to shaft 125 is a cup shaped drum 126 counterbored from one end to fit over part of bearing 124 and which has an outwardly projecting flange 127. Assembled against flange 127 is an arm 113. Against arm 113 is a spring washer 114 and a sleeve 115 fastened to drum 126 with a set screw. Another set of these parts, consisting of an arm 112, washer 114, and another sleeve 115 is assembled on drum 126 in a similar manner. An arm 111 assembled rigidly on a collar 116 is next assembled on drum 126 and secured thereto with a set screw. Each of arms 111, 112, and 113 has an index line in an identical position. The two sleeves 115 are each calibrated in percent around their periphery and are positioned when assembled so that their "0" calibration is in alignment with the index line on arm 111. Arms 111, 112, and 113 are positioned to actuate fingers 106 and close switches 101, 102, and 103 respectively for a brief part of each revolution.

Arms 112 and 113 can be shifted or offset from "0" by sliding them around drum 126. They will be held in position by spring washers 114 and the amount of "offset" from "0" will be indicated by the position of the index marks on arms 112 and 113 in relation to calibrated sleeves 115.

A dial and dial lever assembly, best shown in Fig. 9, is carried by the shaft 125 in front of drum 126. This consists of a hub 128 having an outwardly projecting flange at its rear end with the opposite end threaded and two keyways on its outside periphery. The inside of hub 128 is a free running fit on shaft 125. A dial lever 132 is assembled on the hub 128 against its flange. Next is assembled a flat spring washer 129 having two projections which fit into the keyways of hub 128. Dial levers 131, 136, 135, 134, and 133 are assembled on hub 128 with spring washers 129 between each pair of levers. Spacer washers 130 are used to fill the extra space on the hub 128 as this hub is of sufficient length to receive a larger number of dial levers if necessary. Dial 137 is assembled after the last lever and has two projections which fit into the keyway in hub 128 to prevent it from turning relative thereto. Hexnut 108 is then screwed to hub 128 with wrench 138. With nut 108 loosened part of a turn, dial levers 131 through 136 are loose and can be moved around to any point of the dial. Tightening nut

108 locks them in a fixed relationship with dial 137.

Dial lever 132 has an inwardly projecting portion 132*a* positioned so that it actuates finger 106 and closes switch 105 once upon each revolution of the dial but which does not close switch 104. Dial lever 132 is the only lever which will close switch 105. This lever also has an outwardly extending projection 132*b* which extends approximately to the back surface of the dial 137 and then extends radially therefrom and on which an identifying numeral "2" is stamped. Each of dial levers 131, 133, 134, 135, and 136 has a shorter inwardly projecting portion which is in alignment to actuate finger 106 and close switch 104. Their outwardly projecting portions are stamped "1," "3," "4," "5," and "6" respectively.

The dial 137 and the dial levers described above comprise an assembly on hub 128 which is free to rotate on shaft 125. The manner of locking dial 137 to shaft 125 will now be described. A hub 139 with a dial 140 is mounted on end of shaft 125 and secured by a set screw. The outer periphery of dial 140 has gear teeth meshed with a pinion 141. This pinion is carried by a threaded stud 142 on dial 137 and which may be locked thereon by thumbnut 143. Therefore dial 137 can be rotated freely about shaft 125 as long as pinion 141 turns freely. Tightening thumbnut 143 locks pinion 141 and dial 137 is locked to dial 140 and shaft 125. Dial 140 is calibrated in percent and its "0" is positioned to be under index mark 144, shown in Fig. 1, at the point at which arm 111 closes switch 101. This is defined as the "0" position of shaft 125.

Shaft 125 extends beyond plate 121 and has a collar 145 pressed on it. A cycle gear 146 is mounted on the shaft and clamped against collar 145 with a thumnut 147. Cycle gear 146 is removable so that different size gears can be installed to rotate dial 137 at selected speeds. A constant speed motor 150 having a pinion 151 drives gear 146. Motor 150 has a stud 152 attached thereto with a groove in the outer end which engages and slides in a vertical slot in plate 121. A stud 153 attached to the lower end of the mounting plate has a screw 154 extending through the stud with a thumbnut 155 on the opposite side of the plate. Tightening thumbnut 155 clamps plate 121 between head of screw 154 and stud 153. This mounting arrangement allows motor 150 to be positioned vertically to mesh its drive pinion 151 with different size cycle gears 146.

