

Oct. 11, 1938.

H. I. TURNER ET AL

2,133,157

SIGNAL CONTROLLING AND DURATION VARYING SYSTEM AND MECHANISM THEREFOR

Filed Dec. 3, 1934

10 Sheets-Sheet 1

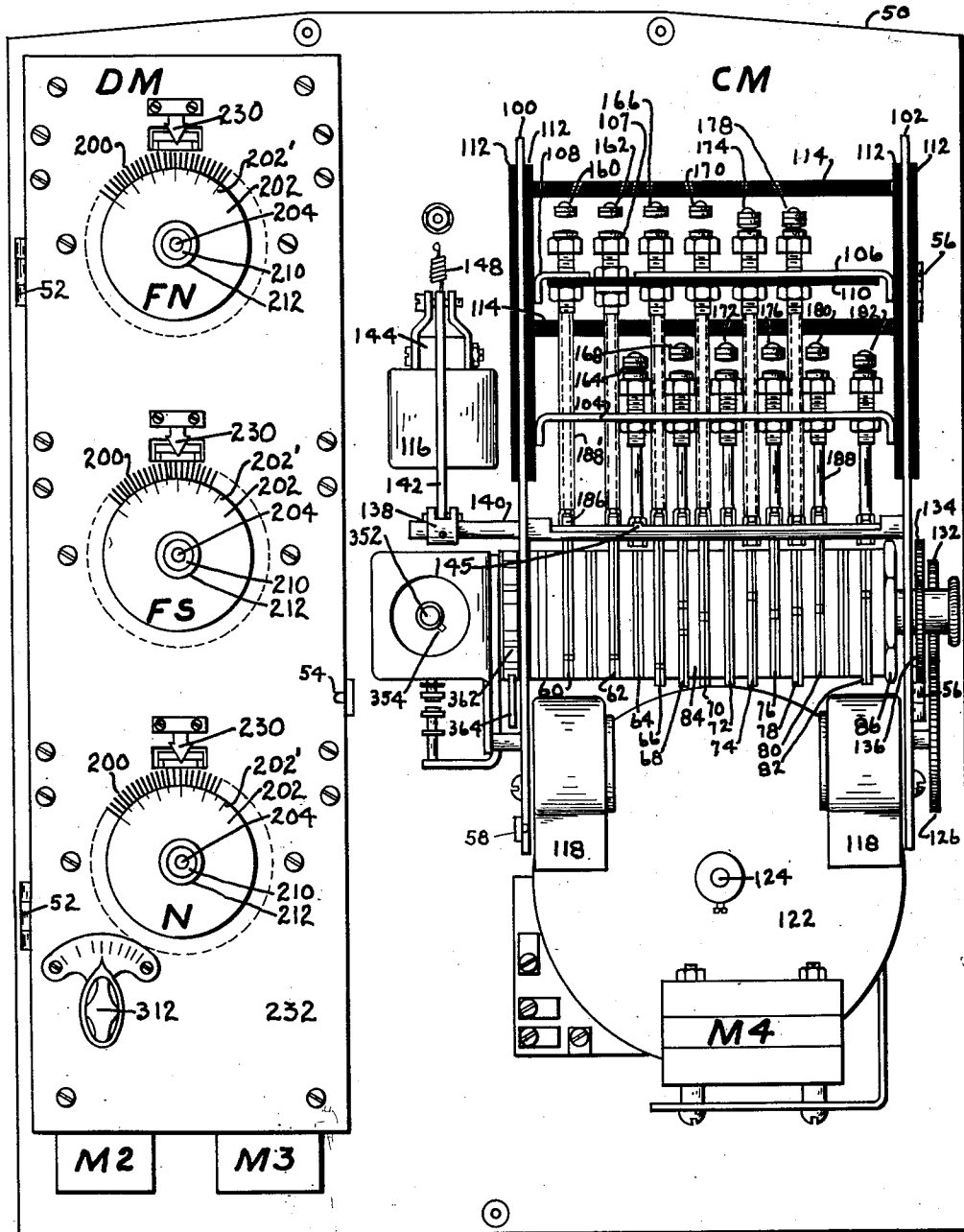


FIG.-1

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Oct. 11, 1938.

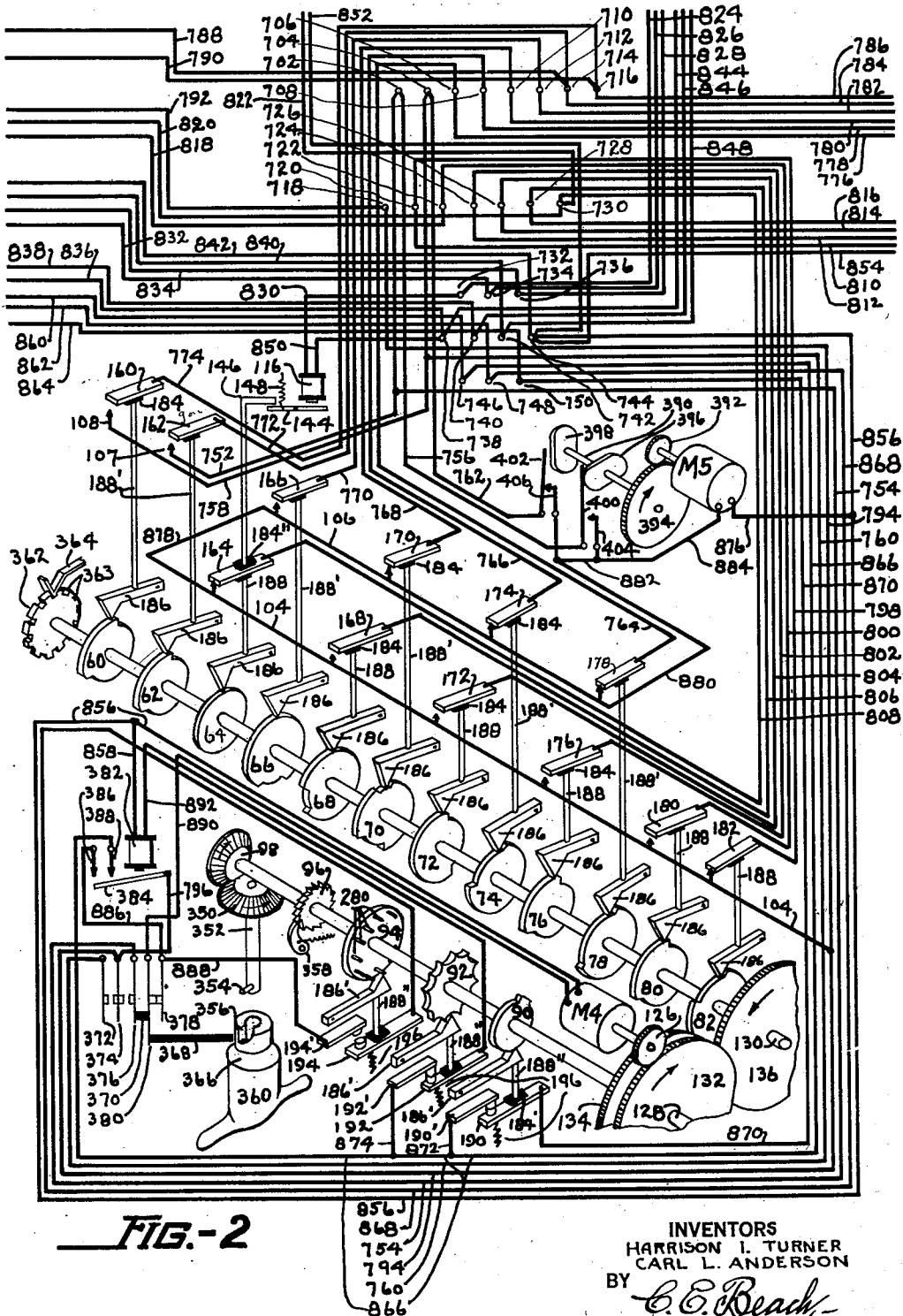
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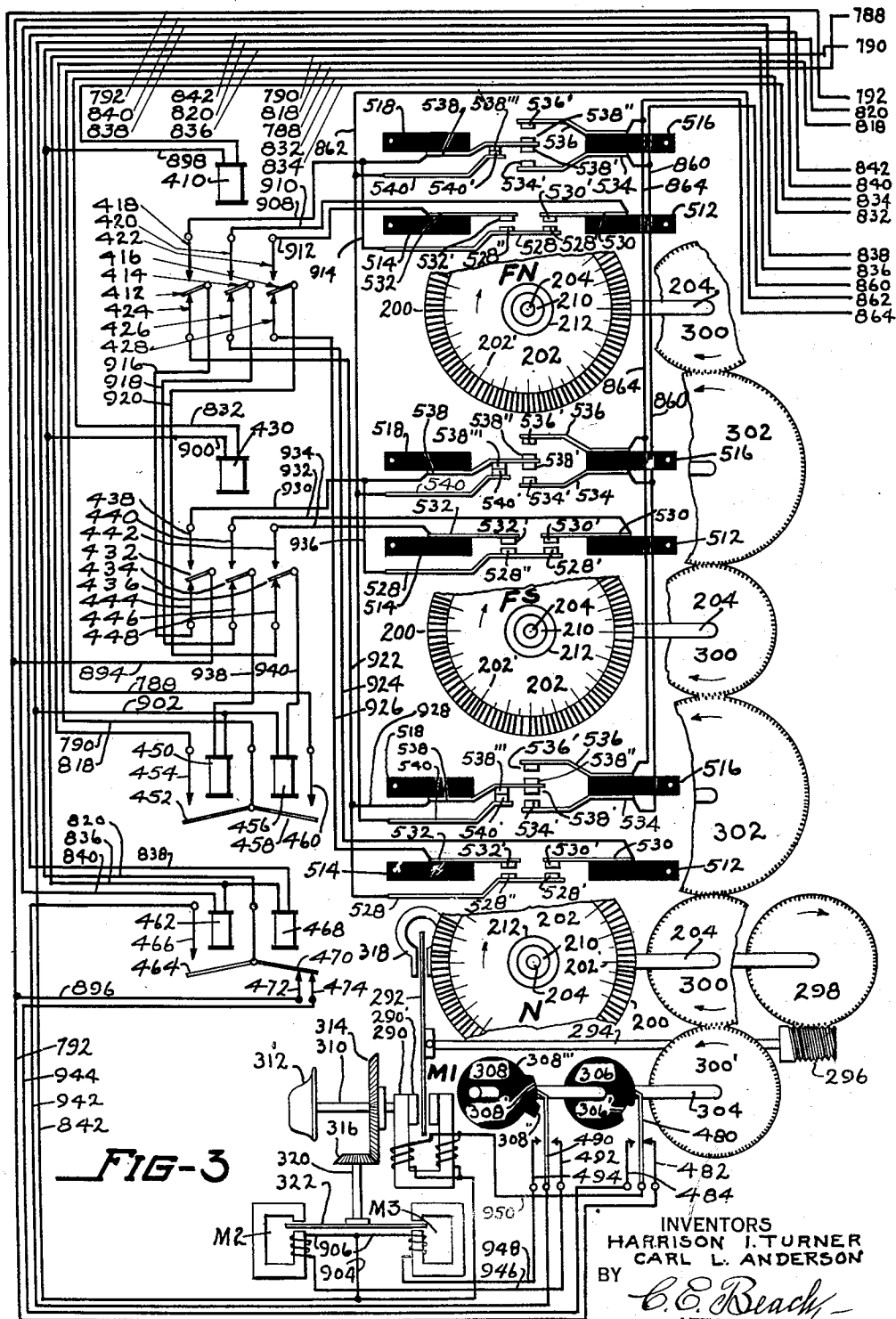
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10 Sheets-Sheet 4

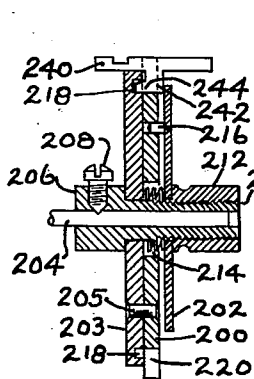
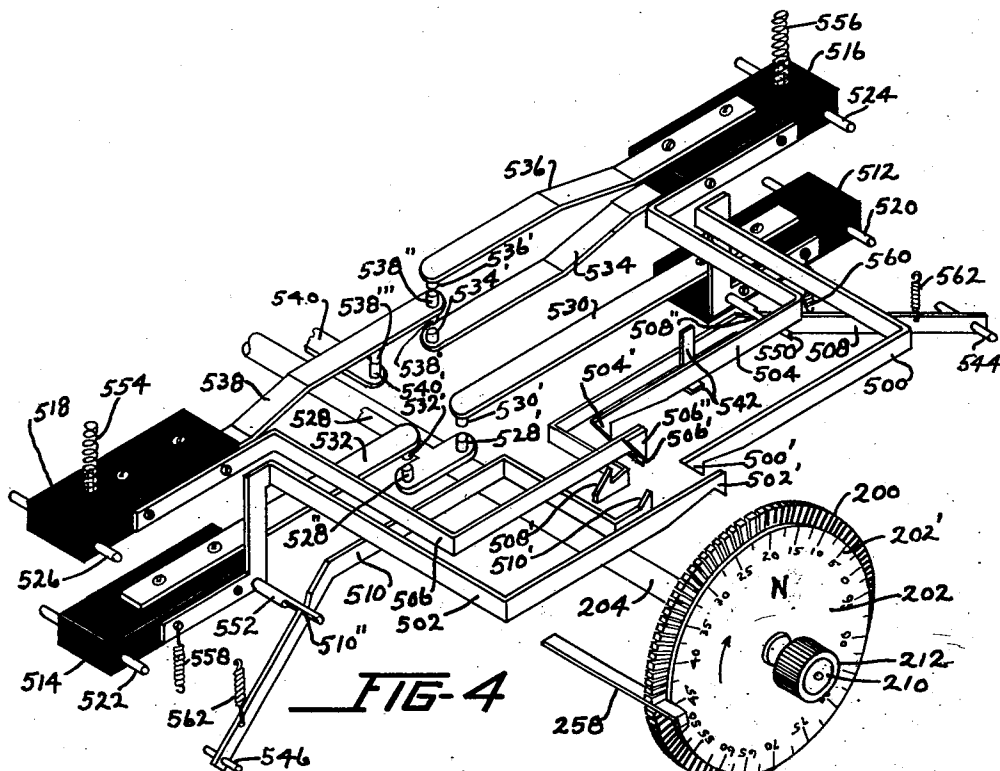
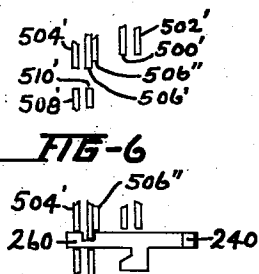
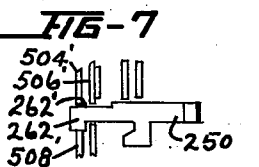


FIG-5



FTG-6



ITB-7

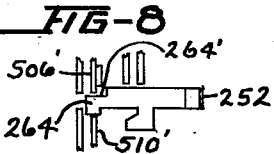
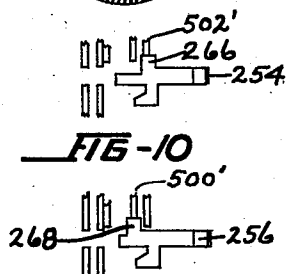


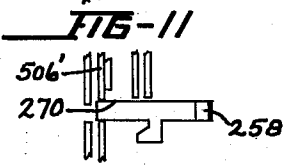
FIG-8



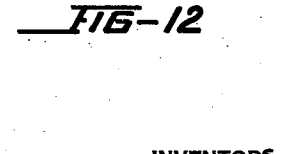
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ITG-11



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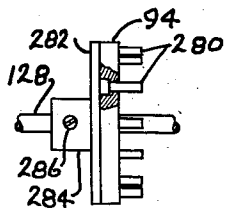


FIG-13

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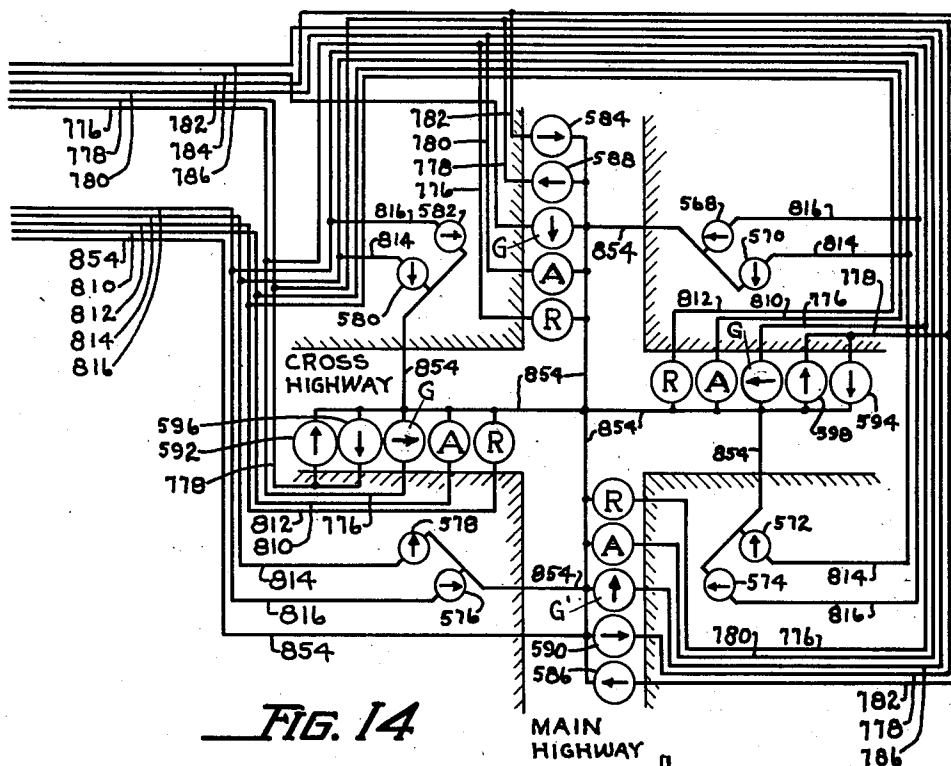


FIG. 14

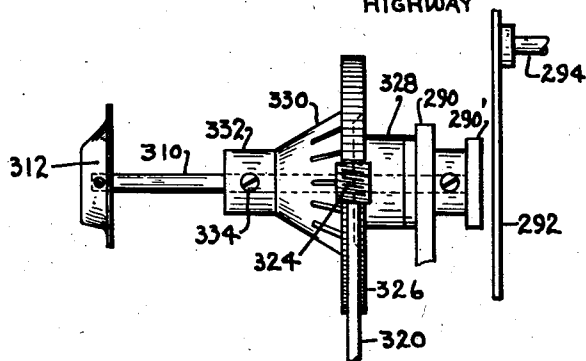


FIG. 15

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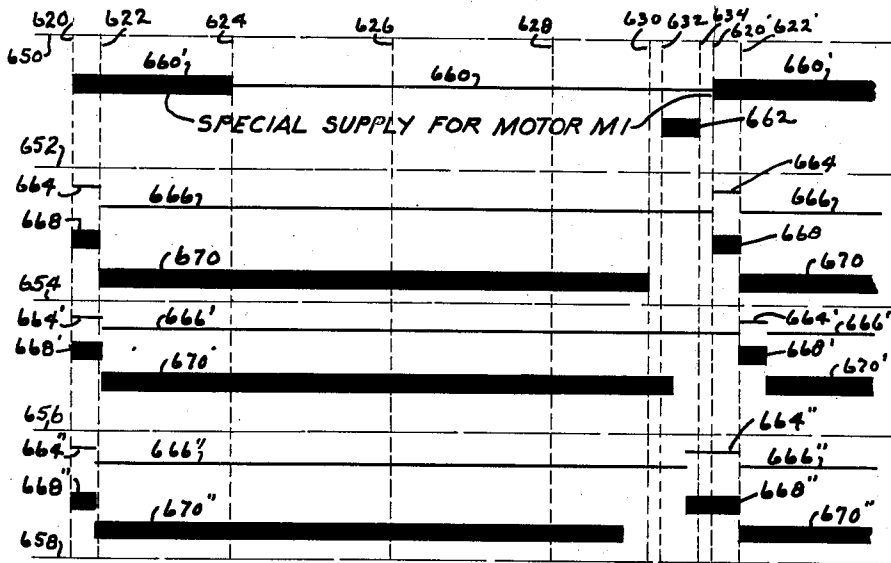