The time cycle provided by each size gear is indicated on a calibrated scale 156 by a pointer 157 attached to shaft 158. Scale 156 is mounted on front plate 120. Shaft 158 extends through plate 121 and on the end of this is secured an arm 159 which rides under stud 152.

A spring 160 around shaft 158 has one end held stationary by screw 161 and the other end secured to collar 162 attached with set screws to shaft 158. Spring 160 normally holds arm 159 upward against stud 152 as the motor is moved into position. Therefore, the positioning of motor 150, as determined by the size gear 146 used, determines how far arm 159 as depressed, which likewise determines the position of pointer 157 on scale 156.

Details of motor 150 are shown in my pending application No. 769,091, now Patent No. 2,597,369. Briefly, energizing coils 165 drives disc 166 at a constant speed. Disc 166 is geared to drive pinion 151 four R. P. M. through a solenoid operated clutch operated by coil 167. When coil 167 is

energized, the clutch disengages disc 166 from pinion 151 allowing the disc to continue rotating while the gears associated with pinion 151 are locked in position. In this way motor disc 166 can be operated continuously at constant speed and clutch coil 167 can be actuated to start and stop dial 137 instantly to effect synchronization with the master timer as hereinafter described.

Wires from motor coils 165 and the clutch coil 167 terminate in a plug 168. Wires from switches 101 through 105 terminate in a plug 169. Three cycle dial units as described above are assembled into the controller housing and plugs 168 and 169 plugged into mating receptacles inside the housing.

The step switch assembly 400 shown in Fig. 3 and mounted in controller housing 1 below the cycle dial units consists of a shaft 420 with suitable bearing supports upon each end. Attached to the shaft 420 is a series of cams 401 through 409 (see Fig. 8) and two ratchet wheels 421 and 422 (Figs. 1 and 8) each having 12 notches. Free to oscillate upon shaft 420 is a laminated armature 423 (Fig. 3) consisting of laminations riveted between side plates 425 and 426. The C-shaped laminations 427 are the field poles for the armature which are magnetized by coil 410. Two brackets 428 are attached to the top sides of the laminations 427 and project past the front of the laminations to hold a rubber bumper 429 which is attached with 2 screws 430. On the bottom side of the laminations, an angle bracket 431 is securely bolted. At the back side and near the bottom of laminations 427, a stud carries pawl 433 in lateral alignment with ratchet 421. A spring 434, attached between the pawl and a screw 435 in the laminations 427, causes the pawl 433 to be biased toward engagement with ratchet 421.

The armature side plates 425 and 426 have a projecting portion which extends toward the front of the assembly. A pawl 436 is secured in lateral alignment with ratchet 422. A spring 438 keeps the end of pawl 436 in engagement with the ratchet 422. Attached between the projecting portions of the side plates 425 and 426 is a weight 439. A rod 440 projects from the weight 439 and the armature side plates. The top and bottom portion of the armature laminations 423 are each spiral shaped so that when the weight 439 holds the armature as shown in Fig. 3, approximately a $\frac{1}{16}$ inch air gap exists between the field pole and the front of the spiral armature. When the coil 410 is energized, the magnetic lines of force, endeavoring to establish a magnetic path of minimum reluctance, rotate the armature and raise the weight 439 until it strikes the rubber bumper 429. At this point there is only a few thousandths air gap between the armature and field laminations. This movement is sufficient to cause pawl 436 to move slightly past the next tooth in ratchet 422. Pawl 433 prevents the shaft 420 from rotating in the upward direction with the armature. When coil 410 is deenergized, weight 439 falls downward and pawl 436 causes the shaft 420 to move forward the angular distance equal to one ratchet tooth. When pawl 436 hits the angle plate 431, the armature stops and the shaft is prevented from moving farther because of the wedging action of pawl 436 between the angle plate 431 and ratchet 422.

Associated with the cam 401 is an L-shaped contact finger 411 which is pivotally mounted on a terminal lug 441 secured to an insulating base

panel 450. A screw 442 going through the panel 450 and lug 441 holds a spring 443 between nut 444 and contact finger 411. This spring presses contact finger 411 downward so that a contact point 411*a* attached to the finger comes into engagement with contact 411*b* on a stationary bus bar 445. The end of finger 411 rides on cam 401 and is lowered and raised as the cam is rotated according to cut out sections of the cam.

Contact finger 412 operates in a similar manner except it is controlled by cam 402 and in addition by a cam 446 which oscillates about shaft 420. Cam 446 has a projecting portion with an opening 447 through which rod 440 projects. When coil 410 is energized to move the armature upward, rod 440 moves cam 446 upward. Deenergizing coil 410 releases the armature and cam 446 drops to its normal position. Cam 402 has a cut out section or notch, which permits contact finger 412 to close its contact if the cam is positioned as shown in Fig. 4. However, the cam 446 prevents the finger 412 from falling into the notch in cam 402. When coil 410 is energized, cam 446 is rotated and the raised portion of the cam is moved away from the contact finger 412 allowing it to close as shown in Fig. 5. When coil 410 is deenergized, cam 446 drops and cam 402 is also rotated one step so its notch is no longer presented to finger 412. Thus the next five succeeding oscillations of cam 446 will not lower finger 412 as it is held by cam 402 as shown in Fig. 6.

Therefore in the position of shaft 420 corresponding to the cut out portion of cam 402, switch 412 will close when coil 410 is energized and will open when the coil is deenergized. This switch provides an impulse to release the transfer relays hereinafter described. The other cams 403 thru 409 operate fingers 413 thru 419 respectively according to the cut out portions on their edges. Ratchets 421 and 422 have 12 notches for the particular controller being described. This is a number standardized upon for commercial convenience in providing various signal combinations. Only 6 of the 12 step switch positions are used for the signal display herein described so that the cam contour of each cam between 0° and 180° is duplicated between 180° and 360°. The cams are cut to close the switches in each of six positions shown in the table below where "X" indicates a switch closed and "O" indicates a switch open.

Switch	Position of shaft 420					
	1	2	3	4	5	6
411	O	X	X	X	X	X
412	O	O	O	O	O	X
413	X	O	O	O	O	O
414	X	X	O	O	O	O
415	O	O	X	O	O	O
416	O	O	O	X	X	X
417	O	O	O	X	X	O
418	O	O	O	O	O	X
419	X	X	X	O	O	O

Transfer relay 500 shown in Fig. 7 consists of a frame 521 mounted on an insulating panel 500*a*. Coil 501 mounted therein operates an armature 502 pivoted on the frame and normally held away from coil 501 by spring 522. A contact leaf 523, carried by armature 502, is normally in contact with a stationary contact member 505. A coil 503 is mounted at right angles to coil 501 to operate a pivoted armature 504 normally held away from coil 503 by a spring 524. A pin 504*a* carried by armature 504 latches armature 502 in either its retracted position away from coil 501 or in its attracted position. To close the circuit to contact 506, it is necessary to energize coil 501 and also coil 503. Coil 503 has only to be energized momentarily to allow the armature 502 to be unlatched. Releasing armature 504 when armature 502 is pulled forward will cause pin 504*a* to latch armature 502 closed. Coil 503 will therefore have to be energized momentarily to release armature 502 after coil 501 is deenergized. Relay 500 has 2 additional sets of contacts mounted on armature 502 identical to 523—505—506 providing the relay with 3 pole double throw switch contacts. Another transfer relay 600 shown in the diagram in Fig. 8 is identical to that above.

The controller housing 1 contains in addition to the above parts, a three pole double throw relay 700 with coil 701 and contacts 702 through 707. It also contains a motor driven flasher 750 consisting of a motor 751 driving a cam 752 which closes and opens switch 753 approximately 60 times per minute.

The electrical connections for the component parts of a controller and set of signals is shown in Fig. 8 together with a master supervisory controller.

The master controller has 3 motors, 801, 802, 803. These motors run continuously being connected to line 804 by wire 806 and to line 805 by wire 807. Motor 801 drives a cam 821 through a set of gears 811. Cam 821 has a series of projections which actuate switch 831 momentarily as the cam rotates. Two projections 821*a* and 821*d* on the cam are exactly 180° apart. Projections 821*b*, 821*c*, and 821*e* are spaced so no two are exactly 180° apart. The gears 811 are selected so that cam 821 rotates 180° in the same period of time as dial 137 rotates 360°.

Likewise, motor 802 drives a cam 822 (identical to cam 821) through gears 812 at a speed one half that of dial 237. Cam 822 actuates contact 832. Motor 803 drives a cam 823 (identical to cam 821) through gears 813 at a speed half that of dial 337. Cam 823 actuates switch 833.