FIG-17

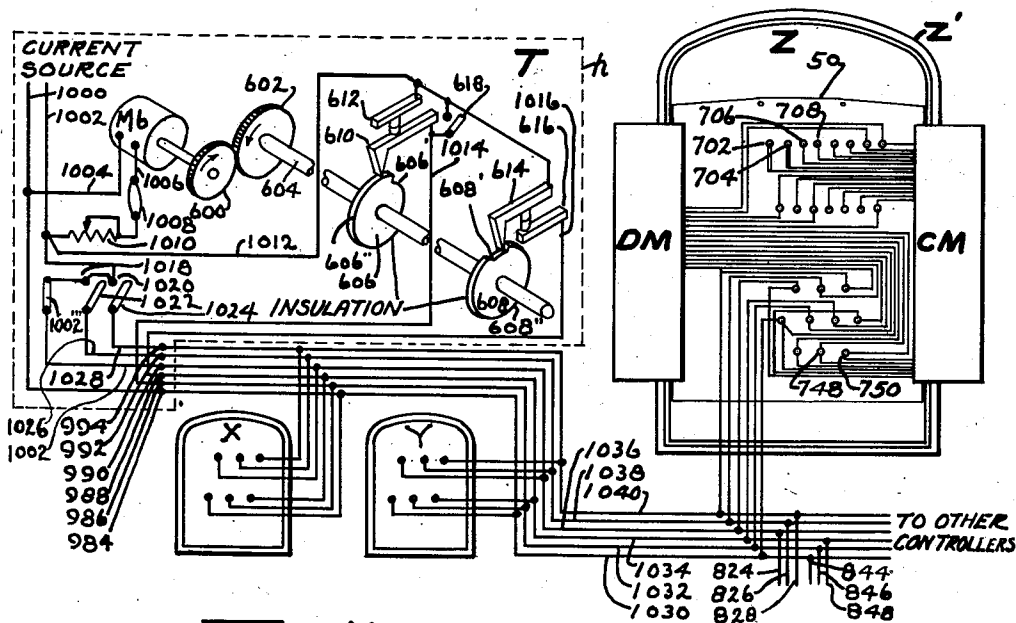


FIG-16

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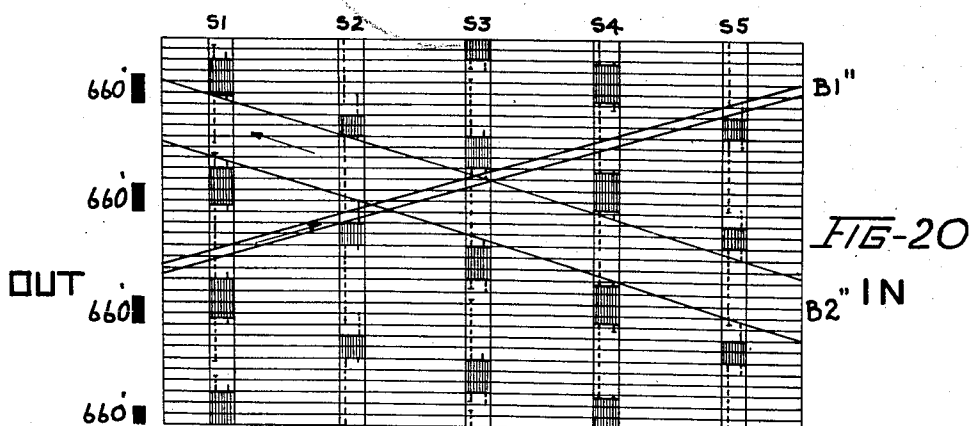
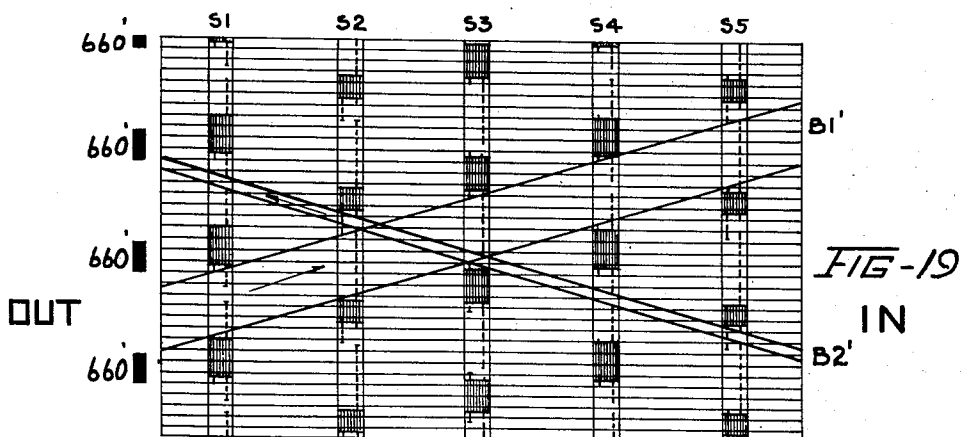
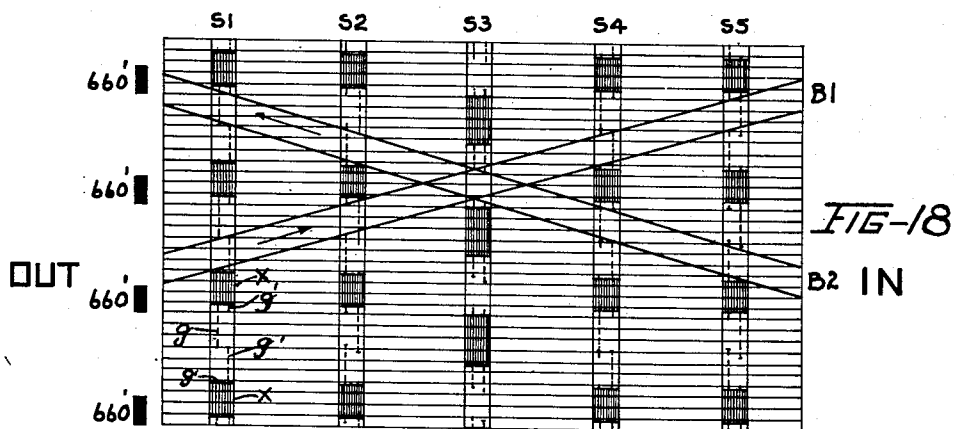
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10 Sheets-Sheet 7



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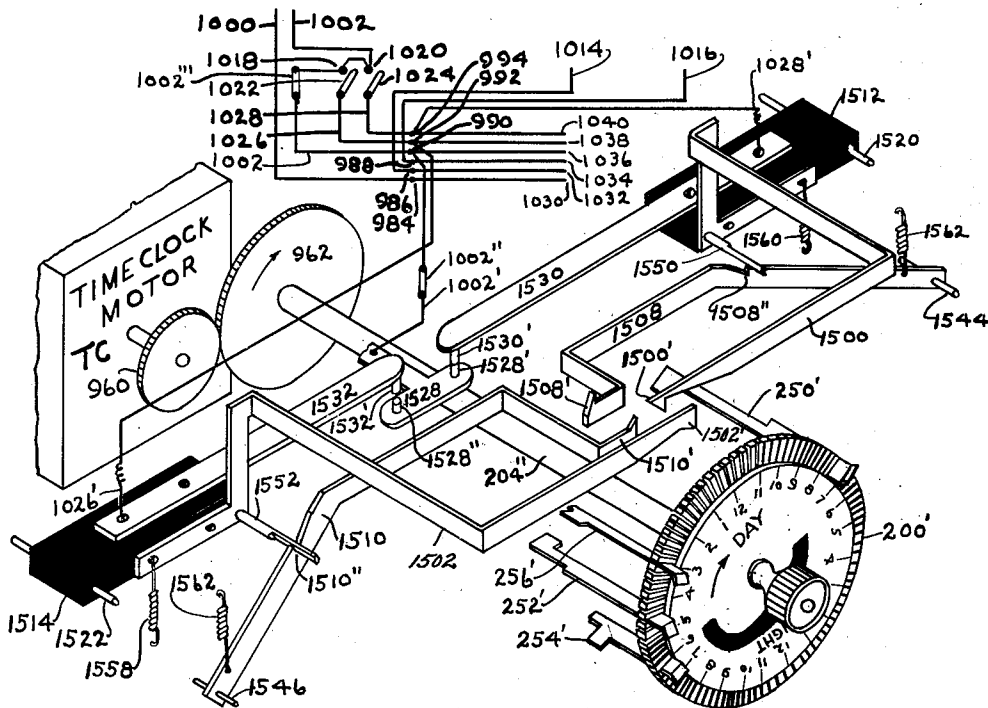


FIG.-21

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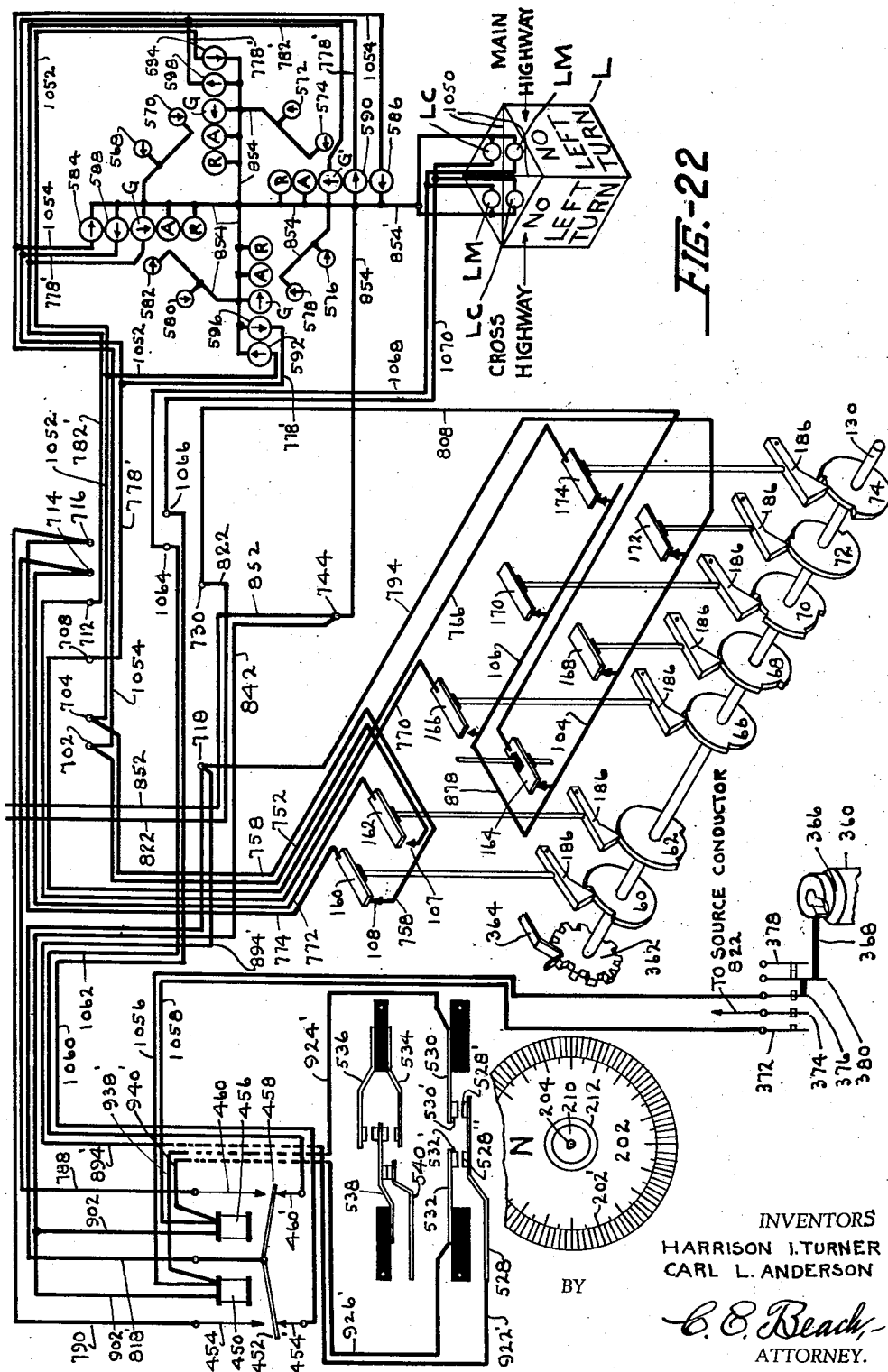
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UNITED STATES PATENT OFFICE

2,133,157

SIGNAL CONTROLLING AND DURATION
VARYING SYSTEM AND MECHANISM
THEREFOR

Harrison Irving Turner and Carl Ludwig Anderson, Moline, Ill., assignors to Eagle Signal Corporation, Moline, Ill., a corporation of Massachusetts

Application December 3, 1934, Serial No. 755,742

14 Claims. (Cl. 177—337)

This invention relates to signal controlling and duration varying systems and mechanisms therefor, and more particularly to those for governing highway traffic in situations where it is desirable to at times vary the duration and/or characteristics of components entering into cycles of changes of signal aspects.

A novel form of system and mechanism for synchronizing and controlling the speed of operation of a traffic signal controller or controllers and a novel form of variable circuit making and breaking mechanism are described in this application in order to facilitate a complete understanding of this invention, but such system and mechanism and such making and breaking mechanism are described and claimed in divisions of this application, Serial No. 49,766, filed November 14th, 1935 and Serial No. 52,848, filed December 4th, 1935, respectively. In this application, it is intended to claim the broad features of the invention and also to claim the novel form of system and mechanism for selectively attaining and presenting a plurality of diverse cycles of signals for controlling the movements of traffic.

Mechanism and systems heretofore available for governing highway traffic have embodied characteristics which precluded facility of revisions of settings and adjustments after completion of manufacture, to render same suitable for the varied needs of different locations; but, on the contrary, involved extensive and costly re-designing, as well as revision of assembled mechanism.

Furthermore, the complex and intricate character of traffic signal controlling mechanism which has heretofore been supplied for such service has resulted in the adoption of designs and methods of manufacture which have rendered the resultant mechanism subject to disarrangement and, when disarranged, requiring highly skilled services for effecting repair and readjustment.

It is readily apparent that traffic signal controlling mechanism should be of such type as to meet a large proportion of the requirements of the many diverse intricate highway traffic controlling situations without involving diversity of structural details and without requiring variations of settings or adjustments other than those of a simple nature which can be quickly and conveniently accomplished by persons of ordinary training and ability. In contrast with such characteristics of standardization of manufacture and simplification of adaptation, the use of prior traffic signal controlling mechanisms of which we are aware has involved the disadvan-

tages and economic waste incidental to individually designing and building such controlling mechanisms, each to suit conditions of specific character and very limited application, as well as multiplying costs of adjustment, repair and replacement of parts to an extent which has heretofore served as a deterrent to prospective users of such systems.

It has also been found that, in many locations, it is highly desirable to provide for utilization of diverse alternative types of cycles of the presentation of signaling aspects, each such type of cycle characterized by the establishment of time durations for the respective aspects which will be suited for some predictable condition of relative traffic density; such as, for example, establishing one type of cycle for morning "residence-to-business" and evening "going-to-theatre" traffic, establishing another type of cycle for opposite predominating traffic density, and establishing another type of cycle to meet some other condition, as when traffic densities lack directional predominance.

Furthermore, it has been found that, under circumstances wherein attempts have been made to furnish a mechanism capable of providing such diversity of types of cycles, difficulties have arisen in so maintaining operation of such mechanism under supervision of a "master timer" or "master controller" as to permit so-called "progressive movement" of traffic.

It is, therefore, an important object of this invention to provide a signal controlling and duration varying system, and mechanism therefor, which is susceptible of adjustment and adaptation, readily accomplished by users of ordinary intelligence and without special facilities, for the purpose of caring for the greatest practicable proportion of the diverse circumstances and conditions presented in effecting the control and regulation of highway traffic in a manner which will promote its safe and expeditious movement.

It is another important object of this invention to provide a signal controlling and duration varying system, and mechanism therefor, which is capable of governing the display of a sufficient variety of signaling aspects to provide for substantially all needful types of sequential displays.

Another important object of this invention is to provide a signal controlling and duration varying system, and mechanism therefor, which is capable of effecting displays of signal aspects in accordance with one or another of a plurality of sets of cycle characteristics each of

which sets so differs in the number and/or duration and/or character of various aspects as to be suitable and adequate for governing the flow of traffic on occasions when such traffic presents some certain outstanding characteristic as, for example, directional predominance.

Another object of this invention is to provide such a system and mechanism which affords ready interchangeability and/or replacement of parts.

Another object of this invention is to provide such a system and mechanism which is capable of operating under the supervision of a master timer or controller for so displaying signal aspects as to permit progressive movement of traffic irrespective of the set of cycle characteristics then in effective display.

Another object of this invention is to provide such a system and mechanism which is capable of at times displaying special characteristic signals whereby to indicate, to progressively moving traffic, the need of either an increase or a decrease in its rate of movement in order to maintain a desired positioning relative to a progressive display of signaling aspects.

Another object of this invention is to provide such a mechanism capable of being easily and readily adjusted to revise the sequence of display of signaling aspects.

Another object of this invention is to provide such a mechanism capable of easy and ready adjustment without special facilities to effect a prolongation or shortening of the duration of display of any particular aspect.

Another object of this invention is to provide such a system and mechanism capable of being so supervised and governed from a master timer as to permit effective revision therefrom of cycle characteristics both as to component signaling aspects and as to the timed duration thereof.

Another object of this invention is to provide such a system and mechanism capable of being periodically and automatically brought into a synchronical relationship with respect to a master timer.

Another object of this invention is to provide such a mechanism capable of being periodically and automatically revised as to speed of operation to maintain substantially synchronical speed between such mechanism and that of a master timer.

Another object of this invention is to provide a system and mechanism capable of being periodically and automatically revised as to speed of operation to compensate for any nominal change in speed such as may occur resultant from atmospheric temperature variations and the like.

Still other objects of this invention are to provide for the maintenance of substantially synchronous relationship between one and another of a plurality of traffic signal controllers having the foregoing characteristics; to provide a type of traffic signal controller which may, in less than all of its cycle types, effect recurrent display of special signal aspects for directing certain traffic (as, for example, "right turn" arrows, "left turn" arrows and pedestrian movement signals); to provide a type of traffic signal controller which may be manually operated without affecting the operative characteristics of any controller which is either interrelated or governed by a master controller in common therewith; to provide a type of traffic signal controller which, following a period of manual operation,

will, within a minimum period of time, become resynchronized with other inter-related controllers and with a master timer; to provide means whereby the number of component periods in such cycles of signal display may be readily adjusted; and to provide traffic signal controlling mechanism whereby any or all of the foregoing revisions of operating characteristics may be accomplished without utilization of change gears or other means of such character as to present opportunities for inadvertent disarrangement of intended cycle characteristics incidental to substitution of cycles of one characteristic for those of another.

A further important object of this invention is to provide improved duration varying systems and mechanism therefor which, for the accomplishment of all, any one or of any group of the foregoing objects, shall be of greater effectiveness and reliability, composed of a smaller number of parts severally characterized by strength, durability and facility of assemblage, as well as amenable to a lower cost of manufacture.

Other and more specific objects and advantages will appear in the following description of an illustrative embodiment of this invention, or will be apparent therefrom to those skilled in this art.

In a preferred embodiment of this invention, the foregoing objects and others ancillary thereto are preferably accomplished as follows:

A series of adjustable cams are provided for opening and closing contacts which control various signaling circuits. These cams are rotated, as by means of a motor, subject to the control of a mechanism having several graduated plates or faces each equipped with a plurality of members (herein referred to as "keys") subject to manual placement in diverse relationships, assemblies of said plates or faces, with their associated parts, being hereinafter referred to as "dial assemblies" or "dials". These dials, together with their associated members or keys, are simultaneously driven by a second motor; certain of said keys being effective for causing energization of the cam motor incidental to changes in the display of signaling aspects. Relays contribute to association of the cam motor with the dials for rendering energization of said motor responsive to one or another of said dials, singly, and subject to determinations effected by a master controller. Other means, including certain of the keys associated with said dials, serve to maintain predetermined relationships between the actuation of said cams and the positionings of said dials, as well as making provision for maintaining predetermined relationships between said dials and a master timer. A further means is provided for response to a master timer for effecting regulation of the speed of the dial motor to attain substantially synchronous relationships between the timing of said dials and that established by such a master timer.

For the purpose of facilitating a ready understanding of this invention and what are considered to be its novel characteristics, an embodiment thereof is represented in the annexed drawings and hereinafter described, however, such embodiment, though practical, is by no means the only one which the invention may assume, wherefore the invention is not confined to any strict conformity with the more or less diagrammatic representations of the drawings but may be changed and modified in various particulars so long as such changes and modifications make no

material departures from the invention, as more particularly set forth in the annexed claims.

In the accompanying drawings, like parts are designated by the same reference characters throughout the several views in which

Figure 1 is a front elevation of a traffic signal controller embodying this invention;

Fig. 2 is a schematic representation of mechanism and of circuit connections suitable for association with that portion of the traffic signal controller shown in the right-hand section of Fig. 1;

Fig. 3 is a schematic representation of mechanism and of circuit connections suitable for association with that portion of the traffic signal controller shown in the left-hand section of Fig. 1;

Fig. 4 is a somewhat diagrammatic isometric view of a portion of the mechanism situated within the left-hand section of Fig. 1 and in Fig. 3;

Fig. 5 is a detailed sectional view of certain parts of Fig. 4;

Figs. 6, 7, 8, 9, 10, 11 and 12 are views representative of various alternative positionings of parts of Fig. 4;

Fig. 13 is a detailed view of certain parts of Fig. 2 with certain portions broken away;

Fig. 14 is a schematic representation of circuit connections to a plurality of signal lights at a highway intersection and arranged for cooperation with the traffic signal controller of Figs. 1, 2 and 3;

Fig. 15 is a detailed view of an alternative arrangement of certain of the parts shown in Fig. 3;

Fig. 16 is a schematic representation of a master timer in association with a plurality of traffic signal controllers embodying this invention;

Fig. 17 is a composite chart representative of various operating characteristics of a traffic signal controller in comparison with those of a master timer such as indicated in Fig. 16;

Figs. 18, 19 and 20 are charts representative of the traffic movements permitted under diverse conditions rendered effective through the association of a group of traffic signal controllers as of Fig. 1 with a master timer, in accordance with Fig. 16;

Fig. 21 schematically indicates mechanism for automatically rendering selectively effective, at suitable occasions, the various signal presentation schedules of associated local controllers;

Fig. 22 is a schematic representation of certain revisions of circuit connections illustrative of the readiness to adaptation to differing operative requirements of systems similar to that indicated by Figs. 1, 2, 3 and 14; and

Fig. 23 is a schematic "across-the-line" representation of circuit connections combined with a composite diagrammatic presentation of mechanisms and arrangement of parts embodying this invention.