One side of switches 831, 832, 833 is connected to line 804 by wire 806. Wire 814 connects the other side of switch 831 to one point of a position switch 825. Wire 816 connects the other side of switch 832 to a second point on switch 825 and wire 818 connects the other side of switch 833 to a third point on switch 825. A switch arm 824 on switch 825 completes the circuit from wires 814, 816, or 818 to wire 820 as selected. Wire 820 connects switch arm 824 to switch arm 827 which can be set to connect wire 820 to a selected one of wires 841, 842, or 843.

Wires 841 thru 847 comprise a cable which connects the master timer with the controllers at each street intersection. Wire 844 is connected to position two and wire 845 to position three of a separate pole of switch 825. A switch arm 826 connects either wire 844 to line 804 in position 2 or wire 845 to line 804 in position 3. Wire 846 is connected to switch 848 which completes the circuit to line 804 when the switch is closed.

A set of traffic signals consisting of a green signal 14, yellow signal 15, and red signal 16 indicate "Go," "Caution," and "Stop" respectively to traffic on main street. A similar set of signals 17, 18, and 19 indicate "Go," "Caution," and "Stop" to cross street traffic. Signals 14, 16, 17, and 18 are connected to switches 414, 416, 417, and 418 by wires 24, 26, 27, and 28 respectively. Signal

15 is connected to a normally closed contact 702 by wire 25. A contact 702 is connected to switch 415 by wire 30. Signal 19 is connected to normally closed relay contact 704. Wire 31 connects contact 704 to switch 419. The other side of switches 414 through 419 is a bus bar 449 from which the circuit is completed to line 34 through wire 32, relay contact 706, wire 33, toggle switch 3 and wire 40. The other side of signals 14 through 19 is connected to line 35 by wire 36. Thus with toggle switch 3 closed and relay 700 deenergized, step switch 400 will energize a certain combination of signals in each position of shaft 420 according to the contour of cams 404 through 409. As shaft 420 is advanced periodically through its six positions, the signals will operate through a complete signal cycle.

The manner in which the step switch is periodically advanced by cycle dial unit 100 will now be described. Motor 150 is energized to rotate dial 137 by the circuit from line 34, through toggle switch 5, wire 37, normally closed relay contact 609, wire 38, normally closed relay contact 509, wire 48, motor 150, wire 39 to the other line wire 35. Dial levers 131, 133, 134, 135, and 136 close switch 104 momentarily as dial 137 rotates. Coil 410 is actuated to advance shaft 420 over the circuit from line 34 through wire 40, switch 411, wire 41, switch 104, wire 42, normally closed relay contact 505, wire 43, normally closed relay contact 605, wire 44, switch 4, wire 45, coil 410, wire 46 to line 35. The time between advances of shaft 420 is therefore determined by the speed of dial 137 and the angular distance between the dial levers. When shaft 420 advances to its number 1 position, cam 401 opens switch 411. Switch 104 can not energize coil 410 when shaft 420 is in number 1 position. Dial lever 132 closing switch 105 then completes the circuit from line 34 through switch 3, wire 33, normally closed relay contact 706, wire 32, switch 105, wire 42, contact 505, wire 43, contact 605, wire 44, switch 4, wire 45, to coil 410. Since dial lever 132 is the only one which closes switch 105, shaft 420 must always be advanced out of its number 1 position by dial lever 132 and thus start each revolution properly synchronized with dial 137.

Opening the shutdown toggle switch 3 or energizing coil 701, which opens contact 706, interrupts the circuit to switch 105 but does not interrupt the circuit to switch 104. Shaft 420 will continue to advance to position number 1 where where switch 414 is closed. Therefore upon reclosing switch 3 to resume normal signal operation, shaft 420 will be in position 1 and the first signal indication will be the main street green. If shaft 420 is out of step with dial 137, shaft 420 will stay in its number 1 position with the main street green "On" until dial lever 132 closes switch 105 to start shaft 420 in its synchronized relationship. In this way the waiting period of shaft 420 for synchronization always occurs in the main street green interval to give the "Go" signal for this extra time to the street having the largest traffic volume.

The supervision of each controller from the master station will now be described. When switch arm 826 of switch 825 is in position one to select dial 137, it does not complete any electrical circuit and relay coils 501 and 601 are deenergized. When both of these coils are deenergized, motor 150 runs and switches 104 and 105 are effective to actuate coil 410 over the circuit previously described.

Switch arm 824 of switch 825 completes a circuit from line 804, wire 806, switch 831, wire 814, switch arm 824, wire 820, switch arm 827, wire 841, switch 101, wire 49, through clutch coil 167, wire 50, contact 507, wire 51, contact 607, wire 52, wire 847 to line 805. Switch 831 is normally closed so that closing of switch 101 by arm 111 will energize coil 167. This disengages the clutch and stops dial 137. Dial 137 remains stopped until cam 821 opens switch 831. This deenergizes coil 167 allowing clutch to reengage. Cam 821 holds switch 831 open slightly longer than arm 111 holds switch 101 closed. Therefore switch 101 opens before 831 closes and clutch coil 167 remains deenergized for another complete revolution of dial 137. Cam 821 is geared to rotate from point 821*a* to 821*d* in exactly the same time required for dial 137 to make one revolution. Therefore if point 821*a* opens switch 831 to restart dial 137, point 821*d* will reopen switch 831 at exactly the same time that arm 111 recloses switch 101. Coil 167 will not be energized and dial 137 will continue to rotate in a fixed relationship with cam 821 without stopping. All the other controllers in the system will likewise be synchronized with cam 821.

Should the synchronized relationship not exist, closing of switch 101 stops dial 137. So that dial 137 does not remain stopped for a complete signal cycle waiting for projection 821*a* or 821*d* to open switch 831, which would unnecessarily delay traffic on the cross street, I provide additional projections 821*b*, 821*c*, and 821*e* on cam 821. Any of these projections opening switch 831 will restart dial 137. However, since there are no projections 180° across from these, dial 137 will be stopped upon the completion of the next cycle and will be started by a different projection on cam 821. Within a few cycles, either projection 821*a* or 821*d* will start dial 137 and the synchronized relationship will be maintained for succeeding cycles.

The "0" point of dial 140 will normally be under index mark 144 each time 821*a* or 821*d* opens switch 831. This is true for the dials of each controller connected to the system. The "0" point on dial 137 can be shifted to any relationship with the "0" on dial 140 and locked. The "0" point of dials 137 at each intersection can be set for a predetermined "offset" from the "0" on dial 140. Dial lever 131 is set at "0" on dial 137 and determines the start of main street green. Thus the main street green signs come "On" at successive intersections along the street according to the offset between dials 137 and 140 of the respective controllers. The coordinated start of the green signal periods provides for a progressive movement of traffic.

A selection of two additional "offsets" for dial 137 is provided by switches 102 and 103 and their actuating arms 112 and 113. When switch arm 827 is moved to its second position, the circuit from wire 820 is established to coil 167 through wire 842 and switch 102. Therefore positioning arm 112 establishes a new synchronizing position of dial 137 with cam 821. For example, if arm 112 is set at 15%, it will close switch 102 when "15" on dial 140 is under index mark 144. The start of the main street green (determined by "0" on dial 137 at which arm 131 is set) is thus shifted 15% of a revolution of dial 137 in its synchronized relationship with projections 821*a* and 821*d* on cam 821. In a similar manner, moving switch arm 827 to wire 843 completes the circuit to coil 167 through switch 103.

Arm 113 actuating this switch can be set for a selected third offset position.

Switch 825 selects which one of cycled dial units 100, 200, or 300 is to actuate coil 410. In the second position of switch 825, a circuit is completed from line 804, arm 826, wire 844, relay coil 501, wire 52, wire 847 to line 805. Coil 501 cannot immediately actuate armature 502 which is lacthed open by the pin on armature 504. When the main street red signal is "On" (position 6 of shaft 420) cam 402 is positioned as shown in Figure 4 but switch 412 is held open by cam 446. When dial lever 131 closes switch 104 to energize coil 410, cam 446 is raised to position shown in Fig. 5 and switch 412 closes. A circuit is now completed from line 34, wire 40, bus bar 445, switch 412, wire 452, coil 503, wire 39 to line 35. Armature 504 withdraws pin from armature 502 which now opens contact 505, 507, 509 and closes contacts 506, 568, and 510.

Opening contacts 509 stops motor 150 at the point where arm 131 holds switch 104 closed. In some cases, the motor may coast far enough to allow arm 131 to open contact 104. Closing contact 510 starts motor 250. This motor will have stopped from its previous operation with its dial arm 231 either holding switch 204 closed or with arm 231 coasted slightly past its closing point. If switch 204 is closed, coil 410 will remain energized without advancing shaft 420 as the opening of contact 505 and closing of contact 506 is much faster than required for the heavier armature of coil 410 to release. When motor 250 drives dial far enough for arm 231 to release switch 204, coil 410 is denergized and shaft 420 advances to its next position. If switch 204 is open when contact 506 closes, coil 410 will be deenergized immediately and advance shaft 420 to its next position. In either case, dial lever 232 will close switch 205 as the next operation and advance shaft 420 to its number two position in the same manner as it would have been advanced by dial lever 132. Transfer has been made from one dial to the next in this way with cam shaft 420 remaining in its proper relationship with the dial levers.