The traffic signal controller of Fig. 1, sometimes referred to as "local controller", comprises a panel 50 upon which is mounted a timer dial mechanism DM and a signal circuit controlling mechanism CM responsive thereto.

The timer dial mechanism DM includes means for establishing the durations of the respective periods or components of a cycle of the operation of the controller, together with facilities for manually altering same; which facilities include the slotted dials 200 and the indicia dials 202. (See also Figs. 4 and 5.)

Three assemblies of dials FN, FS and N are shown, however, since the dials themselves as well as the associated mechanisms are similarly constructed and assembled the following description will be directed to but one such dial and assembly.

As more clearly shown in Figs. 4 and 5, the basic dial 203 is fixed upon the hub 206, which hub is, in turn, secured to the shaft 204 by the set screw 208; and the slotted dial 200 is firmly secured to the basic dial 203 as by rivet pin 205.

Indicia dial 202 is slidably positioned on the threaded extension 210 of the hub 206, and is retained in position by means of the thumb nut 212.

The spring 214 urges the indicia dial 202 away from the slotted dial 200, so that when the nut 212 is partially withdrawn from the threaded extension 210, said indicia dial 202 will be moved away from the slotted dial 200, for a purpose which will be hereinafter more fully explained.

The pin 216 serves to maintain the indicia dial 202, when in its normal axial position, in a fixed rotational relationship to the slotted dial 200.

As further indicated in Fig. 5, the basic dial 203 has a circular groove 218 formed around one face thereof near its periphery, said groove being situated in such relation to the slots 220 of dial 200 that an operating key, such as key 240, having projections 242 and 244 thereon, when inserted in one of the slots 220, may be securely fastened in position by tightening thumb nut 212 and thereby carrying indicia dial 202 into engagement with projection 242, which will force the tapered edges of the projection 244 against the sides of the groove 218.

From the foregoing it will be seen that establishment of desired settings of operating keys, such as the key 240, is greatly facilitated by the construction shown, in that the axial movement of the indicia dial 202, which occurs responsive to the spring 214 when the nut 212 is partially withdrawn from the threaded extension 210, permits insertion, transfer or removal of desired ones of such keys without thereby disturbing the settings of the others thereof.

In order to adapt the controller for effecting certain durations of signaling aspects, keys having projections 242 and 244 corresponding to those of key 240, but varying in the contour of other portions thereof, are assembled and secured in desired positions in the slotted dial 200 to act in a manner and for a purpose which will be hereinafter more fully described.

As indicated in Fig. 1, stationary reference pointers 230, 230, 230 are closely associated with the indicia 202' provided upon the faces of the indicia dials 202, in order to facilitate determinations as to required relative settings of keys in the dials 200 and as to the positionings of the dials relative to a cycle of their operation.

As best shown in Fig. 3, the shafts 204 of the dial assemblies FN, FS and N, are driven by means of an induction type motor M1 comprising the electromagnet 290, disc 292, shaft 294, worm gear 296, worm wheel 298, driving gears 300, 300, 300 and idler gears 302, 302; said driving gears being fixed upon their respectively associated shafts 204, 204, 204.

Gear 300', driven by one of the gears 300, is secured to shaft 304 and acts therethrough to drive two cams which will be herein respectively referred to as the "synchronizing cam" 306 and the "speed control cam" 308.

It is preferable that the gears 300, 300, 300 and 300' shall be of such character that simultaneous

and synchronical movement will be imparted to the dials 200, 200, 200 of the assemblies FN, FS and N, as well as to the cams 306 and 308.

The motor M1 has a shading coil 290' rotatable with shaft 310 for effecting revisions of the torque applied to the disc 292, in a well known manner.

The disc 322 drives the shaft 310 through the beveled gears 314 and 316 and is associated with the electromagnets M2 and M3 such that the excitation of one of said electromagnets will cause said disc to rotate said shaft in one direction and the excitation of the other of said electromagnets will correspondingly cause rotation of said shafts in opposite direction. For convenience in description, the electromagnet M2 and the portion of the disc 322 associated therewith will be herein referred to as "motor M2" and the electromagnet M3 and its associated portion of the disc 322 will be herein referred to as "motor M3".

From the foregoing it will be evident that energization of motor M2 will cause rotation of the coil 290' in one direction, and energization of the motor M3 will cause rotation of said coil in the opposite direction.

The permanent magnet 318 is associated with disc 292, in a manner well understood by those skilled in the art, to serve as a magnetic brake and thereby maintain a comparatively slow and uniform speed of rotation of the disc 292 and to further serve to minimize coasting by hastening deceleration when driving current has been cut off.

As best indicated in Fig. 1, the timer dial mechanism DM is secured to panel 50 by means of the hinges 52, 52, so that the entire dial mechanism may be so swung as to carry the right-hand edge of frame plate 232 away from panel 59 and thereby afford convenient access to all portions of said mechanism. The latch 54 is secured to the panel 50 for engagement with the front plate 232, for maintaining same in normal service position.

The details of the mechanical structure of the signal circuit controlling mechanism CM are somewhat similar to those of the controlling mechanism SC disclosed in a co-pending application for Signal controlling mechanism and system filed July 20th, 1934, Serial No. 736,266.

The frame plates 100 and 102 of this mechanism are maintained in suitably spaced relation by the contact bars 104, 106 and 108, together with the insulating tie strip 110, and by the insulating rods 114, 114. The bars 104, 106 and 108 and the contact 107 are electrically isolated from said frame plates by the insulating plates 112, 112, 112, 112.

The frame plate 102 of the mechanism CM is secured to the panel 50 by means of the hinges 56, 56, in a manner corresponding to that described in connection with the mechanism DM, so that the entire signal circuit controlling mechanism may be so swung as to carry the frame plate 100 away from the panel 50 and to thereby afford convenient access to all portions of said mechanism. The latch 58 is secured to the panel 50 for engagement with the frame plate 100, for maintaining same in normal snug engagement with said panel.

Further details of the mechanical structure of the signal circuit controlling mechanism CM will be best understood by referring both to Fig. 1 and to the diagrammatic representation of Fig. 2, wherein a general arrangement of parts is shown which corresponds substantially with the disclosure of Fig. 1; however, it will be noted that

certain parts, for example, electromagnet 116, have been shown in Fig. 2 in a diagrammatic manner, in order to more clearly disclose their intended manner of operation, and also in order to avoid distortion of representation or obscuring of other parts.

The cam motor M4 is secured to the frame plates 100 and 102 and comprises the metal disc 122, which is fixed upon the shaft 124, to drive the gear 126 through any well known medium of gearing such, for example, as that utilized in the disclosure of the aforementioned copending application.

The permanent magnets 118, 118, are applied in a well known manner to effect a slow and uniform speed of rotation of the disc 122 and to further serve to minimize coasting by hastening deceleration when driving current has been cut off.

The motor M4 drives the cam shafts 128 and 130, said shaft 128 being driven by said motor through the gears 126 and 132, and said shaft 130 being driven in even ratio with said shaft 128 through the gears 134 and 136.

The cams 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80 and 82 are adjustably secured upon the shaft 130 between spacers 84, as shown in Fig. 1, and each of said cams consists of two relatively movable discs or sections capable of presenting a greater or less angular raised portion, depending upon whether the raised portions of the discs are in side-by-side or overlapping relationship, as more fully disclosed in the aforementioned copending application; thus facilitating wide variations in the relative settings and durations of the effectiveness thereof.

As indicated by Fig. 2, supervising cam 90, the impulse cam 92, the carryover wheel 94, the ratchet wheel 96 and the bevel gear 98 are rotated by the shaft 128, for accomplishing results which will be hereinafter more clearly pointed out.

The ratchet wheel 96 and its pawl 358 may be provided to prevent rotation of shafts 128 and 130 in other than the intended direction.

The contact arm 160 is biased for movement to effect closure of an electrical connection between such arm and the contact bar 108 and is arranged to open such connection responsive to actuation communicated to said arm, (through the lift rod 188' and the insulating member 184) from the follower 186 which traces the contour of the cam 60. The contact arm 162 is of similar construction and correspondingly associated with the cam 62 and the contact 107 which is mounted on the tie strip 110. The contact arms 164, 168, 172, 176, 180 and 182 are also of similar construction and correspondingly associated with the cams 64, 68, 72, 76, 80 and 82, and with the contact bar 104; while the contact arms 166, 170, 174 and 178 are of similar construction and correspondingly associated with cams 66, 70, 74 and 78 and with the contact bar 106 (see also Fig. 1).

The contact arms 190, 192 and 194 are biased, as by the springs 196, to effect closure of electrical connections between said arms and the contact bars 190', 192' and 194', respectively; and are associated with the cams 90 and 92 and with pins 280 which are carried by the wheel 94, through their respective insulating members 184', 70 push rods 188'' and followers 186'.

As best indicated by Fig. 1, a rock shaft 140 extends between the frame plates 100, 102 as well as outside of plate 100. A conventional crank 138 and lever 142 are so associated with the por-

tion of the shaft 140 which extends outside of plate 100, with the electromagnet 116 and with the armature 144 thereof, that the rock shaft 140 is in a certain rotative position during energization of said electromagnet, and is rocked to another position, during deenergization of said electromagnet, responsive to the spring 148. The shaft 140 is uniformly cut away between the plates 100, 102 except at that portion 145 which is adjacent the follower 186 associated with cam 64, where a projecting section of this shaft coacts with the projecting end of said follower to effect separation of arm 164 from bar 104 whenever the rock shaft 140 is rocked to the position which it assumes during deenergization of electromagnet 116.

While the arrangement of the electromagnet 116 and its associated parts as indicated in Fig. 1 is based upon actual details of a practical embodiment of this invention, Fig. 2 incorporates slight differences in the representations of certain of these parts in order that they may be better suited to its diagrammatic form; although the operative effect of one arrangement is substantially identical with that of the other. Thus in Fig. 2 the armature 144 is represented as associated with the arm 164 through the rod 146 and its insulating block 184'' in such manner that retraction thereof responsive to spring 148 will cause movement of said arm to break its connection with the bar 104, and so that when said armature is in attracted position said arm will be free to assume either open or closed circuit relationship with said bar.

The bevel gear 350 mounted on shaft 352 meshes with bevel gear 98 on shaft 128. The pin 354, in shaft 352, is adapted to register with the slot 356 in the manual control handle 360 so that, when the handle 360 is applied over the end of said shaft, said pin will be engaged by the walls of the slot 356, to the end that rotation of the handle 360 will cause corresponding rotation of the shafts 128 and 130.

As previously pointed out, the pawl 358 may be utilized in conjunction with the ratchet wheel 96 to prevent unintended directional rotation of shaft 128, and therefore of shafts 130 and 352.

The shaft 130 has fixed thereon a notched wheel 362 which cooperates with the spring 364 in a well known manner, to retain said shaft and the shaft 128 in any one of a plurality of index positions, as well as serving to indicate rotation of said shafts past such positions. So-called "slugs" 363 are provided for insertion and secure retention within any desired one of the notches of the wheel 362, for the purpose of "blanketing" or rendering such notches ineffective for cooperation with said spring 364, for reasons which will be hereinafter more fully explained.

Positioning of the manual control handle 360 on the shaft 352, as just described, effects engagement between the cam surface 366 on the handle 360 and the insulating rod 368. The resultant movement of said rod in a lateral direction away from the handle 360 causes the separation of the spring 380 from the spring 378 and, through the insulated rod 370, serves to move the three contact springs 372, 374 and 376 into closed relationship, for reasons which will be hereinafter more fully explained.

A relay 382, having a movable contact 384 and stationary contacts 386 and 388 is so arranged that, when energized, contact 384 moves into engagement with contacts 386 and 388.

Associated with the controller of Fig. 1, is a mechanism for formulating intermittent current impulses. As best shown in Fig. 2, this mechanism comprises a motor M5 which drives a shaft 390 through gears 392 and 394. Secured to the shaft 390 are cams 396 and 398, which, in rotating, engage the movable contacts 400 and 402 and move them away from their respectively associated stationary contact members 404 and 406. Thus, when motor M5 is energized, contact 400 is continuously acting to alternately make and break with contact 404 and, correspondingly, contact 402 is making and breaking with contact 406.

Referring again to Figs. 3, 4 and 5, as well as to Figs. 6, 7, 8, 9, 10, 11 and 12; as hereinbefore described, keys (such as key 240 of Fig. 5) may be firmly secured in selected slots of dial 200. Each slotted dial 200 may preferably have one hundred uniformly spaced slots about its circumference.

The indicia 202' on dial 202 assists in determining the location of any given setting of a key in terms of percentage of an operative cycle.

It will be noted that the keys 240, 250, 252, 254, 256 and 258, as shown in Figs. 7, 8, 9, 10, 11 and 12, respectively, differ from one another as to certain details of their contour, in order that each of these types of keys will, when assembled in a dial 200, perform its own characteristic function of operation as may be understood by reference to Fig. 4, in connection with more detailed descriptions thereof which are hereinafter set forth.

Associated with each dial 200 are six finger ends 500', 502', 504', 506', 508' and 510', which are formed at the ends of the fingers 500, 502, 504, 506, 508 and 510, respectively. In addition, the end 506' has secured thereto a secondary end 506'', the purpose of which will be hereinafter more fully explained.

The fingers 500, 502, 504 and 506 are secured to the insulating mounting blocks 512, 514, 516 and 518, respectively, each of which blocks is free to rotate in an intended manner about its associated pivot shaft 520, 522, 524 or 526.

Also secured to contact block 512 is a contact member 530, having a contact 530' for at times engaging the contact 528' of a stationary contact member 528.

Secured to the contact block 514 is a contact member 532, carrying a contact 532' adapted for at times engaging the contact 528'' of the member 528.

The contact members 534 and 536 are secured to the contact mounting block 516 in insulated relationship and carry the contacts 534' and 536', respectively.

The contact member 538 is secured to the contact mounting block 518 and carries the contacts 538', 538'' and 538''' for at times engaging the contacts 534', 536' and 540', respectively. Said contact 540' is carried by the stationary contact member 540 and is normally engaged by contact 538'''.

A stop 542 serves to limit the downward movement of the finger 504 and hence of the members 534 and 536. Contact 540' serves to limit such movement of the finger 506 through its associated member 538 and the contact 538'''. Contacts 528' and 528'' correspondingly serve to limit such movement of fingers 500 and 502.

Fingers 508 and 510 are free to swing about their respectively associated pivot shafts 544 and 546.

The pins 550 and 552 are secured in fingers 500 and 502, respectively, and are arranged to extend into the path of movement of fingers 508 and 510. The shoulders 508'' and 510'' are formed in the upper edges of the fingers 508 and 510, respectively, for engagement with the associated pins 550 and 552. When the pin 550 engages the shoulder 508'', the block 512 will be in a raised position such that contact 530' will be separated from contact 528'. Correspondingly, when the pin 552 engages the shoulder 510'', the block 514 will be in a raised position such that contact 532' will be separated from contact 528''.

The spring 554 urges movement of the block 518 to effect engagement between the contacts 538''' and 540'; the spring 556 urges movement of the block 516 to bring finger 504 against the stop 542; the spring 558 urges movement of the block 514 to bring the contact 532' into engagement with the contact 528''; the spring 560 urges movement of the block 512 to bring the contact 530' into engagement with the contact 528'; and, the springs 562, 562 maintain fingers 508 and 510 against their respectively associated pins 550, 552 to bring the shoulders 508'' and 510'' in position to be engaged by the pins 550 and 552 for a purpose which will be hereinafter more fully explained. In this connection it should be noted that the springs 558 and 560 are of sufficient tension to prevent the springs 562, 562, acting through the fingers 508 and 510 and the pins 550 and 552, from lifting the fingers 500 and 502.

During intended operation, the closure and separation of certain contacts are effected by the movement of the keys, carried by dial 200, past the finger ends 500', 502', 504', 506', 506'', 508' and 510'. Each key passes above the ends 508', 510' and below the ends 500', 502', 504', 506' and 506'', and each key is of such contour that it either depresses or lifts a certain end or ends as predetermined by the characteristics of its contour.

Fig. 6 shows the relative positionings of the finger ends of Fig. 4, as normally assumed by them, in the absence of actuation thereof by any of the keys.

Fig. 7 differs from Fig. 6 in that it indicates the revised positioning of the end 504' resultant from engagement thereof by the projecting portion 260 of the key 240. However, in the operation of this mechanism, just before the end 504' has been lifted to the positioning here shown, the main body portion of the key 240 will have acted to slightly raise the end 506'', with the result that the contact 538''' will be slightly separated from contact 540' just before engagement of contact 534' with contact 538'.

Fig. 8 shows how the contour of the key 250 acts, through its projecting portion 262, to depress the end 508', while the cut-away portion 262' of its main body passes beneath the ends 504' and 506' without raising them. Such depression of the end 508' causes the finger 508 to withdraw the shoulder 508'' from the path of the pin 550, whereupon the block 512 is rotated by the spring 560 so as to bring the contact 530' into engagement with the contact 528'.

Fig. 9 shows how the contour of key 252 acts through its projecting portion 264, to depress the end 510', while the cut-away portion 264' of its main body passes beneath the end 506' without raising it. Such depression of the end 510' causes the finger 510 to withdraw the shoulder 510'' from the path of the pin 552, permitting the block

514 to rotate responsive to the spring 558 and thereby bring contact 532' into engagement with contact 528''.

In Fig. 10, the key 254 is shown acting through its projecting portion 266 to lift the end 502' and thereby rotate the block 514 and carry the contact 532' away from the contact 528''. Such lifting of the end 502' tends to carry the pin 552 away from the finger 510, which finger will then be raised by its spring 562 until its shoulder 510'' engages said pin 552; so that, when said projecting portion 266 of key 254 is withdrawn from the end 502', said finger 510 will act, through the shoulder 510'', to latch and thereby maintain the finger 502 in its raised position. As a result, the contact 532' will remain away from the contact 528'' until the finger 510 is depressed (as, for example, by engagement of key 252 with the end 510' of said finger 510), whereupon the shoulder 510'' will be disengaged from the pin 552, as hereinbefore more fully explained.

In Fig. 11, the key 256 is shown acting through its projecting portion 268 to lift the end 500' and thereby so rotate the block 512 as to carry the contact 530' away from the contact 528'. Such lifting of the end 500' tends to carry the pin 550 away from the finger 508, which finger will then be raised by its spring 562 until its shoulder 508'' engages said pin 550; to the end that, when said projecting portion 268 of key 256 is withdrawn from the end 500', said finger 508 will act, through its shoulder 508'', to latch and thereby maintain the finger 500 in its raised position. As a result, the contact 530' will remain away from the contact 528' until the finger 508 is depressed (as, for example, by engagement of key 250 with the end 508' of said finger), whereupon the shoulder 508'' will be disengaged from the pin 550, as hereinbefore more fully explained.

In Fig. 12, the upper edge 270 of the key 258 is shown supporting the finger end 506' in such position as to cause the block 518 to carry the contact 538''' away from the contact 540' and to carry the contact 538'' into engagement with the contact 536'.

It will be noted that, throughout the operation of the various keys, as just described, given keys actuate but one or, at most, two of the finger ends, leaving the other fingers undisturbed.

It should also be understood that the representation of certain key contours in the accompanying drawings, and the foregoing description thereof, are presented for purposes of illustration; as it will be evident to those skilled in the art that various other key contours may be devised for effecting different operative results, as may be required in order to cause a display of desired signals.

In the interest of clearness of disclosure, fingers, finger ends, springs, keys, etc., are omitted from Fig. 3. On the other hand, several relays and contacts which have been omitted from other views for like reasons, are here diagrammatically indicated, as follows:

Relay 410 has individually insulated movable contacts 412, 414 and 416 for engaging the front contacts 418, 420 and 422, respectively, during energization, and for correspondingly engaging the back contacts 424, 426 and 428 during deenergization.

Relay 430 has similar movable contacts 432, 434 and 436 for like cooperation with the front contacts 438, 440 and 442 and the back contacts 444, 446 and 448.

Relays 450 and 456 have the electrically inter-

connected movable contacts 452 and 458, respectively, for cooperation with their respective front contacts 454 and 460.

Relays 462 and 468 have electrically interconnected movable contacts 464 and 470, respectively, said contact 464 for cooperation with the front contact 466 and said contact 470 for cooperation with the pair of back contacts 472 and 474.