Opening contact 507 and closing contact 508 transfers the synchronizing circuit from clutch coil 167 to 267. One of switches 201, 202 and 203, as selected by the position of switch arm 827, now synchronizes dial 237 with cam 822 of the master timer in the same manner as dial 137 was synchronized with cam 821. The dial 237 is geared to rotate one revolution during one half revolution of cam 822. Dial 237 will ordinarily be set for a different speed of rotation and its dial levers set for a different traffic schedule.

Dial 337 is selected by moving switch 825 to position 3. Relay coil 601 is energized but armature 602 is held open by the pin on armature 604. When shaft 420 is in its number six position and dial arm 231 closes switch 204 to energize coil 410, switch 412 closes to energize coil 603. Armature 604 withdraws the pin and releases armature 602. Contacts 605, 607, 609 then open and 606, 608, and 610 close. Switch arm 824 transfers the synchronizing circuit to switch 833 and cam 823. Dial 337 is geared to turn one revolution during one half revolution of cam 823.

When switch 825 is returned to its first position, coil 601 will be deenergized but pin on armature 604 will hold armature 602 in its attracted position. When shaft 420 reaches its number six position, switch 412 is closed when dial arm 331 closes switch 304 to energize coil 410. Relay coil 603 is energized which removes the pin from behind armature 602 allowing relay to release. Transfer can thus be made to any dial by positioning switch 825, but the actual transfer does not occur until the dial arm 131 (or 231 or 331) actuates its switch 104 (or 204 or 304) and shaft 420 is in position six. The one dial then stops and the other dial starts with the step switch properly synchronized with the new dial.

When there is little traffic at night, the signal display may be stopped and one of the signals on each street flashed as a caution signal. A switch 848 is provided for this purpose which, when closed, establishes a circuit from line 804 through switch 848, wire 846, switch 413, wire 448, coil 701, wire 847 to line 805. Coil 701 can be energized only when shaft 420 is in its number one position where switch 413 is closed. This insures completion of the signal cycle before the signals are transferred to flashing. When transferred back to normal operation, shaft 420 will be in position number one to give main street the "Go" signal first. Energizing coil 701 opens contacts 702, 704, 706, and closes contacts 703, 705, and 707. Motor 751 starts which drives cam 752 to close switch 753 approximately sixty times a minute. Switch 753 flashes the main street yellow light 15 and the cross street red light 19.

Switches 825, 827, and 848 are shown as manual switches but can be replaced with automatic time switches to operate them according to a preset schedule without departing from this invention. If the controller is to be operated independently of the master controller and not as part of a system, switches 825 and 848 could be located at the controller. In this case, wires 841, 842, and 843 would not be required. No synchronization would be required and coils 167, 267, and 367 could be omitted.

Switch 4 may be turned to hand operation to operate the signals by pressing hand control button 61. Each closing and opening of switch 61 advances shaft 420 one position. This permits a police officer to operate the signals during some abnormal traffic condition. He can watch the traffic movement and advance shaft 420 as fast as conditions warrant.

It is of course understood that the specific description of the structure set forth may be departed from without departing from the spirit of this invention as disclosed in this specification and as defined in the appended claims.

Having now described my invention, I claim:

1. In a traffic signal system for controlling "Stop" and "Go" signals for intersecting main and cross streets, the combination of a step switch for operating said signals in a predetermined sequence, a plurality of timers, each for operating said step switch according to a predetermined time schedule, selecting means for selecting one of said timers to operate said step switch and to stop the other timers, locking means for preventing operation of said selecting means, and a release circuit operative when said timer reaches a predetermined position whereby said timer is stopped in said position and the other selected timer is started from said position.