The contact 480 of the timer dial mechanism DM is situated between the contacts 482 and 484 and is biased for movement away from the former and into engagement with the latter; said contacts 482 and 484 being so positioned with relation to said contact 480 that, in the course of the movement thereof, it will make with one before breaking with the other. The cam 306 is situated in the path of the free end of said contact 480, for holding same in engagement with said contact 482 except when the cut-away portion 306' of said cam is situated in the path of the end of said contact 480, when its bias will cause it to move into engagement with contact 484 and away from contact 482.

The contact 490 of the timer dial mechanism DM is situated between the contacts 492 and 494 and is biased for movement away from the former and into engagement with the latter; said contacts 492 and 494 being so positioned with relation to said contact 490 that, in the course of the movement thereof, it will break with one before making with the other. The cam 308 is situated in the path of the free end of said contact 490, for holding same in engagement with said contact 492 when the full raised portion 308'' of said cam is situated in the path of the end of said contact 490; for holding said contact 490, against the urge of its bias, in an intermediate or non-contacting position when the semi-raised portion 308' of said cam is situated in the path of said end; and for permitting said contact to move, responsive to the urge of its bias, into engagement with contact 494 and away from contact 492 when the depressed or cut-away portion 308''' of said cam is situated in the path of said contact.

Referring now to Fig. 13, there is here shown a detailed view of the carryover wheel 94 previously referred to in connection with Fig. 2. This wheel 94 is secured to the shaft 128 and has twelve openings in equidistant spacing near the periphery thereof for receiving a desired number of pins such as the pins 280. As clearly indicated at the portion of the wheel 94 shown cut-away, the retaining disc 282, hub 284 and set screw 286 serve to retain the pins 280 in intended position and to provide means which permit ready removal or insertion of such pins for purposes which will be hereinafter more fully pointed out. Eight of the pins 280 are shown in the wheel 94 of Fig. 2 positioned for effecting separation of arm 194 from bar 194' at occasions in suitably timed relation to the closures of the contact 192 with bar 192', as hereinafter more fully explained.

Referring next to Fig. 14, the signal lamps 568, 570, 572, 574, 576, 578, 580 and 582 are for indicating, by the display of the arrows marked thereon, permitted movements of pedestrian traffic.

The signal lamps 584, 586, 588 and 590 are situated in main highway, the signals 584 and 588 facing traffic in one direction on main highway approaching the intersection with cross highway, and the lamps 586 and 590 facing traffic approaching said intersection from the oppo-

site direction. The signal lamps 592, 594, 596 and 598 are correspondingly situated in cross highway, so that the lamps 592 and 596 face traffic approaching said intersection from one direction, and the lamps 594 and 598 face traffic approaching from the opposite direction. In each of said highway approaches, there are also provided a "stop" lamp R, a "caution" lamp A and a "go" lamp G or G'; such letters R, A and G alluding to the conventionally used colors for such signaling aspects of red, amber and green.

The lamps 584, 586, 592 and 594 display arrows when lighted for indicating that vehicular traffic approaching lighted ones thereof may make left-hand turns. Correspondingly, the lighting of the lamps 588, 590, 596 and 598 indicates that vehicular traffic approaching lighted ones thereof may make right-hand turns.

Fig. 15 discloses an alternative form of the driving connection shown in Fig. 3 between the shaft 320 of motors M2 and M3 and the torque revising shaft 310 of motor M1. Utilization of this form of connection may be desirable in instances in which the ratio of gearing needed between these shafts is greater than readily obtainable with the form of Fig. 3.

Such alternative form of connection comprises a worm gear 324 fixed upon the shaft 320; a worm wheel 326 loosely mounted on the shaft 310, meshing with said worm gear, and held in place by the spacing collar 328; the cup-shaped spring 330 pressed against said wheel 326 by the hub 332, which hub is fastened to said shaft by the set screw 334, so that the shaft 310 is frictionally driven responsive to rotation of said wheel. The amount of friction may be regulated by moving the hub 332 along shaft 310 either toward or away from the wheel 326. As previously explained, rotation of shaft 320 effects rotation of coil 290' and said frictional connection facilitates manual adjustment of coil 290', effected by rotating the knob 312.

The master timer or controller T, indicated within the confines of the dash line h of Fig. 16, is associated with a plurality of traffic controllers X, Y, Z, each embodying characteristics of the controller of Fig. 1.

In the instance of the traffic controller Z, the panel 50 is shown partially withdrawn from its outer casing Z' to permit the mechanisms DM and CM to be swung about their respective hinges 52, 52 and 56, 56, as previously mentioned in connection with the description of Fig. 1.

Such withdrawal of panel 50 and mechanisms DM and CM may be accomplished through the utilization of any one of a number of well known types of supporting structure, whereby said panel may be moved directly out of the casing Z' a sufficient distance to allow the swinging of the mechanisms DM and CM to substantially the positions indicated in Fig. 16.

The master timer T comprises a motor M6 for driving a gear 600 which, in turn, drives the gear 602 which is secured to the shaft 604. The cams 606 and 608 are also fixed on said shaft, and have the cut-away portions 606' and 608' and the raised portions 606'' and 608'', respectively.

The tracer contact 610 is so associated with the cam 606 and with the contact 612 that, when rotation of said cam carries its raised portion 606'' into the path of said tracer contact, said contact 610 is moved into engagement with said contact 612; and, when said raised portion 606'' is withdrawn and said cut-away portion 606' is

presented, said contact 610 is moved out of engagement with said contact 612.

The tracer contact 614 is so associated with the cam 608 and with the contact 616 that, during presentation of the raised portion 608'' of said cam, said tracer contact is separated from said contact 616; and, when said raised portion 608'' is withdrawn and said cut-away portion 608' is presented, said tracer contact is moved to engage said contact 616.

Circuit connections

The electrical connections provided between the mechanism thus far described and the series of terminals indicated in the upper central portion of Fig. 2 are as follows:

From terminal 702,—conductor 756 leads to movable contact 400; conductor 752 leads to contact 107; and conductor 754, branching from conductor 752, leads to contact spring 376.

From terminal 704,—conductor 762 leads to movable contact 402; conductor 758 leads to contact bar 108; and conductor 760, branching from conductor 758, leads to contact spring 372.

From terminals 706, 708, 710, 712, 714 and 716,—conductors 764, 766, 768, 770, 772 and 774 lead, respectively, to contact arms 178, 174, 170, 166, 162 and 160; conductors 776, 778, 780, 782, 784 and 786 lead, respectively, to correspondingly marked conductors relatively shown in Fig. 14; and, in addition, conductors 788 and 790 lead, respectively, from the terminals 714 and 716 to correspondingly marked and relatively positioned conductors shown in Fig. 3.

From terminal 718,—conductor 792 leads to a correspondingly marked and relatively positioned conductor shown in Fig. 3; conductor 794 leads to contact spring 374; and conductor 796 continues on from spring 374 to the movable contact 384. Contact bar 104 is connected to, and is therefore a branch from, conductor 794.

From terminals 720, 722, 724, 726, 728 and 730, conductors 798, 800, 802, 804, 806 and 808 lead, respectively, to contact arms 182, 180, 176, 172, 168 and 164. Furthermore,—conductors 810, 812, 814 and 816 lead, respectively, from terminals 720, 724, 726 and 728 to correspondingly marked and relatively positioned conductors of Fig. 14; conductors 818 and 820 lead, respectively, from terminals 722 and 730 to correspondingly marked and relatively positioned conductors of Fig. 3; and, in addition to the foregoing conductor 822 is for association of the terminal 730 with one side of a suitable source of electric current supply.

From terminals 732, 734 and 736, conductors 824, 826 and 828 lead, respectively, to correspondingly marked conductors of Fig. 16. In addition, conductor 830 leads from terminal 732 to one end of the winding of the electromagnet 116; and conductors 832 and 834 lead, respectively, from terminals 734 and 736 to correspondingly marked and relatively positioned conductors shown in Fig. 3.

From terminals 738, 740, 742 and 744,—conductors 836, 838, 840 and 842 lead, respectively, to correspondingly marked and relatively positioned conductors shown in Fig. 3; from terminals 738, 740 and 742, conductors 844, 846 and 848 lead to correspondingly marked and relatively positioned conductors shown in Fig. 16; conductor 850 leads from terminal 738 to the remaining end of the winding of the electromagnet 116; conductor 852 is for association of the terminal 744 with the other side of a suitable current source; conductor 854 leads from terminal 744 to a correspondingly

marked and relatively positioned conductor shown in Fig. 14. Furthermore, conductor 856 leads from terminal 744 to one terminal of motor M4, while the branch conductor 858 leads from conductor 856 to one end of the winding of relay 382.

From terminals 746, 748 and 750,—conductors 860, 862 and 864 lead, respectively, to correspondingly marked and relatively positioned conductors shown in Fig. 3; conductors 866, 868 and 870 lead, respectively, to the stationary contact 388 of relay 382, to the contact arm 194, and to the contact arm 190. Conductors 872 and 874 branch from conductor 866 and lead, respectively, to contact bars 190' and 192'; while conductor 876 branches from conductor 856 and leads to one terminal of motor M5.

Other conductors are shown in Fig. 2, as follows:

Conductor 878 connects the contact bar 104 with the contact bar 106, conductor 880 connects the contact bar 106 with the stationary contact 406, conductor 882 branches from conductor 880 and connects with the stationary contact member 404, and conductor 884 connects the stationary contact member 404 with the remaining terminal of motor M5. Conductor 886 leads from the stationary contact 386 of relay 382, to the contact spring 378, conductor 888 leads from the contact spring 378 to the contact bar 194', conductor 890 connects the contact spring 380 with the remaining terminal of motor M4, and conductor 892 connects the remaining end of the winding of relay 382 with the contact arm 192.

Referring now to continuations in Fig. 3 of the conductors which have been described in connection with Fig. 2:

Conductor 792 leads to the contact 482 of the group associated with the cam 306. Conductors 894 and 896 branch from conductor 792, the former leading to the movable contact 432 of relay 430 and the latter leading to the contact 472 of relay 468.

Conductor 840 leads to one end of the winding of relay 462. Conductor 838 leads to one end of the winding of relay 468.

Conductor 842 leads to one end of the winding of motor M1, and conductors 902 and 904 branch from conductor 842, the former leading to an end of each of the windings of relays 450 and 456 and the latter leading to the conductor 906 which connects to one end of each of the windings of motors M2 and M3.

Conductor 820 leads to the movable contacts 464 and 470 associated with relays 462 and 468.

Conductor 836 leads to the remaining end of the winding of relay 468 as well as to the remaining end of the winding of relay 462. Conductors 898 and 900 branch from conductor 836, the former leading to one end of the winding of relay 410 and the latter leading to one end of the winding of relay 430.

Conductor 790 leads to contact 454 of relay 450, conductor 818 leads to the movable contacts 452 and 458 of relays 450 and 456 and conductor 788 leads to contact 460 of relay 456.

Conductors 832 and 834 lead to the remaining ends of the windings of relays 430 and 410, respectively.

Conductor 862 leads to the contact members 540, 540, 540 associated with the assemblies of dials FN, FS and N, respectively; and, correspondingly, conductor 860 leads to the contact members 534, 534, 534, and conductor 864 to the members 536, 536, 536 which are associated with

respective ones of the assemblies of dials FN, FS and N.

Other conductors are shown in Fig. 3 as follows:

5 Conductors 908, 910 and 912 respectively lead from the contacts 418, 420 and 422 of relay 410 to the contact members 530, 530 and 532 associated with the dial assembly FN. A branch conductor 914 leads from conductor 908 to the contact member 528 of said dial assembly FN.

10 Conductors 916, 918 and 920 respectively lead from the movable contacts 412, 414 and 416 of relay 410 to the contacts 444, 446 and 448 of the relay 430.

15 Conductors 922, 924 and 926 respectively lead from the stationary contacts 424, 426 and 428 of relay 410 to the contact members 528, 530 and 532 associated with dial assembly N. A branch conductor 928 leads from conductor 922 to contact member 538 of said dial assembly N.

20 Conductors 930, 932 and 934 respectively lead from the contacts 438, 440 and 442 of the relay 430 to the contact members 538, 530 and 532 associated with dial assembly FS. A branch conductor 936 leads from conductor 930 to contact member 528 of said dial assembly FS.

25 Conductors 938 and 940 respectively lead from the movable contacts 434 and 436 of the relay 430 to the remaining ends of the windings of relays 450 and 456.

30 Conductor 942 leads from the contact 466 of relay 462 to the tracer contact 490 associated with the cam 308.

35 Conductor 944 leads from contact 474 of relay 468 to the contact 484 associated with the cam 306.

40 Conductors 946 and 948 lead, respectively, from the remaining ends of the windings of motors M2 and M3 to the contacts 492 and 494 associated with cam 308.

Conductor 950 leads from the remaining end of the winding of motor M1 to the tracer contact 480 associated with cam 306.

45 Referring now to continuations in Fig. 14 of the conductors which have been described in connection with Fig. 2:

Conductor 786 leads to one of the terminals of the lamp G' which is shown in the lower portion of main highway.

50 Conductor 784 leads to one terminal of the lamp G which is shown in the upper portion of main highway.

Conductor 782 leads to one terminal of left turn arrow lamp 586 and to one terminal of left turn arrow lamp 584.

55 Correspondingly, conductor 780 leads to the amber signal lamps A, A for main highway, conductor 778 leads to the arrow lamps 588, 590, 592, 594, 596 and 598, conductor 776 leads to the cross highway signal lamps G, G and to the main highway signal lamps R, R, conductor 816 leads to the pedestrian signal lamps 568, 574, 576 and 582, conductor 814 leads to the pedestrian signal lamps 570, 572, 578 and 580, conductor 812 leads to the cross highway signal lamps R, R, and conductor 810 leads to the cross highway signal lamps A, A.

60 Conductor 854 (which is sometimes herein referred to as a "common return conductor") leads to the remaining terminals of all of said signal lamps.

65 Referring now to Fig. 16, conductors 1000 and 1002 are for conducting energy from a suitable source of current supply to the terminals 984 and 990. Such source of current supply as is

associated with these terminals may either be the same as that to which the conductors 822 and 852 of Fig. 2 are connected or one which is independent thereof.

The conductor 1004 leads from conductor 1000 5 to one terminal of the motor M6, the remaining terminal of motor M6 being connected to conductor 1002 through conductor 1006, closed switch 1008, and adjustable resistance 1010.

The conductor 1012 leads from conductor 1002 10 to the contact 612 associated with cam 606, and to the tracer contact 614 associated with cam 608. Conductors 1014 and 1016 lead from contacts 610 and 616 to the terminals 986 and 988, respectively.

15 The conductor 1002 also connects with the switch points 1018 and 1020 which points are respectively positioned to cooperate with the independently operable switch arms 1022 and 1024. Conductors 1026 and 1028 lead from the switch 20 arms 1022 and 1024 to the terminals 992 and 994, respectively.

25 The bus conductors 1030, 1032, 1034, 1036, 1038 and 1040 are respectively connected to the terminals 984, 986, 988, 990, 992 and 994. The continuations of the conductors 844, 846, 848, 824, 826 and 828 of the controller of Fig. 2 are connected to said respective bus conductors, and the controllers X, Y and Z, as well as any other controllers which are to be supervised by the master 30 timer T, are correspondingly connected to the aforementioned bus conductors.

Assuming that the density of traffic upon main highway is considerably greater than that upon cross highway, and further assuming that the various parts are positioned as shown in Figs. 2, 3, 14 and 16, and that the adjustments are such as to cause the dial mechanism DM and the master timer T to operate substantially in synchronism, current flow would be effective through 40 paths as follows:

In Fig. 16, from current source conductor 1000, through conductor 1004, motor M6, conductor 1006, switch 1008, adjustable resistance 1010 to current source conductor 1002.

45 Other current paths effective from current source conductor 1000 are as follows:

50 To terminal 984, bus conductor 1030, conductor 844 to terminal 738 (Fig. 2); from whence one branch path leads by way of conductor 850, electromagnet 116, conductor 830, terminal 732, conductor 824, bus conductor 1036, (Fig. 16) terminal 990 to source conductor 1002; another branch leads through conductor 836 (Fig. 2), winding of relay 462, (Fig. 3) conductor 840, terminal 742 55 (Fig. 2), conductor 848, bus conductor 1034 (Fig. 16), terminal 988, conductor 1016, contacts 616 and 614 and conductor 1012 to source conductor 1002; still another branch leads through conductor 836 (Figs. 2 and 3), winding of relay 462, conductor 838, terminal 740 (Fig. 2), conductor 846, bus conductor 1032 (Fig. 16), terminal 986, conductor 1014, contacts 610 and 612 and conductor 1012 to source conductor 1002.

65 Establishment of the current paths thus far described will cause the motor M6 to drive the cams 606 and 608 at a speed determined by the adjustment of the resistance 1010 (Fig. 16); the electromagnet 116 (Fig. 2) will be energized, thus causing the armature 144 to be so positioned as to permit the engagement of arm 164 with bar 104; the magnet of relay 462 (Fig. 3) will be energized causing the contact 464 to engage the front contact 466; and contact 470 of relay 468 will be dis- 75

engaged from its contacts 472 and 474 responsive to energization of its magnet.

From the current source conductor 822 a current path is provided through terminal 730, conductor 888 and contact arm 164 to contact bar 104, from which numerous parallel paths are effective as follows:

For causing motor M1 to drive the dial assemblies FN, FS and N, together with the cams 306 and 308, at such speed as is determined by the adjustment of the shading coil 290', a path is established from source conductor 822 (Fig. 2) to and through bar 104 as already described, thence through conductor 794, terminal 718, conductor 792, (Fig. 3) contact 482, tracer contact 480 associated with cam 306, conductor 950, motor M1, conductor 842, terminal 744 (Fig. 2) and thence back to the other side of the source by way of conductor 852.

For the energization of motor M5, another current path is effective from source conductor 822, to and through bar 104, as already described, thence through conductor 878, bar 106, conductors 880, 882 and 884 to and through motor M5, conductors 876 and 856, terminal 744 and conductor 852 to the other side of the source. It will be noted from the path just traced that motor M5 will be constantly energized to rotate cams 396 and 398 as long as arm 164 remains in engagement with bar 104.

For effecting display of the signal lamps of Fig. 14, current paths are provided from source conductor 822 (Fig. 2), to and through bar 104, as previously described, as follows:

One path leads through contact arm 182, conductor 798, terminal 720, conductor 810 (Fig. 14), to the amber lamps A, A located in cross highway; another path leads through conductor 878, contact arm 174, conductor 766, terminal 708, conductor 778 (Fig. 14), to the arrow lamps 592, 594, 596 and 598 located in cross highway as well as to the arrow lamps 588 and 590 located in main highway; another path leads through conductor 878, contact arm 178, conductor 764, terminal 706, conductor 776 (Fig. 14), to the green lamps G, G located in cross highway as well as to the red lamps R, R located in main highway; and still another path leads through conductor 878, bar 106, arm 170, conductor 768, terminal 710, conductor 780 to the amber lamps A, A located in main highway.

The return current path for the signal lamp circuits just traced leads through the various indicated signal lamps (Fig. 14) to conductor 854 and thence to terminal 744 (Fig. 2) and back to the other side of the source by way of conductor 852.

From the foregoing, it will be seen that the six arrow lamps 588, 590, 592, 594, 596 and 598; the amber lamps A, A, A, A; the green lamps G, G located in cross highway and the red lamps R, R located in main highway will be lighted.

For convenience in description, the lamps just referred to will be hereinafter collectively designated as "Aspect Group XII", and the lighting of this or any other aspect group will be referred to as a "Signal presentation".

As will be readily apparent, throughout presentation of aspect Group XII, traffic movements through the intersection are permitted as follows:

The lighting of the cross highway green lamps G, G, the left-hand turn lamps 592, 594, the right-hand turn arrow lamps 596, 598 and amber lamps A, A signifies that vehicles are permitted

to complete movements along cross highway directly through the intersection or turning to the right or left, but should proceed with caution and, if approaching the intersection should be prepared to stop short of it upon the display of the red light; while, for main highway, the lighting of the red lamps R, R, the amber lamps A, A and the right-hand turn arrow lamps 588, 590 indicates that vehicles approaching the intersection along main highway should stop before reaching cross highway, except in that vehicles which have already undertaken a right-hand turn may, driving cautiously, complete same, and the drivers of waiting vehicles may prepare to start.

The energization of the motor M1 (Fig. 3), previously referred to, causes rotation of the shaft 294 and of the dial assemblies FN, FS and N, together with the cams 306 and 308. Such rotation causes the cut-away portion 306' of the cam 306 to be presented to the tracer contact 480, whereupon the previously effective current supply path for the motor M1 is interrupted at contacts 480, 482; the contacts 480, 484 having previously been closed in preparation for the establishment of another current path for subsequent restarting and/or continued operation of said motor.

If, at the time of the interruption of such previously effective current supply path of the motor M1, the dial assemblies of Fig. 3 are somewhat in advance of synchronism of the master timer T, the relay 468 will be energized, so that its movable contact 470 will be separated from the stationary contacts 472, 474, and such other current path will not be immediately available. The motor M1 will therefore be brought to and maintained at rest until such time as such other current path is rendered available through deenergization of relay 468. This stage in the operation of this dial mechanism is sometimes referred to as "the re-synchronizing period".

Assuming that the master timer T of Fig. 16 and the dial assemblies of Fig. 3 are in synchronism at the re-synchronizing period, as would ordinarily be the case,—the cam 606 of the master timer T will, as the re-synchronizing period is about to become effective, withdraw its raised portion 606' and present its cut-away portion 606' to the tracer contact 610, thus permitting this contact to separate from the contact 612, and thereby breaking the previously effective current path for energization of the relay 468.

Following such deenergization of said relay, its contact 470 moves into engagement with the contacts 472, 474. Two paths are thus made available for supplying energizing current for motor M1. One of these paths leads from the source conductor 822 (Fig. 2) to terminal 730, thence through conductor 820 (Fig. 3), contacts 470 and 474, conductor 944 to contact 484; and the other path leads from said source conductor to and through contact bar 104, as previously described, thence through conductor 794, terminal 718, conductors 792 and 896, contacts 472 and 474, conductor 944 to contact 484. The purpose of these two paths in parallel will be hereinafter more fully explained in connection with the description of the operation of the traffic controller of Fig. 1, without the supervision of a master timer.

When the motor M1 thus resumes rotation of the dials and cams, the cut-away portion 306' will be withdrawn and the raised portion of the cam 306 will be presented for engagement with the tracer contact 480; which contact 480 will

therefore move into engagement with the contact 482 and thereby close the originally described energizing current path for motor M1, which path will thereafter remain closed until the cut-away portion 386' of cam 386 is again presented to the tracer contact 488, at the next re-synchronizing period; contact 488 being moved away from contact 484 after it has engaged contact 482.

Ensuing operation of the motor M1, driving the associated shafts, dials and cams, will cause the then effective dial to act through a key 258 (Fig. 12) carried thereby, to lift the finger end 506' and thereby separate contact 538''' from contact 540', while causing momentary engagement between the contacts 538''' and 536'.

Pursuant to the assumption hereinbefore referred to, the switches 1018—1022 and 1020—1024 will be deemed, for the purposes of this description, to be positioned as shown in Fig. 16; i. e. for breaking their respective circuits. For reasons which will be hereinafter more fully explained such positioning of these switches renders dial assembly N (Fig. 3) exclusively effective.

Following this assumption, such momentary engagement between contacts 538''' and 536' renders effective a current path from the source conductor 822 (Fig. 2) to and through bar 104, as already described, thence through conductor 794, terminal 718, conductor 792 (Fig. 3), through conductor 894, contacts 432, 444 associated with relay 430, conductor 916, contacts 412 and 424 associated with relay 410, conductors 922 and 928, contact member 538, contacts 538''' and 536', contact member 536, conductor 864, terminal 750 (Fig. 2), conductor 870, contact arm 190, bar 190', conductors 872, 866 and 874, bar 192', contact arm 192, conductor 892, relay 382, conductors 858, 856, terminal 744 to source conductor 852.

The establishment of this latter path effects energization of relay 382 (Fig. 2) causing its contact 384 to close with its contacts 386, 388, and thereby effecting energization of the motor M4 through the following current path:

From source conductor 822, to and through contact bar 104, thence through conductors 794 and 796, movable contact 384, stationary contact 386, conductor 886, contact springs 378 and 380, conductor 890, motor M4, conductor 856, and terminal 744 to the source conductor 852.

The closure of contact 384 with contact 388 further establishes a lock-up path for said relay 382, supplemental to the path through which said relay was original energized, as follows:

From source conductor 822, to and through contact bar 104, thence through conductors 794 and 796, contacts 384 and 388, conductor 866, thence through conductor 874 and remainder of previously described path including relay 382, to the other source conductor 852.

Operation of the motor M4 resultant from its aforesaid energization, rotates the shafts 128 and 130, causing one of the raised portions of impulse cam 92, acting through the follower 186', to move contact arm 192 away from bar 192' and thus terminate energization of relay 382. Contact 384 of said relay thereupon leaves contacts 386 and 388, and thereby breaks the current path therethrough for the motor M4.

During the rotation of the cam 92 which culminated in the separation of the contacts 192, 192', the accompanying rotation of the carry-over wheel 94 reaches a stage which permits

closure of contacts 194, 194', and the concurrent operation of motor M1 (Fig. 3) causes one of the dials (as, for example, that of the assembly N) to withdraw its previously engaging key 258 and thereby permit reclosure of its associated contacts 538''' and 540'; thus establishing a path for prolonging operation of motor M4, following separation of contacts 192, 192', through a path as follows:

From source conductor 822 (Fig. 2), to and through contact bar 104, thence through conductor 794, terminal 718, conductor 792 (Fig. 3), conductor 894, contacts 432, 444 of relay 430, conductor 916, contacts 412, 424 of relay 410, conductors 922, 928, contact member 538, contacts 538''' and 540', contact member 540, conductor 862, terminal 748 (Fig. 2), conductor 868, contact arm 194, bar 194', conductor 888, contact springs 378 and 380, conductor 890, motor M4, conductor 856, terminal 744 to source conductor 852.

Such prolonged operation of motor M4 will continue until the next pin in carryover wheel 94 effects separation of contact arm 194 from bar 194', and thereby interrupts the energizing current path of said motor; and, during this prolonged operation, the motor M1 will supplement the effect of the operation of motor M4 so that five functional stages will be successively attained, each accompanied by a distinctive aspect group of signal presentation, as follows:

The first of said stages, involving signal presentations of aspect Group I, is attained when presentation of raised portions of the cams 70, 74, 78 and 82 will have effected separation of contact 170 from 106, 174 from 106, 178 from 106, and 182 from 104, respectively, and withdrawal of the raised portions of the cams 60, 62, 72, 76 and 80 have permitted closure of the contacts 160 with 108, 162 with 107, 172 with 104, 176 with 104, and 180 with 104, respectively. It is desirable that all the changes in contact positionings as just described, shall occur at or about the same time.

The separation of contacts just referred to effects interruption of the previously described current paths in which they are respectively included and thereby causes extinguishment of the main highway amber lamps A, A, the arrow lamps 588, 590, 592, 594, 596 and 598, the cross highway green lamps G, G, the main highway red lamps R, R and the cross highway amber lamps A, A.

Closure of contact arm 160 with contact bar 108, as just described, establishes a current path for effecting intermittent display of the main highway green lamps G', as follows:

From source conductor 822 to and through bar 104 (Fig. 2), thence through conductor 878, bar 106, conductor 880, intermittently closed contacts 406 and 402, conductor 762, terminal 704, conductor 758, bar 108, arm 160, conductor 774, terminal 716, conductor 786 (Fig. 14), green lamp G', conductor 854, terminal 744 (Fig. 2), to source conductor 852.

Closure of contact arm 162 with contact bar 107, as just described, establishes a current path for effecting intermittent display of the main highway green lamp G, as follows:

From source conductor 822 to and through bar 104 (Fig. 2), thence through conductor 878, bar 106, conductors 880 and 882, intermittently closed contacts 404 and 400, conductor 756, terminal 702, conductor 752, insulated contact 107, arm 162, conductor 772, terminal 714, conductor 784 (Fig. 14), main highway green lamp G, con-

ductor 854 (Fig. 2), terminal 744, to the source conductor 852.

Closure of contact arm 172 with contact bar 104 establishes a current path for lighting the pedestrian arrow lamps 570, 572, 578 and 580 (Fig. 14), as follows:

From source conductor 822 (Fig. 2), to and through bar 104, thence through arm 172, conductor 804, terminal 726, conductor 814 (Fig. 14), arrow lamps 570, 572, 578 and 580 in parallel, thence through conductor 854 (Fig. 2), terminal 744, to the source conductor 852.

Closure of contact arm 176 with contact bar 104 establishes a current path for lighting the cross highway red lamps R, R, as follows:

From source conductor 822 (Fig. 2), to and through bar 104, thence through arm 176, conductor 802, terminal 724, conductor 812, cross highway lamps R, R, and thence through conductor 854 (Fig. 2), and terminal 744 to the source conductor 852.

The closure of contact arm 180 with contact bar 104, incidental to attainment of the first stage, does not complete the establishment of any current path, but is for a purpose which will be hereinafter more fully explained.

The signals of aspect Group I, the presentation of which has just been described, indicate, by the lighting of the cross highway red lamps R, R, that vehicles should not enter the intersection therefrom; by the lighting of pedestrian arrow lamps 570, 572, 578 and 580, that pedestrian movements are permitted paralleling the movement of main highway vehicular traffic, although the failure to light pedestrian arrow lamps 568, 574, 576 and 582 withholds permission for pedestrians to cross main highway; and the flashing of the main highway green lamps G', G, immediately following the lighting of the red and amber lamps (which occurred during aspect Group XII) indicates that vehicles may pass through the intersection on main highway without turns, and that the green or "go" period for main highway is at or near its inception, and, hence, that there is ample time for vehicles to pass.

Rotation of the slotted dial 200, of assembly N, during presentation of aspect Group I, will lead to attainment of the second functional stage during which aspect Group II will be presented when the next effective dial key 250 (Fig. 8) has been carried to a position where it depresses finger end 508' and thereby causes withdrawal of the shoulder 508'' from the path of the pin 550 (see Fig. 4), thus causing the closure of the contacts 530', 528', and the establishment of a current path for effecting energization of the relay 450, as follows:

From source conductor 822 (Fig. 2), through terminal 730, conductor 820 (Fig. 3), contacts 470 and 472 of relay 468, conductors 896, 792 and 894, contacts 432 and 444 of relay 430, conductor 916, contacts 412 and 424 of relay 410, conductor 922, contact member 528, contacts 528' and 530', contact member 530, conductor 924, contacts 426 and 414 of relay 410, conductor 918, contacts 446 and 434 of relay 430, conductor 938, winding of relay 450, conductors 902, 842, terminal 744 (Fig. 2), to source conductor 852.

The resultant energization of relay 450 (Fig. 3) causes closure of contacts 452, 454, thereby establishing a short-circuit around the intermittently closed contacts 402, 406 associated with the flasher motor M5 (Fig. 2), to the end that

the lighting of the main highway green lamp G' will thereafter be continuous. Such circuit leads as follows:

From source conductor 822 (Fig. 2), to and through bar 104 as previously described, thence through arm 180, conductor 800, terminal 722, conductor 818, contacts 452, 454 of relay 450 (Fig. 3), conductor 790, terminal 716 (Fig. 2), conductor 786 (Fig. 14), the main highway green lamp G', return conductor 854, terminal 744 (Fig. 2), to source conductor 852.

From the foregoing it will be evident that the signals now being presented differ from those of aspect Group I only in the change of the lighting of the main highway lamp G' from a flashing display to a continuous display; and, with this change, constitute aspect Group II which is effective during the second of the aforesaid functional stages. Such continuity of the lighting of the main highway green lamp G' indicates that vehicles approaching the intersection along that portion of main highway may pass through the intersection without turns, and that the green or "go" period for that direction of main highway travel is to continue long enough to afford ample time for vehicles to pass.

Rotation of the slotted dial 200, of assembly N, during presentation of aspect Group II, will lead to attainment of the third functional stage, during which aspect Group III will be presented. This will occur when the next effective dial key 252 (Fig. 9) has been carried to a position where it depresses finger end 510' and thereby causes withdrawal of the shoulder 510'' from the path of the pin 552 (see Fig. 4), thus causing the closure of the contacts 532', 528'' and the establishment of a current path for effecting energization of the relay 456, as follows:

From source conductor 822, to and through terminal 730 (Fig. 2), conductor 820, contacts 470, 472 of relay 468 (Fig. 3), conductors 896, 792 and 894, contacts 432, 444 of relay 430, conductor 916, contacts 412, 424 of relay 410, conductor 922, contact member 528, contacts 528' and 532', contact member 532, conductor 926, contacts 428, 416 of relay 410, conductor 920, contacts 448, 436 of relay 430, conductor 940, winding of relay 456, conductors 902, 842, terminal 744 (Fig. 2) to source conductor 852.

The resultant energization of relay 456 (Fig. 3) causes closure of contacts 458, 460 thereby establishing a short-circuit around the intermittently closed contacts 400, 404 associated with the flasher motor M5 (Fig. 2), to the end that the lighting of the main highway green lamp G will thereafter be continuous. Such circuit leads as follows:

From source conductor 822 (Fig. 2) to and through bar 104 as previously described, thence through arm 180, conductor 800, terminal 722, conductor 818, contacts 458, 460 of relay 456 (Fig. 3), conductor 788, terminal 714 (Fig. 2), conductor 784 (Fig. 14), the main highway green lamp G, return conductor 854, terminal 744 (Fig. 2), to source conductor 852.

From the foregoing it will be evident that the signals now being presented differ from those of aspect Group II only in the change of the lighting of the main highway lamp G from a flashing display to a continuous display; and, with this change, constitute aspect Group III which is effective during the third of the aforesaid functional stages. Such continuity of the lighting of the main highway green lamp G indicates that vehicles approaching the intersection along that

portion of main highway may pass through the intersection without turns, and that the green or "Go" period for that direction of main highway travel is to continue long enough to afford ample time for vehicles to pass.

Rotation of the slotted dial 200, of assembly N, during presentation of aspect Group III, will lead to attainment of the fourth functioning stage, during which aspect Group IV will be presented. This will occur when the next effective dial key 256 (Fig. 11) has been carried to a position where it lifts the finger end 500', permitting re-engagement of the shoulder 508'' with the pin 550 (see Fig. 4), with consequent separation of the contacts 530', 528', causing deenergization of relay 450 with the resultant interruption of the short-circuit around the flasher contacts 402, 406 for main highway lamp G'.

From the foregoing it will be evident that the signals now being presented differ from those of aspect Group II only in the change of the lighting of the main highway lamp G' from a continuous display to a flashing display; and, with this change, constitute aspect Group IV which is effective during the fourth of the aforesaid functional stages. Such flashing of the main highway lamp G', immediately following its continuous lighting, indicates that the green or "Go" period for that direction of main highway travel is approaching its end, so that vehicles which are to then cross the intersection from that portion of main highway should attain or maintain an adequate speed.

Rotation of the slotted dial 200, of assembly N, during presentation of aspect Group IV, will lead to attainment of the fifth functional stage, during which aspect Group V will be presented. This will occur when the next effective dial key 254 (Fig. 10), has been carried to a position where it lifts the finger end 5042', permitting re-engagement of the shoulder 510'' with the pin 552 (see Fig. 4), with consequent separation of contacts 532', 528'' causing deenergization of relay 456 with the resultant interruption of the short-circuit around the flasher contacts 400, 404 for main highway lamp G.

From the foregoing it will be evident that the signals now being presented differ from those of aspect Group IV only in the change of the lighting of the main highway lamp G from a continuous display to a flashing display; and, with this change, constitute aspect Group V which is effective during the fifth of the aforesaid functional stages. Such flashing of the main highway lamp G, immediately following its continuous lighting, indicates that the green or "Go" period for that direction of main highway travel is approaching its end, so that vehicles which are to then cross the intersection from that portion of main highway should attain or maintain an adequate speed.

It is desirable that the rotational speed of the motor M4 (Fig. 2) be such that, within a comparatively brief time, it will move the shafts 128 and 130 from one to another of the stopping positions determined, in the manner hereinafter explained, by the pins 280 in wheel 94. On the other hand, the shading coil 290' (Fig. 3) should be so adjusted that the motor M1 will move the dial assemblies FN, FS and N at a speed suited for effecting desired signaling aspect durations by available settings of keys such as 240, 250, 252, 254, 256, 258.

It will be noted that the representation of the wheel 94 in Fig. 2 indicates that, after the fol-

lower 186' has been disengaged by one of the pins 280 there shown in engagement therewith, the four pin holes which will be next moved toward said follower are vacant, so that said follower will not be moved by any of said pins until the wheel 94 has moved through five spaces, representing 1/5ths or 150° of a complete cycle of signaling aspects.

Rotation of the wheel 94, to the position where the follower 186' is engaged by the pin in the hole immediately following the four vacant holes, will move contact 194' away from bar 194' and thereby discontinue the current supply for the motor M4 through the path hereinbefore traced. At the same time, the raised portion of the cam 90 will be brought to a position where it will effect separation of the contact arm 190 from the bar 190'. Such contact separation will so condition the hereinbefore described current paths as to prevent reenergization of the motor M4 resultant from the lifting of the end 506' by any key such as key 258 of Fig. 12.

Rotation of the slotted dial 200, of assembly N, during presentation of the aspect Group V, will lead to the signal presentation of aspect Group VI. In attaining this result, the next effective dial key 240 (Fig. 7) will first be carried to a position where it slightly lifts the secondary end 506'' and thus separates the contacts 538''', 540'. Said key will next lift the end 504' and thereby close contacts 534', 538', to thus formulate what will be hereinafter referred to as a "supervising impulse" in an energizing current path for the relay 382, as follows:

From source conductor 822 (Fig. 2), through terminal 730, conductor 820, contacts 470, 472 of relay 468 (Fig. 3), conductors 896, 792 and 894, contacts 432, 444 of relay 430, conductor 916, contacts 412, 424 of relay 410, conductors 922 and 928, contact member 538, contacts 538', 534', contact member 534, conductor 860, terminal 746 (Fig. 2), conductors 866 and 874, bar 192', arm 192, conductor 892, winding of relay 382, conductors 858 and 856, terminal 744, to source conductor 852.

The resultant energization of relay 382 causes closure of contacts 384, 386 and 388, thereby establishing the current paths for initially energizing motor M4, and for maintaining energization of relay 382, as previously described. Rotation of motor M4 now continues in the manner hereinbefore explained, until the next pin assembled in wheel 94 effects the separation of contact arm 194 from bar 194'.

During the prolonged running of motor M4 (Fig. 2) just described, resultant rotation of the cams assembled on shaft 130, was insufficient to bring about any change in the contact arm-and-bar relationships as controlled by said cams. However, following the restarting of motor M4, just referred to, the shaft 130 and the cams thereon are rotated to effect changes in the circuits controlled thereby, as follows:

Cam 72 withdraws its cut-away portion from its associated follower 186, separating contact arm 172 from contact bar 186, with resultant interruption of the path for lighting the pedestrian arrow lamps 570, 572, 578 and 580.

Cam 66 withdraws its raised portion from the associated follower 186, thereby permitting engagement between contact arm 166 and bar 106, with resultant establishment of a path for lighting the main highway left turn arrow signal lamps 584 and 586, as follows:

From source conductor 822 (Fig. 2), to and

through bar 104 as previously described, thence through conductor 878, bar 106, arm 166, conductor 770, terminal 712, conductor 782, main highway left turn arrow lamps 584, 586 (Fig. 14), conductor 854, terminal 744 (Fig. 2) to source conductor 852.

From the foregoing it will be evident that the signals now being presented differ from those of aspect Group V in the extinguishment of the pedestrian arrow lamps 570, 572, 578 and 580, and in the lighting of the main highway left turn arrow lamps 584 and 586; and, with these changes, constitute aspect Group VI. Such display of the main highway left turn arrow lamps 584 and 586 indicates that vehicles approaching the intersection along main highway may make left turns into cross highway; while the extinguishment of all of the pedestrian lamps indicates that pedestrians should defer crossing either highway.

Rotation of the wheel 94, following establishment of aspect Group VI, as just described, will bring another of the pins 280 into engagement with the follower 186' and thereby effect separation of contact arm 194 from bar 194', so as to interrupt the operation of motor M4, as previously described. Thereafter, rotation of the slotted dial 200, of assembly N, will lead to the presentation of aspect Group VII. This will occur when the next effective dial key 258 (Fig. 12) has been carried to a position where it lifts the finger end 506', thus withdrawing contact 538''' from contact 540', and bringing contact 538'' into engagement with contact 536', as hereinbefore more fully explained, causing energization of relay 382 with resultant establishment of a lock-up path for said relay and a restarting path for the motor M4, as hereinbefore more fully explained in connection with aspect Group XII.

Following the restarting of the motor M4, just referred to, the cam 70 is rotated by the shaft 130 so as to withdraw its raised portion from its associated follower 186, thereby permitting closure of arm 170 with bar 106, to thereby establish a current path for lighting the main highway amber lamps A, A,—from source conductor 822 through the path already described in connection with aspect Group XII.

From the foregoing, it will be seen that this signal presentation differs from that of aspect Group VI in the lighting of the main highway amber lamps A, A, to provide a warning that a change is imminent which will be restrictive of previously permissible movements.

The signal presentation, with this change, constitutes aspect Group VII; during which, in the manners already more fully explained, the motor M4 will be stopped by one of the pins 280 and restarted through the action of a key 258 in dial 200, and the cam 66 will be caused to present its raised portion to its associated follower 186 and thereby effect separation of contact arm 166 from bar 106, to extinguish the main highway left turn arrow lamps 584 and 586.

The signal presentation, with this change, constitutes aspect Group VIII; during which stoppage and restarting of motor M4 will occur in accordance with preceding detailed explanations, and the rotation of the cams 60, 62, 70, 76, 80 will result in lifting their associated followers 186, thereby causing extinguishment of the main highway green lamps G, G' and amber lamps A, A, as well as the cross highway red lamps R, R. Furthermore, the lifting by cam 80 of its associated follower 186 assures continued interruption of the supply current path for the

main highway green lamps G, G', irrespective of accidental or unintended energization of either or both of the relays 488, 486, such as might, for example, occur incidental to revisions of adjustments or settings, or to placing a key in a position in one of the dials 200 to which a key of that type was unsuited; the purpose being to render it impossible to effect lighting of the main highway lamps G, G' at a time when the cross highway green lamps are lighted.