2. In a traffic signal system for controlling "Stop" and "Go" signals for intersecting main and cross streets, the combination of a step switch for operating said signals in a predetermined sequence, a solenoid for advancing said step switch step by step, a plurality of cycle dials having adjustable actuators, driving means to rotate each

dial, control switches associated with each dial and operated by said actuators to energize said solenoid and advance said step switch according to a timed schedule, circuits for connecting said step switch to a selected one of said dial control switches including a synchronizing circuit for maintaining a synchronized relationship between said selected dial and said step switch whereby the "Go" signal is transferred from the cross street to the main street when said dial is in a predetermined position, a relay means having multiple positions, said relays means in one position energizing the driving means for one of said dials, deenergizing the driving means of the other dials, and connecting said circuits to the control switches associated with said dial, said relay means in a second position energizing the driving means for a second one of said dials, deenergizing the driving means for the first dial, and connecting said circuits to the control switches associated with said second dial, a selector switch for positioning said relay means, locking means preventing movement of said relay means, and release means effective when the dial actuating the step switch is in a predetermined position to render said locking means ineffective, whereby said first dial is stopped in said predetermined position and the other dial is started.

3. In a traffic signal system, a set of traffic signals, a step switch for operating said signals in a predetermined sequence, a first motor driven dial, adjustable actuators rotated with said dial, a first switch closed by said actuators for advancing said step switch step by step according to the spacing of the actuators on the dial, a second motor driven dial, adjustable actuators rotated with said second dial, a second switch closed by said actuators for advancing said step switch, a transfer relay having one position for causing operation of said first motor driven dial and connecting said step switch to said first switch and having a second position for operating said second motor driven dial and connecting said step switch to said second switch, a third switch for selecting the first and second positions of said relay, latch means for latching said transfer relay in its first or second positions, a release coil on said relay, a fourth switch comprising part of said step switch and operable when said step switch is in a predetermined position to energize said release coil, said release coil effective to release the latch means allowing the transfer relay to assume the position determined by the third switch and transfer the step switch control to the other dial and to start its motor.

4. In a traffic signal system, a set of traffic signals, a step switch for operating said signals in a predetermined sequence, a solenoid for advancing said step switch, a plurality of timers for energizing and deenergizing said solenoid to advance said step switch according to a cyclic timed schedule, a relay normally connecting said solenoid to one of said timers to be advanced thereby, a second switch to operate said relay to disconnect said one of said timers from said solenoid and to connect another timer thereto, locking means to prevent operation of said relay by said second switch, and release means including a first means, a cam actuated by said step switch normally preventing operation of said first means except in a predetermined position of said step switch, and a second means actuated by said solenoid normally preventing operation of said release means when said solenoid is deenergized whereby said locking means is released when the

step switch is in a predetermined position and said solenoid is energized.

5. In a traffic control system for controlling a series of "Stop" and "Go" signals at cross streets intersecting a main street, the combination of a series of controllers, each controller having a step switch for operating the signals at an intersection in a predetermined sequence, a plurality of cycle dials having adjustable actuators to advance said step switch according to a timed schedule, driving means for each dial, relay means for connecting said step switch to a selected one of said dials and to operate the driving means for said selected dial, synchronizing means between the step switch and the selected dial whereby the cycle dial is in a predetermined position when the "Go" signal is transfered to the main street, a selector switch for operating the relay means in the controllers to select a dial to operate the said step switch in each, locking means in each controller to prevent operation of said relay means, and a release switch to release said locking means including a cam on said step switch for closing said release switch in one position of said step switch, a member to hold said release switch unresponsive to the cam in one position and responsive to the cam in a second position, connecting means between said member and said solenoid to hold said member in its first position when the solenoid is deenergized and in its second position when the solenoid is energized, and a circuit to release said locking means upon closure of said release switch whereupon said relay means operates to stop said dial and to start the newly selected dial in said predetermined position when the "Go" signal is being transferred to the main street.

6. In a traffic signal controller for controlling "Stop" and "Go" signals at a traffic intersection, the combination of a cyclically operated switch for operating said signals in a timed sequence, a relay for connecting said signals for a secondary signal display, a control switch for energizing said relay to select said secondary signal display, a contact on said cyclically operated switch closed in a predetermined position of the cyclically operated switch and connected in series with said control switch and said relay to prevent operating the relay except when the cyclically operated switch is in said predetermined position, and a contact on said relay to stop the cyclically operated switch when the relay is energized.

7. In a traffic signal controller, "Stop" and "Go" signals, a cyclically operated signal switch for operating said signals in a timed sequence, a relay with a plurality of contacts having one position connecting said signals to said signal switch and a second position to connect said signals for a non-cyclic signal indication, a circuit to operate said relay including a first switch to select the position of said relay, a second switch in series with the first switch, and means on said signal switch to operate said second switch when the signal switch is in a predetermined position, one of said relay contacts connected to stop the advance of said step switch in said predetermined position.