At or about the time that the followers 186 associated with the cams 60, 62, 70, 76 and 80 were lifted, as just referred to, the raised portions of cams 68 and 78 were withdrawn from their associated followers, whereupon the contact arms 168 and 178 moved into closed circuit relationship with their associated bars 104 and 106, respectively.

Such closure of contacts 168, 104 caused lighting of the pedestrian arrow lamps 568, 574, 576, 582, through establishment of a current path from source conductor 822, to and through bar 104 as previously described, thence through arm 168, conductor 806, terminal 728, conductor 816 (Fig. 14), lamps 568, 574, 576, 582, conductor 854, terminal 744 to source conductor 852.

Such closure of contacts 178, 106 caused lighting of the cross highway green lamps G, G and the main highway red lamps R, R through establishment of a current path from source conductor 822 to and through bar 104 as previously described, thence through conductor 878, bar 106, arm 178, conductor 764, terminal 706, conductor 776 (Fig. 14), cross highway lamps G, G and main highway lamps R, R, conductor 854, terminal 744 to source conductor 852.

The signal presentation as thus changed constitutes aspect Group IX, indicating that vehicles should not enter the intersection from main highway, but that vehicles and pedestrians may cross main highway, although no vehicle turns are permitted.

During presentation of aspect Group IX, the motor M4 will be stopped by one of the pins 280 and restarted through the action of a key 258 in the dial 200 as previously explained; and the follower associated with the cam 68 will be lifted, with resultant extinguishment of the pedestrian arrow lamps 568, 574, 576, 582; while the cam 74 will permit its associated follower to move to the position which will cause lighting of the right turn arrow lamps 588, 590, 596, 598 and the left turn arrow lamps 592, 594, through current paths previously described in connection with aspect Group XII. It is thus indicated that pedestrians should defer crossing either highway and that right and left turns are permitted from cross highway, while right turns only are permitted from main highway.

The signal presentation just described constitutes aspect Group X, during which will occur the stopping and restarting of the motor M4 in the manner already explained. After such restarting, the follower 186 associated with the cam 82 will be permitted to move to the position effecting establishment of the path previously described in connection with aspect Group XII for lighting the cross highway amber lamps A, A, thus to provide warning that a change of signal presentation is imminent which will be restrictive of previously permissible movements.

During the signal presentation just described, which constitutes aspect Group XI, will occur stopping and restarting of the motor M4 as already described, and thereafter the follower 75

186 associated with the cam 70 will be permitted to move to a position which will cause lighting of the main highway amber lamps A, A, thus restoring the various parts and circuit conditions to those already described in first referring to aspect Group XII.

A cycle of signal presentations is thus completed, repetitions of which will be effected incidental to each succeeding revolution of the dials 200 and of the shafts 128, 130.

The foregoing detailed description of operation may be summarized as follows:

The cams 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80 and 82 on the shaft 130 (Fig. 2) may be variously relatively positioned so that displays of differing signal aspects will be effected as desired. These cams are moved by the motor M4 from one to another of the positions significant of the differing signal aspects. Pins in the carryover wheel 94 cause interruption of the current supply to said motor during respective ones of such positionings. Keys (such as key 258, Fig. 12) serve to restart said motor following such interruption of its current supply, with the exception that, once in each cycle, at or about the time that one of said pins acts to cut off the current supply of said motor, the follower 186' associated with the cam 90 is lifted by the raised portion of said cam, following which said motor is restarted only responsive to the engagement of finger end 504' by a special key 240 (Fig. 7) thereby closing contacts 534', 538' and thus formulating a "super-vising impulse" as hereinbefore more fully explained. Keys, such as 254 and 256 of Figs. 10 and 11, serve to initiate special signal displays (e. g. flashing green) while keys, such as 250, 252 of Figs. 8 and 9, serve for terminating such displays.

Having described the operation of a controller such as that of Figs. 1, 2 and 3, in connection with signals such as those of Fig. 14, without special reference to the governing of such a controller by a master timer such as the timer T of Fig. 16; the details of such governing action will now be taken up.

Referring to Fig. 16, it will be observed that the contour of the cam 606 is such as to maintain the contacts 610, 612 in closed relationship throughout approximately $\frac{3}{4}$ of each revolution of the shaft 604, upon which said cam is fixed; and that the contour of the cam 608 is such as to permit closure of the contacts 614, 616 during approximately 6% of its rotation, incidental to the latter portion of the closure of the contacts 610, 612.

During the closure of the contacts 610, 612, just referred to, a current path is effective from source conductor 1000, through terminal 984, bus conductor 1030, conductor 844 (Fig. 2), terminal 738, through the current path hereinbefore described for energizing relay 468, to terminal 740, thence through conductor 846, bus conductor 1032, terminal 986, conductor 1014, contacts 610, 612, conductor 1012, to source conductor 1002.

Similarly, during closure of the contacts 614, 616, a current path is effective from source conductor 1000, through terminal 984, bus conductor 1030, conductor 844 (Fig. 2), to terminal 738, thence through the current path hereinbefore described for energizing relay 462, to the terminal 742, thence through conductor 848, bus conductor 1034, terminal 988, conductor 1016, contacts 616, 614, conductor 1012 to source conductor 1002.

The relative times of occurrence and durations of energizations and deenergizations of the relays

462 and 468, as well as the consequences thereof under various conditions, are graphically represented in the charts of Fig. 17.

Between horizontal dashed lines 650 and 652, in the upper portion of the chart of Fig. 17, are lines 660, 660' and 662 representative of the significant results of the operation of the master timer T in establishing times of occurrence and durations of resynchronizing and speed regulating periods; between horizontal dashed lines 652 and 654, the lines 664, 666, 668 and 670 are representative of the significant results of the operation of a local controller in synchronism with the master timer T, in terms of the conditioning thereof for response to the current path revisions incidental to the operation of said timer; between horizontal dashed lines 654 and 656 the lines 664', 666' and 670' correspondingly indicate results effective in a local controller operating at a speed slower than that which would maintain an intended relationship thereof with the master timer; and between horizontal dashed lines 656 and 658 the lines 664'', 666'', 668'' and 670'' correspondingly indicate results effective in a local controller operating at a speed faster than that which would maintain an intended relationship thereof with the master timer.

The space between the dashed vertical lines 620 and 620' is representative of the time of one revolution of the shaft 604 together with the cams 606 and 608 moving therewith, and hence of the intended time for a cycle of signal presentations. The vertical dashed lines 622, 624, 626, 628, 630, 632 and 634 are spaced from the line 620 at distances respectively representative of approximately 4%, 25%, 50%, 75%, 90%, 92% and 98% of the duration of a signal presentation cycle.

Returning now to a consideration of the significant results of the operation of the master timer T, and associating such results with the representations thereof in Fig. 17,—the line 660', extending from vertical line 620 to the vertical line 624, is representative of the time of occurrence within the cycle, and the duration, of the separation of the contacts 610, 612 due to withdrawal of the raised portion of the cam 606, together with the consequent deenergization of the relay 468 (Fig. 3) the contact 470 of which therefore moves into engagement with its contacts 472 and 474. For want of a better term, the phrase "Special supply for motor M1" has been applied to this line on the drawings.

The portion of the cycle during which the contact 470 is out of engagement with the contacts 472, 474 is indicated by the line 660. The line 662, extending from vertical line 632 to vertical line 634, is representative of the time of occurrence within the cycle, and the duration, of the closure of the contacts 464, 466 of the relay 462, resultant from withdrawal of the raised portion of the cam 608 from the contact 614, which thereupon engages the contact 616.

The line 666, extending from vertical line 622 to vertical line 634, is representative of the portion of the time occupied by one cycle of the operation of the master timer T, during which portion a local controller operating in synchronism with said timer will have its contact 480 held in connection with its contact 482 by the raised portion of its cam 306; the line 664, extending from vertical line 620 to vertical line 622, is representative of the portion of such cycle during which the contact 480 is permitted (by withdrawal of the raised portion of the cam 306) to engage the contact 484.

The line 668, which also extends from vertical line 620 to the vertical line 622, is representative of the portion of said cycle during which the full raised portion 308'' of the cam 308 causes the contact 490 to engage the contact 492; and the line 670 is representative of the portion of said cycle during which said contact 490 is permitted to engage the contact 494, through presentation of the depressed portion 308''' of said cam 308 thereto. In the portion of such cycle represented by the space between the vertical lines 630 and 620', the contact 490 is supported by the semi-raised surface 308' in such a position that it does not engage either contact 492 or 494, and for this reason neither line 668 nor line 670 extends through this space.

Lines 664', 666', 668' and 670' are representative of lines 664, 666, 668 and 670, respectively, for a local controller which is operating at a speed insufficient to maintain it in synchronism with the master timer; and the lines 664'', 666'', 668'' and 670'' are correspondingly representative for a local controller which is operating at a speed exceeding that which would maintain it in synchronism with the master timer.

Results of relay and contact positionings just described, in view of the current paths established therebetween as hereinbefore more fully explained, may be summarized as follows:

A local controller operating in synchronism with the master timer will maintain continuous operation of its motor M1, and its motors M2 and M3 will not be energized. The continuous operation of the motor M1 will be effected for the reason that (as represented by the synchronous inception of the lines 660' and 664 in Fig. 17) upon each occurrence of the resynchronizing period, the current path through the contact 484 will be completed because the relay 468 is de-energized whenever the cut-away portion 306' of the cam 306 is presented to its contact 480, and said contact 480 has thereupon moved into engagement with said contact 484 and away from the contact 482. Furthermore, the non-energization of the motors M2 and M3 will result from the positioning of the contact 490 (by the semi-raised portion 308' of the cam 308) out of engagement with the contacts 492 and 494, throughout the time when relay 462 is energized by closure of the master timer contacts 614, 616, resultant from presentation of the cut-away portion 608' of its associated cam 608. Such cyclic relationship is indicated by the absence of lines 668 and 670 in the portion of the cycle occupied by the line 662, and by recurrence of the lines 664 and 668 in relationship to vertical line 620' identical with that of such lines to the vertical line 620.

A local controller operating at a speed somewhat less (say not more than 20% slower) than that necessary for keeping it in synchronism with the master timer T, will maintain continuous operation of its motor M1 and its motor M2 will not be energized. However, its motor M3 will be energized during a portion of the cycle for the purpose of revising the adjustment of the shaft 310, and parts controlled thereby, in order that the speed of the motor M1 may be accelerated. The continuous operation of the motor M1 will be effected for the reason that whenever the cut-away portion 306' of its associated cam 306 is presented to its contact 480, and said contact 480 has thereupon moved into engagement with the contact 484 and away from the contact 482, the current path through the contact 484 will be

completed because the relay 468 is at such time deenergized due to the contacts 610, 612 of the master timer being separated by withdrawal of the raised portion of the cam 608. This is represented by the line 664' which, starting at vertical line 620 simultaneously with line 660', falls entirely within the portion of the cycle occupied by the latter line; and, in the recurrence of the line 664' to the right of the vertical line 620', although not having its inception simultaneously with that of the corresponding line 660', nevertheless falls entirely within that portion of the cycle which is represented by said line 660'. The non-energization of the motor M2 results from positioning of the contact 490 away from the contact 492, throughout the energization of the relay 462 caused by closure of master timer contacts 614, 616, because the full raised portion 308'' of the cam 308 does not at that time engage said contact 490. Inasmuch, however, as the time required from the start of the cycle for the cam 308 to carry its semi-raised portion 308' into engagement with the contact 490 exceeds that intended therefor (as represented by line 670') to the extent which said line 670' projects to the right of the vertical line 630, the contact 490 is permitted to remain in connection with the contact 494 during a portion of the closure of the contacts 464, 466 of relay 462, throughout which portion the motor M3 will act through the shaft 320, the gears 316, 314 to so rotate the shaft 310 as to cause acceleration of the motor M1. Such accelerating action will be thereafter repeated, at the corresponding point in each succeeding cycle, until the speed of the motor M1 has been so increased as to cause the cycle of the local controller mechanism operated thereby to catch up with its intended relationship with the cycle of the master timer. It is evident that, in bringing about this result, the speed of the motor M1 will have been so increased that, once the cycle of the local controller has overtaken its intended relationship to the master timer, the speed of the motor M1 will exceed that which would maintain such relationship. Action will therefore ensue, in a manner which will hereinafter be more fully explained, for suitably decreasing the speed of said motor M1.

The current path for energizing the motor M3, as just referred to, is as follows:

From source conductor 822, through terminal 730, conductor 820, contacts 464, 466 of relay 462, conductor 942, contacts 490, 494, conductor 948, motor M3, conductors 906, 904 and 842, through terminal 744 to source conductor 852.

A local controller, operating at a speed greater than that necessary for keeping it in synchronism with the master timer T, will have the operation of its motor M1 suspended during a portion of each cycle, and its motor M3 will not be energized. However, its motor M2 will be energized during a portion of the cycle for the purpose of revising the adjustment of the shaft 310 and the parts controlled thereby, in order that the speed of the motor M1 may be retarded. The suspension of the operation of the motor M1 will occur, when the cut-away portion 306' of its associated cam 306 is presented to its contact 480, and such contact has thereupon moved into engagement with the contact 484 and away from the contact 482; because the current path through the contact 484 will then be interrupted at the relay 468, energization of which will be sustained due to the contacts 610, 612 of the

master timer T remaining closed pending withdrawal of the raised portion of the cam 606.

Upon deenergization of the relay 468, energization of the motor M1 will be resumed, so that it will drive the mechanism operable thereby until a corresponding stage is attained in the next succeeding cycle. This is represented in Fig. 17 by line 664'', which is shown as starting at a point in the cycle corresponding with the termination of the line 666'' and extending to the vertical line 622'. The portion of the line 664'' between its inception and the vertical line 620 represents that portion of the cycle of the master timer during which the motor M1 is deenergized, and that portion of said line 664'' which extends between lines 620' and 622' represents that portion of said cycle during which the motor M1 is energized through the retracted positioning of the relay contact 470, as represented by line 660'. The non-energization of the motor M3 results from positioning of the contact 490 away from contact 494 throughout the energization of the relay 462, as represented by the line 662.

The energization of the motor M2 results from the closure of the contacts 490, 492 during a portion of the energization of the relay 462, as indicated in Fig. 17 by the distance which the line 668'' extends to the left of the vertical line 634. Throughout such energization, said motor M2 will so rotate the shaft 310 as to cause retardation of the motor M1. Such retardation will thereafter be repeated in the corresponding stage of each succeeding cycle until the speed of the motor M1 has been so decreased that such stage of the cycle of the local controller mechanism operated thereby assumes its intended relationship to the cycle of the master timer. It is evident that, in bringing about this result, the speed of the motor M1 will have been so decreased that, once the cycle of the local controller has thus attained intended relationship with the master timer, the speed of said motor M1 will be insufficient to maintain such relationship. Action will therefore ensue in a manner already fully described for suitably increasing the speed of motor M1.

The current path for energizing the motor M2 as just referred to is as follows:

From source conductor 822, through terminal 730, conductor 820, contacts 464, 466 of relay 462, conductor 942, contacts 490, 492, conductor 946, motor M2, conductors 906, 904 and 842, through terminal 744 to source conductor 852.

Under ordinary operating conditions, the regulating actions which have just been described are not of extensive amplitude. If, however, a local controller has, by any means, gotten greatly out of step with the master timer, so that extensive rotation of the shaft 310 occurs before an approximation of synchronism is attained, a so-called "hunting" action of the speed controlling mechanism of progressively decreasing amplitude will continue until an adjustment of the shaft 310 has been attained which will cause operation of the motor M1 at a speed such that the cycle of the local controller will substantially coincide with that of the master timer.

As hereinbefore referred to, traffic conditions along arterial highways have been found to vary in density characteristics at different times of the day. For example, during the greater part of a day it may be desirable to give traffic movements in one direction or the other along a main highway equal opportunity. Such an arrangement is diagrammatically indicated by Fig.

18. On the other hand, there are certain portions of the day during which the schedule of signal presentations should give predominance to traffic in one direction or the other, such, for example, as what are termed the "Residence-to-business" or morning rush hour, the "Business-to-residence" or afternoon rush hour, the "Residence-to-theatre" or early evening rush hour, and the "Theatre-to-residence" or late evening rush hour. Obviously, it is desirable to provide for most expeditious movement of traffic from suburban areas to a business center during the morning and early evening rush hours, as diagrammatically indicated by Fig. 19, and in the opposite direction during the afternoon and late evening rush hours, as indicated by Fig. 20.

In utilizing local traffic controllers, such as those of Figs. 1, 2 and 3, along an arterial highway for obtaining results such as those just indicated, it is of course obvious that all of such controllers should be associated with a single master timer, or otherwise so arranged that the periods of deenergization of their relays 468, as represented by line 660' of Fig. 17, will initiate simultaneously. Furthermore, the cams on the shaft 130 of each controller should be so adjusted as to bring about the desired sequence as well as the number of signal presentations at its associated intersection, and the number and positioning of the pins 280 in the wheel 94 (Fig. 2) should be such as to correspond with the number and relative stopping positionings of the cams of shaft 130 for effecting presentation of the signals involving the diverse aspect groups. In order that differing schedules of signal presentation shall be effected to correspond with the needs as to directional predominance of traffic density occurring during certain portions of the day, a corresponding one or another of the dials at each controller should be rendered effective throughout respective ones of such day portions, and the key positionings in each dial should be arranged so as to cause the beginning and the ending of each aspect group of signal presentations to occur in timed relationship suited for the characteristics of directional predominance expected to occur during the portions of the day when that dial is to be effective. Thus, for example, during the morning and early evening rush hours, the dials FN of all of the controllers could be rendered effective; during the afternoon and late evening rush hours, the dials FS of all of the controllers could be rendered effective, and during the remainder of the day the dials N of all of the controllers could be rendered effective.

To the end that each dial shall cause signal presentations such as will facilitate the type of "progressive" or "ripple" traffic movements in respective directions suitable for the directional predominance of the traffic anticipated for the portions of the day when such dial is to be effective, the positioning of the keys in each dial of each controller should bear suitable relationship to the positioning of like keys in corresponding dials of other controllers.

Desired relationships of the positionings of the keys in the dials of the controllers along main highway at the cross highways may be determined by the use of charts such as those of Figs. 18, 19 and 20.

The following preliminary explanations will facilitate discussion of these charts. The bands S1, S2, S3, S4 and S5 represent a series of cross highways. Portions X of each of the cross high-

way bands are shaded to represent red, thus indicating occasions when red "stop" signals are presented for main highway, accompanied by green "go" signals for cross highway. Short dash lines *g* and *g'* in the cross highway bands are representative of occasions during which a flashing green signal is presented respectively to "in" and "out" bound traffic on main highway. The spaces between the cross highway bands are representative of distance, and the spaces between the light horizontal lines extending across these charts are representative of time intervals (say ten seconds from line to line). The heavy vertical dashes 660' at the left of these charts are representative of periods of deenergization of the relays 468 of the local controllers, the lower end of each of said dashes being representative of the inception of the period represented thereby, and therefore corresponds to the ends of the lines 660' of Fig. 17 at vertical lines 620 and 620'. It will be seen that, because of the distances between cross highways and the arrangement and durations of aspect groups selected for presentation thereat, continuous movement of traffic along main highway is permitted upon occasions the time of occurrence and duration of which are indicated in Fig. 18 by the band B1 for "in" bound traffic and the band B2 for "out" bound traffic; such traffic movement opportunities being similarly indicated by the bands B1' and B2' of Fig. 19 and B1'' and B2'' of Fig. 20. In the interest of clearness, representations of incidental signal displays such as amber, right turn arrows, left turn arrows and pedestrian arrows have been omitted from the charts; however, it will be obvious that, those cams hereinbefore designated as the ones for effecting such displays may be so adjusted as to bring about the display of such signals in proper sequence; that proper keys may be positioned in the dials and that pins 280 may be positioned in the wheel 94 to cause the display of aspect groups involving such signal presentations in the manner most expeditious for corresponding traffic movements.

From the foregoing it will be observed that the time of occurrence and extent of opportunities for movement of main highway traffic, as well as the speed at which such movements can occur, are dependent upon proper selections as to sequence of presentation of signals as well as times of occurrence and durations of aspect groups of the signals at the various cross highways, giving due consideration to the distances between such highways and to the purpose of making provision for any anticipated directional predominance of traffic movements.

Referring now to Fig. 18, it will be observed that the bands B1 and B2 provide for a constant speed movement of traffic along main highway in either direction within a time period of nearly 30 seconds; such speed enabling a vehicle to move from the entry of the intersection of cross highway S1 to the entry of the intersection of cross highway S5, or vice versa, within about 160 seconds.

With the foregoing explanations in mind, it will be seen that, in order to obtain the results indicated by Fig. 18, the positioning of keys in the dials N of the controllers associated with cross highways S1 and S4 (the effectiveness of which dials are assumed to be indicated by this chart) should each be as follows:

Assuming, for convenience, that the zero positioning of indicia dial 202 of assembly N with relation to the reference pointer 230 on the front

plate 232 (Fig. 1) is representative of cycle inception, a key 256 should be placed in the 0% slot, a key 258 in the 8% slot, another such key in the 38% slot, a key 252 in the 40% slot, a key 250 in the 70% slot, and a key 254 in the 71% slot.

In addition to keys just referred to, a key 240 should be placed in some slot representative of a signal presentation which could be best prolonged, should prolongation be necessary for the purpose of bringing the cams of the signal circuit controlling mechanism CM (Fig. 1) into step with the timer dial mechanism DM, after they had been subjected to manual actuation. Under most circumstances, some point between signal presentations X, X seems preferable, as this would permit continued movement of main highway traffic throughout any such period. Thus, the key might well be placed in some slot between 40% and the end of the cycle.

Keys 258 in slots representative of the terminations of the first 8% and 38%, respectively, of the cycle, are for causing presentation of the red "stop" signal X for main highway (which is accompanied by the green "go" signal for cross highway) to start at about eight seconds from the cycle inception and to end about 38 seconds from the cycle inception.

Keys 252 and 254 positioned in the 40% and 71% slots are for respectively causing the termination and resumption of the flashing green signal *g* for "in" bound main highway traffic.

Key 250 positioned in the 70% slot is for causing the termination of the flashing green signal *g'* for "out" bound main highway traffic, while key 256, placed in the 0% slot (which may likewise be considered as the 100% slot) is for causing the resumption of such signals.

With keys positioned as thus far described, each revolution of the dials and cams effects one complete cycle of aspect group presentations, during which supervising, synchronizing and speed adjusting activities will occur when needed, as hereinbefore more fully explained.

From the foregoing it will be observed that, under these assumed conditions, the main highway red "stop" signal X (Fig. 18) will be displayed for about 30 seconds and the green or "go" signals of one form or another will be displayed for about 70 seconds. Furthermore, during display of the main highway "go" signals there will be two periods each having a duration of somewhat less than 30 seconds, wherein steady green "go" signals will be respectively presented to each direction of main highway traffic. These periods combine with like periods effected by the key positionings of the controllers at the cross highways S2, S3 and S5 to establish the time durations of the bands B1 and B2.

In the dials N of the controllers at cross highways S2 and S5 (Fig. 18) the keys 252 and 254 for terminating and resuming the flashing green signals *g* should be positioned in approximately the 72% and 0% (or 100%) slots, respectively, and the keys 250 and 256 for controlling the flashing green signals *g'* should be correspondingly positioned in the 40% and 73% slots. Otherwise the key positionings at these controllers should be substantially the same as those described for the controller of cross highway S1.

As indicated by the chart of Fig. 18, the positionings of the keys in the dial N of the controller at cross highway S3 should, in many respects, be unlike the positionings of the keys at the other cross highways, in that, at cross highway S3 the "stop" signal X and the "go" signals

g, g' should occur much later in each cycle, in order that they shall bear suitable timed relationship to the signal presentations at the other cross highways, and thus facilitate a continuous movement of traffic along main highway. Furthermore, inasmuch as the times of occurrence within the cycle as well as the durations of the various signals represented on the chart for cross highway S3 correspond to those which have been hereinbefore described in connection with the operation of a single controller embodying this invention, the various key positionings for the "go" and "stop" signals, as well as for effecting other previously described aspect group signal presentations, will be assumed to be as follows:

For the purpose of effecting the signal presentations comprising aspect Groups I, VII, VIII, IX, X, XI and XII, keys 258 should be placed in the 0%, 61%, 64%, 67%, 86%, 94% and 97% slots. For the purpose of effecting the signal presentations comprising aspect Groups II, III, IV and V, keys 250, 252, 256 and 254 should be placed in the 8%, 10%, 32% and 37% slots, respectively. For supervising in accordance with preceding explanations, and for effecting presentation of the signals comprising aspect Group VI, key 240 should be placed in the 42% slot.

With the foregoing arrangement, the signals of aspect Group II will be presented for a period of approximately two seconds (assuming operation of the controller on a basis of a 100 second cycle), those of Groups VII, VIII, IX and XII for 3 seconds, those of Groups IV and V for 5 seconds, those of Groups I and X for 8 seconds, those of Groups VI and IX for 19 seconds and those of Group III for 22 seconds.

As a result of key positionings in conformity with the chart of Fig. 18, "in" bound traffic, if moving in suitable time relation to the signaling aspects, may traverse the intersections along band B1 from cross highway S1 to cross highway S5 without encountering a red or "stop" signal. This is also true of "out" bound traffic moving within the limits of band B2. Furthermore, should such traffic movements be slower or faster than intended, they would encounter a flashing signal at one or more of the intersections and be warned that proper speed should be regained by acceleration or deceleration as already described.

Referring now to the chart of Fig. 19, it will be noted that certain of the green or "go" periods have been expanded with relation to the corresponding periods of Fig. 18, others of such periods have been contracted and still others have been "shifted" or moved to occupy a position either earlier or later in the cycle relative to the point of cycle inception. Such expansion, contraction and shifting of green "go" periods are arranged for the purpose of permitting an increase in the time duration of the "in" bound band and are accomplished, in a manner hereinafter more fully explained, by placing the dial FN of each controller in condition to exclusively control, by its keys, the signal aspect presentations associated therewith.

Thus, for example, dial N of the controller at cross highway S1 will cause a signal presentation as indicated in Fig. 18 while dial FN of the same controller will cause a signal presentation such as indicated in Fig. 19.

The key positionings for the controller at cross highway S1 (Fig. 19) should be substantially as follows:

Key 254 should be placed in the 0% slot, keys

258 in the 7% and 40% slots, key 252 in the 43% slot, key 250 in the 73% slot, key 256 in the 88% slot, and, as described in connection with the dial assembly N of the controller at cross highway S1 (Fig. 18), a key 240 should be placed in some slot representative of a signal presentation which may best be prolonged.

As indicated by the foregoing, the greatest difference in key positionings between the dial assemblies N and FN of the controller associated with cross highway S1 occurs as to the keys 254 and 256 which, in dial assembly FN, are so positioned as to greatly increase the width of the "in" bound band which is representative of time duration, and to correspondingly decrease such width of the "out" bound band, thus forming the bands B1', B2', respectively.

As the keys of the controllers situated at cross highways S2, S3, S4 and S5 are positioned in their respective dial assemblies for correspondingly providing for the bands B1' and B2', it will be obvious that heavy "in" bound traffic may move through the intersections from cross highway S1 to cross highway S5 at a constant predetermined speed and in much greater volume than would be permitted pursuant to the chart of Fig. 18 without encountering a red "stop" signal while, correspondingly, light "out" bound traffic will be restricted, for such "non-stop" movement, to a comparatively light volume, as represented by the narrow band B2'.

The positionings of the keys, in dials such as FS, for accomplishing the signal presentations indicated by the chart of Fig. 20, will be obvious, from the foregoing, to those skilled in the art, further detailed description thereof will therefore be omitted. It should be noted, however, that the width of the bands B1' and B2' permit "non-stop" movement of "out" bound and "in" bound traffic in approximately the same proportion as permitted for "in" and "out" bound traffic, respectively, in Fig. 19.

The various dials of an associated group of local controllers may be selectively rendered effective as follows:

Assuming that, as indicated in Fig. 3, the relays 410 and 430 are deenergized, the relay 450 will be rendered responsive to closures of contacts 530', 528' of assembly N, relay 456 will be rendered responsive to closures of contacts 532', 528'', and the current supply for motor M4 will be rendered dependent upon contacts 538''', 540', 536', 538'', 538' and 534 of said dial assembly. The current path rendered effective for energization of relay 450, upon closure of contacts 530', 528', extends from source conductor 822 (Fig. 2), through terminal 730 to bar 104, as previously described, thence through bar 104, conductor 794, terminal 718, conductor 792 (Fig. 3), conductor 894, contacts 432, 444 of relay 430, conductor 916, contacts 412, 424 of relay 410, conductor 922, contact member 528, contacts 528', 530' of dial assembly N, conductor 924, contacts 426, 414 of relay 410, conductor 918, contacts 446, 434 of relay 430, conductor 938, winding of relay 450, conductors 902 and 842, terminal 744 (Fig. 2) to other source conductor 852. The current path rendered effective for the energization of relay 456, upon closure of contacts 528'', 532', extends from source conductor 822, through same path as just described to and including contact member 528, thence through contacts 528'', 532', conductor 926, contacts 428, 416 of relay 410, conductor 920, contacts 448, 436 of relay 430, conductor 940, winding of relay 456,

to conductor 902, and thence through same path as that for relay 450 to other source conductor 852.

Inasmuch as the manner of control of the operating current path for the motor M4, by the contacts provided therefor in this dial assembly has been hereinbefore described in detail, such description will not be here repeated.

From the foregoing it will be evident that so long as the relays 410 and 430 remain deenergized, the relays 450 and 456, and the motor M4, will be exclusively responsive to the contacts associated with dial assembly N.

Should it be desired to terminate such responsiveness, and to substitute therefor responsiveness to dial FN, the switch 1020—1024 should be closed (Fig. 16), thereby establishing an energizing current path for relay 410, as follows:

From source conductor 1000 (Fig. 16) through terminal 984, bus conductor 1030, conductor 844 (Fig. 2), terminal 738, conductor 836 (Fig. 3), conductor 898, winding of relay 410, conductor 834 (Fig. 2), terminal 736, conductor 828 (Fig. 16), bus conductor 1040, terminal 994, conductor 1028, switch arm 1024 and switch point 1020 to the other source conductor 1002.

The resultant energization of relay 410 will cause its contacts 412, 414, 416 to move away from its back contacts 424, 426, 428 and into engagement with its front contacts 418, 420, 422, respectively; thereupon, relay 450 will be rendered responsive to closures of contacts 530', 528' of assembly FN, relay 456 will be rendered responsive to closures of contacts 532', 528'', and the current supply for the motor M4 will be rendered dependent upon contacts 538''', 540', 536', 538'', 538' and 534' of said dial assembly.

The current paths thus rendered effective for energization of relays 450 and 456 and for operating the motor M4 are the same as those rendered effective prior to energization of the relay 410, to and including contacts 412, 414 and 416 of said relay. From relay contact 412, a current path is provided through the associated contact 418 and conductor 908 to contact member 538 of dial assembly FN, and a branching path from conductor 908, through conductor 914 to contact member 528 of said assembly. From relay contact 414, a current path is provided through contact 420 and conductor 910 to contact member 530, and from relay contact 416 through contact 422 and conductor 912 to contact member 532 of said assembly. The remaining ones of the contacts associated with dial assembly FN are arranged for controlling the operating current path for the motor M4, as heretofore more fully described.

From the foregoing it will be seen that energization of the relay 410, during deenergization of relay 430, renders the relays 450 and 456, as well as the motor M4, exclusively responsive to the contacts associated with the dial assembly FN.

Should it be desired to render said relays and motor exclusively responsive to dial assembly FS, the switch 1018—1022 should be closed (Fig. 16).

Such closure of the switch 1018—1022 establishes an energizing current path for relay 430 from source conductor 1000 (Fig. 16) through terminal 984, bus conductor 1030, conductor 844 (Fig. 2), terminal 738, conductor 836 (Fig. 3), conductor 900, winding of relay 430, conductor 832 (Fig. 2), terminal 734, conductor 826 (Fig. 16), bus conductor 1038, terminal 992, conductor 1026, switch arm 1022 and switch point 1018 to the other source conductor 1002.

The resultant energization of relay 430 will cause its contacts 432, 434, 436 to move away from its back contacts 444, 446, 448 and into engagement with its front contacts 438, 440, 442.

Positioning of the contacts of relay 430, throughout energization thereof, will subject the relays 450 and 456, and the motor M4, to control by the contacts associated with the dial assembly FS, in a manner corresponding to that in which they were rendered responsive to similar contacts of dial assembly FN, through energization of relay 410, as previously described.

When it is desired to terminate responsiveness to dial assembly FS, the switch 1018—1022 should be moved to its open position. If it is desired that, at such time, responsiveness to the dial assembly N shall be rendered effective, the switch 1020—1024 should also be open.

Should any transfer of responsiveness be made from one dial to another, at a time when the positioning of the cams which had been established by the discontinued dial is not the same as that then intended for the dial rendered effective; the cams will thereafter be moved to one after another of their various stopping positions responsive to the action of the impulse keys 258 in the dial then effective, until the motor M4 has been brought to rest to await a supervising impulse, as previously explained. It may thus happen that the timing of signal presentations from the start of the effectiveness of a dial assembly to the occurrence of such supervising impulse may deviate from those intended; however, the cams will be operated in intended relationship to the newly effective dial assembly after the motor M4 therefore has so awaited a supervising impulse.

Although the dials of assemblies FS, FN and N rotate continuously, so that their respectively associated sets of contacts are moved by the keys secured therein, irrespective of which set of contacts may, at any time, be effective,—such actuation of contacts at a time when they should be ineffective will not bring about unintended results, for the reason that the relays 410 and 430 are each equipped with three sets of contacts, to the end that the current paths of contact members 528, 530 and 532 associated with any given dial assembly may be independently isolated; and, not only are contact members 538 of inactive dials correspondingly isolated but, through the presence of the finger ends 506'', the contacts 538''' are invariably moved away from their cooperating contacts 540' before the contact 538' of the associated dial is engaged by contact 534', thus avoiding any opportunities for feedback which might otherwise be presented.

If it is desired to automatically transfer responsiveness between dials of the associated local controllers, as just described, so that it will be unnecessary to manually operate the switches 1018—1022 and 1020—1024, suitable time switch mechanism may be employed.

A mechanism shown by Fig. 21 is particularly adapted for rendering selectively effective, at suitable occasions, signal presentations pursuant to the schedule contemplated by the various dials of the local controllers, and comprises parts which may be manufactured interchangeably with and which are subject to utilization substantially identical to parts of the dial assembly of Fig. 4.

The dial 200' has a suitable number of slots formed therein, so that the effectiveness of the various dials of local controllers may be initiated

and terminated at suitable times; ninety-six slots being a convenient number for such purpose. Approximately one-half of the periphery of this dial is representative of daylight hours and the remainder is representative of night hours, as marked thereon.

In the interests of clearness and convenience of illustration, a key 250' is shown in the slot representative of 7:30 a. m. for depressing the end 1508' so as to remove the shoulder 1508'' from the path of the pin 1550 and thereby permit closure of contacts 1530', 1528', to cause energization of relay 410, as if switch 1020—1024 had been manually closed, and key 256' is shown in the slot representative of 3:00 p. m. for lifting end 1500' to cause deenergization of said relay by lifting the contact member 1530 to a position where the pin 1550 will be reengaged by the shoulder 1508'' and thereby supported in an elevated position so that contact 1530' will be held out of engagement with contact 1528'. Under practical working conditions, it would probably be deemed desirable to place key 256' in a slot nearer to key 250' as, for example, in the slot representative of 10:00 a. m.; however, if so shown in these drawings, it would be difficult to clearly indicate the outline of this key.

The key 252' is shown in the slot representative of 4:30 p. m. and serves to depress the end 1510' to effect disengagement of the shoulder 1510'' from the pin 1552, in order that contact 1532' may move into engagement with the contact 1528'' to cause energization of relay 430, as if switch 1018—1022 had been manually closed; and key 254' is shown in the slot representative of 6:00 p. m., for engaging end 1502' to effect separation of contact 1532' from contact 1528'' and to carry pin 1522 to a position where it will be supported by shoulder 1510''.

The dial 200' is rotated once during each twenty-four hours, as by the time clock motor TC, acting through the gears 960, 962 and the shaft 204''.

From the foregoing it will be seen that, with the construction and arrangement of parts hereinbefore assumed, (the switches 1020—1024 and 1018—1022 standing open) the time switch of Fig. 21 will render effective the dial assemblies of local controllers associated therewith upon occasions as follows: assemblies FN for "in" bound traffic predominance (Fig. 19) between 7:30 a. m. and 3:00 p. m., assemblies FS for "out" bound traffic predominance (Fig. 20) between 4:30 p. m. and 6:00 p. m., and assemblies N for occasions lacking directional predominance (Fig. 18) at all other times.

It is obvious that other conditions of directional traffic predominance may be correspondingly provided for, by inserting other keys of respectively corresponding contours at other points in the dial.

If desired, the automatic time switch of Fig. 21 may be rendered ineffective by opening manual switch 1002'' shown therein; and while said switch stands open, the switches 1020—1024 and 1018—1022 may be manually operated.

If it is desired to lengthen or shorten the cycle time of the associated controllers, this may be done by varying the resistance 1010 (Fig. 16), whereupon the speed of the motor M6 will be correspondingly altered, with resultant revision of the positionings of the speed regulating shading coils 290' of the motors M1 of all local con-

trollers, in a manner hereinbefore more fully explained.

The normal schedules of signal presentation at any local controller may be suspended, if at any time desired, and manual actuation of the signal aspect controlling cams thereat may be accomplished, as, for example, during some exceptional or abnormal traffic condition. In such an event, a traffic officer or other responsible person may place the manual control handle 360 (Fig. 2) on the shaft 352, and thereby rotate, in the usual direction and at will, the cams assembled on shaft 130.

When the manual control handle 360 is thus applied to the shaft 352, the cam surface 366 formed on said handle will act through the insulating rod 368 to bring the contact springs 372, 374 and 376 into engagement with one another and, at the same time, to move the contact spring 380 away from contact spring 378. Such separation of contact spring 380 from spring 378 interrupts the current supply for motor M4, so that it will not be electrically driven while the handle 360 is being used for the manual actuation of the cams.

Because of the connection established between the contact springs 372, 374 and 376, provision is made for establishment of current paths for assuring avoidance of flashing of the main highway green lamps G, G', irrespective of possible reoccurring action of dial keys which would, under normal operation, cause flashing of these signal lamps. Thus, during engagement of the contact arms 160, 162 with their associated contacts 108, 107, the main highway green lamps G, G' will be continuously lighted, through a current path from source conductor 822 (Fig. 2), to and through bar 104, as previously described, thence through conductor 794 to spring 374, thence through two alternative paths, one of which includes contact spring 372, conductor 760, contact 108, arm 160, conductor 774, terminal 716, conductor 786 (Fig. 14), main highway green lamp G', and conductor 854; and the other of said alternative paths from contact 374, includes contact 376, conductor 754, conductor 752, contact 107, arm 162, conductor 772, terminal 714, conductor 784 (Fig. 14), and main highway green lamp G, thence joining the first named one of said alternative current paths and continuing through terminal 744 (Fig. 2) to source conductor 852.

During actuation of the cams assembled on shaft 130, the ratchet wheel 96 and its co-acting pawl 358 prevent inadvertent rotation in reverse direction, and the notched wheel 362, with its slugs 363 and cooperating locating spring 364, assists the user in stopping rotation of the cams in desired positions.

From the foregoing it will be evident that manually effected positionings of the cam shaft 130 will result in signal presentations corresponding to those resultant from like positionings effected by the motor M4, except that, during manual actuation, there will be no flashing green signal presentations, and, although the aspect groups will be presented in the same sequential order as during motor operation, the duration of each presentation will be in accordance with the wishes of the operator.

Throughout manual control, the motor M1 continues to drive its associated dials, subject to speed control and re-synchronizing from the master timer, and the relays 410 and 430 are subject to such actuation as would transfer responsiveness from one to another of said dials. When

the handle 360 is withdrawn from the shaft 352, the contact springs 372, 374 and 376 move out of engagement with one another, and the contact spring 380 moves into engagement with the contact spring 378.

The connection thus established between contact springs 378 and 380 makes possible restoration of current supply for motor M4, pursuant to routine operation of the controller mechanism; and the separation of contact springs 372, 374 and 376 makes possible the subjection of main highway green lamps G, G' to the flasher mechanism operable by motor M5.

From the foregoing it will be seen that when the handle 360 has been withdrawn from the shaft 352, if the contacts 194—194' associated with wheel 94 are closed, the motor M4 will immediately start, and the same will be true if the relay 382 is then energized. Thereafter, the operation of the parts will continue as hereinbefore more fully described; the operation of the motor M4 being interrupted for a suitable period, if necessary, in order to bring the positionings of the cams on shaft 130 in the intended relationship to the then effective dial.

The foregoing descriptions have been, for the most part, based upon the assumption that mechanism such as that of Fig. 1 is to be utilized in conjunction with a master timer such as the timer T of Fig. 16; however, controllers constructed in accordance with this invention may be placed in service without providing any connection therefrom with a master timer, as when installed at an isolated intersection or location so remotely situated with reference to other intersections or points needing traffic control as to in no way require master timer supervision. In any such case, switches corresponding to switches 1018—1022 and 1020—1024 of Fig. 16, or an automatic time switch such as that of Fig. 21, may be suitably associated with each such local controller.

Furthermore, controllers constructed in accordance with this invention, as hereinbefore more fully described, will maintain efficient operation even in the event of discontinuance of a previously effective resynchronizing or other connection with a master timer. Thus, should the conductors leading from the local controller of Figs. 1, 2 and 3 to its associated master timer T (Fig. 16) be in any wise ruptured, or should the current supply for such master timer be interrupted, such controller would continue to cause the display of its associated traffic signals in accordance with the positionings of the keys in its dial assembly N, and subject to the speed adjustment for motor M1 effective at the time of such interruption; and, upon resumption of such connections and/or of the current supply for the master timer, such local controller will be caused to respond to the one of its dials which should then be effective and will be brought into desired operative relationship with the master timer, as hereinbefore more fully explained.