8. In a traffic signal system, the combination of a set of traffic signals, a step switch including a shaft operable step by step to energize said traffic signals in a predetermined sequence, a plurality of timers providing impulses to advance said step switch, selector switch means normally connecting one of said timers to advance said step switch and operable to disconnect said one of said timers

and to connect a second timer to advance said step switch, interlock means for preventing the operation of said selector switch, a control switch for releasing said interlock means, a cam on said shaft for closing said control switch in a predetermined position of said shaft, a second cam free to oscillate about said shaft and shaped to hold said control switch unresponsive to said first cam in one position, and responsive to said first cam in a second position, and connecting means between said second cam and the solenoid to hold the second cam in one position when the solenoid is deenergized and to move the second cam to the other position when the solenoid is energized.

9. In a signal controller to provide a sequence of signal combinations, a step switch, a plurality of cycle dials each including a control switch for advancing the step switch, actuators carried by each dial for operating the control switch and means for rotating each dial, a selector switch to select one of said dials to advance said step switch, operating means operated by a predetermined actuator closing its control switch, and transfer means operated by said operating means to connect the control switches associated with the dial selected by said selector switch to said step switch.

10. In a signal controller to provide a sequence of signal combinations, a step switch, a plurality of cycle dials each including actuators carried by each dial for advancing said step switch, a motor for rotating each dial, transfer means operable to connect said step switch to a selected dial and to start its motor and to stop the other motors and dials, a selector switch to select one of said dials to advance said step switch, operating means operated by a predetermined actuator closing its control switch, and transfer means operated by said operating means to connect the control switches associated with the dial selected by said selector switch to said step switch.

11. In a signal controller to provide a sequence of signal combinations, a step switch, a plurality of cycle dials each including actuators carried by each dial for advancing said step switch and means to start and stop rotation of each dial, selector means operative to start rotation of a selected one dial, stop rotation of the other dials and connect said step switch to the selected dial to be advanced thereby, means for operating said selector means to stop one dial in a predetermined position and to start another of said dials from said position thereby maintaining a synchronized relationship between said selected dial and the step switch, said means including a first interlock switch actuated by said step switch in one position thereof, and a second interlock actuated by said one dial when said dial is in a predetermined position to advance said step switch.

12. In a traffic-signal system, the combination of a set of traffic signals, a step switch operable step by step to energize said traffic signals in a predetermined sequence, a plurality of timers providing impulses to advance said step switch, connecting means normally connecting one of said timers to advance said step switch and operable to disconnect said one of said timers and to connect a second timer to advance said step switch, and means for preventing the operation of said connecting means, a release means for said connecting means comprising a first means

on said step switch to hold said release means inoperative except in a predetermined position of said step switch and a second means, actuated by an advancing impulse from the timer connected to advance said step switch, to render said release means responsive to the first means.

13. In a traffic-signal system, the combination of a set of traffic signals, a step switch including a shaft operable step by step to energize said traffic signals in a predetermined sequence, a plurality of timers providing impulses to advance said step switch, connecting means normally connecting one of said timers to advance said step switch and operable to disconnect said one of said timers and to connect a second timer and to advance said step switch, a selector switch for selecting one of said timers to operate said step switch, an actuating means operated by a timer impulse which advances the step switch to a predetermined position, and transfer means responsive to said selector switch and said actuating means to connect the selected timer to the step switch.

14. In a traffic signal controller, "Stop" and "Go" signals, a step switch having a plurality of switches for operating said signals in a predetermined sequence, a timing motor, a pair of switches connected to said step switch to advance it, step by step, upon operating said switches, actuators driven by said timing motors to operate one of said pair of switches in a time schedule, said one of said pair of switches connected in series with a switch on said step switch which renders said one of said pair of switches inoperative in one position of said step switch, an actuator driven by said motor to operate the second of said pair of switches to advance said step switch out of said one position, thereby synchronizing the step switch with the actuator driven by the motor, a relay having a plurality of contacts to connect said signals to said step switch in one position and to connect said signals for a secondary signal indication in a second position, a circuit to operate said relay including a selector switch to select the position of said relay, a control switch in series with the selector switch, means on said step switch to operate said control switch when the step switch is in a predetermined position, and a contact on said relay held open in said second position of the relay, said contact in series with said second pair of switches to prevent the actuators from advancing the step switch from said one position of said step switch when said relay is in its second position.

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