In other words, if a local controller mechanism CM gets out of intended relationship with the master timer because of its being subjected to manual actuation, because of interruption of connecting conductors, because of failure of current supply from the master timer, or otherwise, it will not, after restoration of normal conditions, remain out of step with its own then effective dial mechanism DM more than the time required for one revolution of its cam shaft 130, nor remain appreciably out of step with the master

timer for much more than one revolution of its dials.

For example, assuming that all of the conductors 824, 826, 828, 844, 846 and 848 (Fig. 2) are disconnected from the master timer T of Fig. 16,—the electromagnet 116 (Fig. 2) will then immediately become deenergized, and the resultant retraction of its armature will effect separation of contact arm 164 from contact bar 104. Such contact separation does not, however, appreciably disturb the current flow from source conductor 822 (Fig. 2) to the contact bar 104, for the reason that, disconnecting the master timer conductors also assures deenergization of the relay 468 (Fig. 3) so that a path is provided for continuing the supply of energy to the various signal lamps through the respective contact arms, as previously described, from conductor 822 (Fig. 2) to terminal 730, thence through conductor 820 (Fig. 3), movable contact 470 associated with relay 468, stationary contact 472, conductors 896 and 792, terminal 718 (Fig. 2) and conductor 794 to contact bar 104.

Since all of the conductors leading to the master timer T are, in this instance, disconnected; the relay 468 (Fig. 3) will become and at all times will remain deenergized thereby maintaining a path for current to bar 104 (Fig. 2).

During operation of the controller of Fig. 1, as an independent unit, its speed of operation, and therefore the extent and duration of the display of signal aspects, is determined by the speed of operation of the motor M1 (Fig. 3) as governed by the positioning of the coil 290'. Desired positioning of the coil 290' may, as previously stated, be accomplished by manually adjusting the knob 312.

Although the foregoing description has been particularly directed to an arbitrarily selected application thereof, this invention is suited for many other applications, with and without modification of number, form and/or arrangement of parts, as will be readily understood by those skilled in this art. Thus, by merely re-arranging certain connections and providing minor modification of certain parts of the mechanism, systems comprising parts like those hereinbefore described in detail may be suited to distinctly differing operative requirements.

An example of such a re-arrangement is indicated in Fig. 22, whereby, at certain times of the day, signal presentations are made which permit both right and left-hand turns, while, at other times, left-hand turns are not permitted.

In the interests of clearness of presentation and simplicity, only such parts and connections are indicated in Fig. 22 as are needful to facilitate comprehension of the respects in which the application there shown differs from those hereinbefore described and referred to; and the ensuing description will be correspondingly restricted.

In Fig. 22, the shaft 130, together with the parts moving therewith and operable responsive thereto, are assumed to be identical with parts identified by like reference characters as shown in the other drawings and hereinbefore referred to in greater detail.

It is further assumed that the shaft 130 of this view is in operative relationship with other parts, including a driving motor M4, such as indicated by Fig. 2. Correspondingly, the dial N of Fig. 22 is assumed to be associated with one or more additional dials, as may be required, together with operating and controlling mechanism

therefor, and each equipped with suitably placed keys and cooperating contacts, together with facilities whereby the signal presentation controlling mechanism, as typified by the representation of shaft 130 and its associated parts, will be rendered responsive to the contacts associated with one or another of the dials in a manner such, for example, as that indicated in Fig. 3 and hereinbefore more fully described.

The relay 450 is provided with a back contact 454' in addition to its front contact 454, and the relay 456 is provided with a back contact 460' in addition to its front contact 460.

Signal lamps are provided at the intersection of the highways such as those indicated by Fig. 14, and are identified by corresponding reference characters and symbols; and, in addition thereto, there is a lantern L having translucent faces presented to approaching traffic from each direction along each of the highways and bearing the legend "No left turn", each of which legends is rendered visible only incidental to lighting of its associated lamp.

The interior of the lantern L is divided into four compartments, as by the partitions 1050; lamps LM, LM being provided in the compartments associated with the faces presented to main highway, the lamps LC, LC being correspondingly associated with the faces presented to cross highway.

Conductors are indicated in Fig. 22, differing from those hereinbefore described, as follows: conductor 778' connects terminal 708 with a terminal of each of the right turn lamps 588, 590, 596, 598. Conductor 818' connects terminal 718 to the movable contacts 452, 458 of relays 450 and 456, respectively. Conductor 854' connects conductor 854 to one terminal of each of the lamps LM, LM, LC, LC. Conductor 922' forms part of a current path from contact member 528, which path is extended from said conductor, as indicated by a dotted line representative of the various contacts of relays 410 and 430 shown in Fig. 3, and conductor 894' continues such path to terminal 718. Conductors 924' and 938' correspondingly connect contact member 530 with one terminal of the winding of relay 450. Conductor 926' forms part of a current path from contact member 532, which path is correspondingly extended therefrom through conductor 940' to one terminal of the winding of relay 456. Conductor 1052 connects terminal 704 with one terminal of each of the cross highway left turn lamps 592, 594. Conductor 1054 connects terminal 702 with one terminal of each of the main highway left turn lamps 584, 586. Conductor 1056 connects the terminal of the winding of relay 450 to which conductor 938' is also connected, to contact spring 376; and conductor 1058 connects the terminal of the winding of relay 456 to which conductor 940' is also connected, to the contact spring 372. Conductor 1060 connects the back contact 454' of relay 450 to the terminal 1066, and conductor 1062 connects the back contact 460' of relay 456 with terminal 1064. Conductor 1068 connects terminal 1064 with the remaining terminals of the lamps LM, LM, and conductor 1070 connects the terminal 1066 with the remaining terminals of the lamps LC, LC. Other conductors shown in Fig. 22 correspond with those identified by like reference characters in Figs. 2, 3 and 14.

The operation of a system such as that indicated by Fig. 22, insofar as same differs from that hereinbefore described, is as follows:

Assuming that the manual handle 300 is not in use and that the dial to which the system is at the time responsive has not caused energization of either relay 450 or relay 456, the rotation of the shaft 130 will cause presentation of signaling aspects in the order established by the setting of the cams upon said shaft and upon occasions as determined by the positionings of the keys in the then effective dial 200, all as hereinbefore more fully explained. However, the lamps in the lantern L will be lighted, and the left turn lamps 584, 586, 592, 594 will not be lighted at the point in the cycle at which provision for lighting thereof may have been established through the setting of the cams on shaft 130.

Such lighting of the lamps LM, LM is effected through a current path from source conductor 822, through terminal 730, conductor 808, contact arm 164, bar 104, conductor 794, terminal 718, conductor 818', movable contact 458 and back contact 460' of the relay 456, conductor 1062, terminal 1064, conductor 1068, lamps LM, LM in parallel, conductors 854' and 854, and terminal 744 to other source conductor 852.

Such lighting of the lamps LC, LC is effected through a current path from the source conductor 822, through the path just described to and through conductor 818', thence through movable contact 452 and back contact 454' of relay 450, through conductor 1060, terminal 1066, conductor 1070, and the lamps LC, LC in parallel, to conductor 854', and thence through the path just described to the other source conductor 852.

From the foregoing it will be apparent that, so long as the relays 450 and 456 remain deenergized, the signal presentations will be such as to provide for all of the traffic movements hereinbefore described in detail in connection with Figs. 1, 2, 3 and 14, except that left turn lamps will not be lighted and the green lamps will be continuously lighted throughout extinguishments of the red lamps respectively associated therewith. Furthermore, throughout each cycle, the drivers of vehicles approaching the intersection on both highways will be warned that they are not, at this time, permitted to make left turns, and most expeditious movement of traffic for occasions such as are usually termed "rush hours" is thus assured.

Although, at a given intersection, it may be desirable to prohibit all left turns during certain portions of the day, it is likely to be found that left turns are not unduly objectionable insofar as traffic entering the intersection from cross highway is concerned during certain other portions of the day; and, furthermore, that there are still other portions of the day throughout which left turns of all traffic entering the intersection may be properly permitted. In still other instances, it may be found that there are portions of the day during which left turns should be permitted from main highway although none are permitted from cross highway.

In order to condition the system so as to cause signal presentations permitting left turns from cross highway during the effectiveness of a given one of the dial assemblies, the contacts 528', 530' associated with such assembly should be closed. In order to cause signal presentations permitting main highway left turns the contacts 528'', 532' of such assembly should be closed, and in order to permit left turns from both cross and main highways the contacts 528', 530' and 528'', 532' of such assembly should be closed.

Although such contact closures may be manually effected, it is desirable to guard against inadvertently causing reopening of such contacts, by having in the dial a key of such contour as would cause closure of the desired contacts in the manner hereinbefore more fully explained. Such a key may be placed in any desired slot, although it may be preferable that it shall be so positioned as to be rendered effective in the cycle just prior to the stage at which the intended left turn signal presentation or presentations should occur.

During the effectiveness of a given dial assembly, closure of its contacts 528', 530' establishes an energizing current path for the relay 450 from the source conductor 822, through terminal 730, conductor 808, contact arm 164, bar 104, conductor 794, terminal 718, conductor 894', conductor 922', contact members 528, 530, conductor 924', conductor 938', winding of relay 450, conductor 902, conductor 842, terminal 744, to other source conductor 852. Correspondingly, closure of its contacts 528'', 532' establishes an energizing current path for the relay 456 from the source conductor 822, to contact member 528 as just described, thence through contact member 532, conductor 926', conductor 940', winding of relay 456, conductors 902, 842 and terminal 744 to the other source conductor 852.

During energization of relay 450, a current path for lighting cross highway left turn lamps 592, 594 is established throughout each closure of contact arm 160 with contact 108, through a path from the source conductor 822, through terminal 730, conductor 808, contact arm 164, bar 104, conductor 794, terminal 718, conductor 818', the contacts 452, 454 of relay 450, conductor 790, terminal 716, conductor 774, contact arm 160, contact 108, conductor 758, terminal 704, conductor 1052, cross highway left turn lamps 592, 594 in parallel, conductor 854, and terminal 744 to the other source conductor 852.

During energization of the relay 456, a current path for lighting main highway left turn lamps 584, 586 is established throughout each closure of contact arm 162 with contact 107, through a path from source conductor 822, to and through conductor 818' as just described, thence through the contacts 458, 460 of relay 456, conductor 788, terminal 714, conductor 772, contact arm 162, contact 107, conductor 752, terminal 702, conductor 1054, main highway left turn lamps 584, 586 in parallel, conductor 854 and terminal 744 to the other source conductor 852.

From the foregoing it will be apparent that whenever, during energization of relay 450, the raised portion of the cam 60 is withdrawn from the follower 186, incidental to rotation of the shaft 130, the contact arm 160 will move into engagement with the contact 108, and the cross highway left turn lamps 592, 594 will be lighted; the lamps LC, LC for cross highway translucent faces of lantern L being then extinguished.

Correspondingly, during energization of the relay 456, when the raised portion of the cam 62 is withdrawn from its follower 186, the main highway left turn lamps 584, 586 will be lighted and lamps LM, LM associated with the translucent faces of the lantern L facing main highway will be extinguished.

Inasmuch as it may well be assumed that, during control of signaling aspects through the use of the handle 360, it is unnecessary to light the lamps in the lantern L, but it is desirable that the operator shall be enabled to permit left turns at will, the contact springs 372, 376 are brought

into engagement with the contact spring 374 during use of the handle 360, thereby continuously establishing energizing current paths for the relays 450 and 456.

Upon discontinuance of use and removal of the handle 360, the energization of the relays 450 and 456 will be terminated, unless then maintained through their respectively associated contacts of the effective dial assembly. Correspondingly, when responsiveness of the controller is transferred from a dial assembly whose contacts had caused energization of either or both of these relays, to a dial assembly whose contacts are not positioned for continuing such energization, the previously energized relay or relays will become deenergized.

The accompanying drawings and the foregoing description assume the use of three dial assemblies at each local controller, but it will be evident that a greater or lesser number of such dial assemblies may be employed, the number of respectively associated relays, such as the relays 410 and 430, being correspondingly altered.

It will be evident from the foregoing that this invention might have been illustrated in the accompanying drawings as embodied in any one of many different kinds of mechanism. That which has been selected for use as illustrative of the invention has been chosen as a matter of convenience, and not because it exhausts the scope of the invention in its application to the various uses for which it is suited. Furthermore, it should be remembered that various features of this invention may be advantageously utilized singly or in groups containing less than all of said features.

The explanations hereinbefore given as to illustrative applications of this invention to certain of the many possible uses thereof, when considered in connection with the accompanying drawings, are believed to be fully sufficient to enable those skilled in this art to readily apply this invention to all situations to which it is suited.

Claim is made to, and it is desired to secure by Letters Patent of the United States of America, all generic and specific features of the invention shown by the accompanying drawings and as hereinbefore more fully described, including all features which may, as a matter of language, be said to fall between the scope of any of the following

We claim:

1. In a signal system having "stop" and "go" signals for facilitating progressive movements of traffic through a plurality of street intersections, the combination of a plurality of controllers, each having associated therewith signaling means for displaying diverse signal aspects toward the traffic travelling in diverse directions at the respective street intersections, switching means for causing such display in a definite order, at least one signal aspect at each intersection being intended to indicate to approaching traffic the necessity for a change in speed in order that the traffic may keep in step with the signals, mechanism for causing intermittent display of the "go" indication of the last mentioned signalling aspect, and synchronizing means for causing the signal aspect displays effected by each controller to occur in a predetermined relationship with respect to each other.

2. In traffic signal system having "stop" and "go" signals for facilitating progressive movements of traffic, the combination of a plurality of

controllers each having associated therewith traffic signals for displaying diverse signal aspects for controlling the movements of traffic through a series of street intersections, one of said aspects indicating "go" upon one street and "stop" upon an intersecting street, means for causing the display of the diverse signal aspects in a predetermined order, and synchronizing means for causing the signal aspect displays effected by each controller to occur in a predetermined relationship with respect to each other, one of said signal aspects being displayed to indicate "go" to a progressing "band" of traffic and to indicate that approaching traffic, for which progressing movement is to be provided, is in step with the signals, part of the first mentioned means causing a different signal aspect to be displayed to indicate to approaching traffic the necessity for a change in speed in order that the traffic may keep in step with the signals.

3. In a traffic control system comprising groups of "stop" and "go" signals at a plurality of traffic lane intersections along a highway, a master controller having a primary timing unit, a plurality of local controllers, one of which is located at each signalized intersection, each comprising a secondary timing unit having a cycle dial, a switch device associated therewith, adjustable means associated with said dial for actuating the associated switch device at variable intervals during a recurring cycle, a switching mechanism responsive to actuation of said switch device for step-by-step activity for effecting step-by-step conditionings of traffic signal circuits, a synchronizing means for maintaining a predetermined phase relation between the cycles of the master controller and each of the said secondary timing units whereby the "go" signal is displayed at each intersection to provide for traffic movement in one direction or another along the highway in continuously progressing "bands", means associated with the individual local controllers for intermittently displaying one of said signal indications in advance of the time for displaying said "go" signals to indicate to approaching vehicles that they are in advance of the movement of said progressing "band".

4. In a traffic control system comprising groups of "stop" and "go" signals at a plurality of traffic lane intersections along a highway, a master controller having a primary timing unit, a plurality of local controllers, one of which is located at each signalized intersection, each comprising a secondary timing unit having a cycle dial, a switch device associated therewith, adjustable means associated with said dial for actuating the associated switch device at variable intervals during a recurring cycle, a switching mechanism responsive to actuation of said switch device for step-by-step activity for effecting step-by-step conditionings of traffic signal circuits, a synchronizing means for maintaining a predetermined phase relation between the cycles of the master controller and each of the said secondary timing units whereby the "go" signal is displayed at each intersection to provide for traffic movement in one direction or another along the highway in continuously progressing "bands", means associated with the individual local controllers for intermittently displaying one of said signal indications after the display of the said "go" signals to indicate to approaching vehicles that they are behind the movement of said progressing "band".

5. In a traffic control system comprising groups

of "stop" and "go" signals at a plurality of traffic lane intersections along a highway, a master controller having a primary timing unit, a plurality of local controllers, one of which is located at each signalized intersection, each comprising a secondary timing unit having a cycle dial, a switch device associated with said dial, adjustable means also associated with said dial for actuating the associated switch device at variable intervals during a recurring cycle, a switching mechanism responsive to actuation of said switch device for step-by-step activity for effecting step-by-step conditionings of traffic signal circuits, a synchronizing means for maintaining a predetermined phase relation between the cycles of the master controller and each of the said secondary timing units whereby the "go" signal is displayed at each intersection to provide for traffic movement in one direction or another along the highway in continuously progressing "bands", means associated with the individual local controllers for intermittently displaying one of said signal indications in advance of the time for displaying said "go" signals to indicate to approaching vehicles that they are in advance of the movement of said progressing "band" and to intermittently display one of said signals after displaying the "go" signal to indicate to approaching vehicles that they are behind the movement of said progressing "band".

6. In a traffic controlling system, a plurality of traffic control signals comprising, in part, "stop" and "go" signals located at a succession of intersecting traffic lanes along a vehicle highway, a cycle timer located at the signalized intersections for controlling the operation of said signals, synchronizing means for maintaining a predetermined phase relation between the cycles of said timers whereby the "go" signals are operated at each intersection to provide progressing movement of "bands" of traffic along the highway, the said "go" signals being continuously displayed for an interval timed by the cycle timer to indicate the width of the "go" band, and means associated with each cycle timer for intermittently displaying a signal indication, in advance of said "go" signal, to indicate to approaching traffic that it is in advance of said "go" band.

7. In a traffic controlling system, a plurality of traffic control signals comprising, in part, "stop" and "go" signals located at a succession of intersecting traffic lanes along a vehicle highway, a master timer, a cycle timer located at the signalized intersections for controlling the operation of said signals, synchronizing means for maintaining a predetermined phase relation between the cycles of said timers whereby the "go" signals are operated at each intersection to provide progressing movement of "bands" of traffic along the highway, means for causing the initiation of the display of the various signals associated with each cycle timer in a predetermined phase relation with the master timer so the "go" signal will be displayed to vehicles moving along the highway to divide the traffic into progressing "go" bands, and means associated with each cycle timer for displaying a signal indication, after the display of said "go" signal, to indicate to approaching traffic that it is behind the movement of said "go" band.

8. In a traffic controlling system, a plurality of traffic control signals located at a succession of intersections along a highway and comprising, in part, individually operable "go" signals for controlling traffic moving in each direction along

the highway, a cycle timer located at the signalized intersections for controlling the operation of said signals, synchronizing means for maintaining a predetermined phase relation between the cycles of said timers whereby the "go" signals are operated at each intersection to provide progressing movements of "bands" of traffic along the highway in each direction, the said "go" signals being continuously displayed for an interval timed by the cycle timer to indicate the width of the "go" band, adjustable means in connection with said cycle timer for independently adjusting the time of initiation and duration of each "go" period controlling traffic moving in each direction along the highway, and means for causing intermittent display of each of said "go" signals in advance of the intervals when the "go" signals are continuously displayed to indicate to approaching vehicles that they are in advance of the movement of said "band".

9. In a traffic controlling system, a plurality of traffic control signals located at a succession of intersections along a highway and comprising, in part, individually operable "go" signals for controlling traffic moving in each direction along the highway, a cycle timer located at the signalized intersections for controlling the operation of said signals, synchronizing means for maintaining a predetermined phase relation between the cycles of said timers whereby the "go" signals are operated at each intersection to provide progressive movements of "bands" of traffic along the highway in each direction, the said "go" signals being continuously displayed for an interval timed by the cycle timer to indicate the width of the "go" band, adjustable means in connection with said cycle timer for independently adjusting the time of initiation and duration of each "go" period controlling traffic moving in each direction along the highway, and means for causing intermittent display of each of said "go" signals after the intervals when the "go" signals are continuously displayed to indicate to approaching vehicles that they are behind the movement of said "band".

10. In a traffic control system, including "stop" and "go" signals at a succession of street intersections, the combination of a master timer and a plurality of secondary timers, one of said secondary timers being located at each of the street intersections, synchronizing means for synchronizing the cycles of operation of the secondary timers with the master timer, a plurality of cycle dials driven by each secondary timer, a switch device associated with each dial, an adjustable means, also associated with each of said dials, by which each associated switch device may be actuated at variable intervals in a recurring cycle, a switch mechanism for controlling the signal display, a motor arranged to advance said switch mechanism to a different position upon actuation of a selected one of said switch devices, means for selecting from a central point the switch device to be made effective to advance said motor upon actuation, and means for keeping each switch mechanism in a definite operating relation with the actuations of its selected switch device.

11. In a traffic control system, including "stop" and "go" signals at a succession of street intersections, the combination of a master timer and a plurality of secondary timers, one of said secondary timers being located at each of the street intersections, synchronizing means for synchronizing the cycles of operation of the secondary

timer with the master timer, a plurality of cycle dials driven by the secondary timer, a switch device associated with each of said dials, an adjustable means, also associated with each of said dials, by which each associated switch device may be actuated at variable intervals in a recurring cycle, a switch mechanism for controlling the signal display, electro-responsive means arranged to advance said switch mechanism to a different position upon actuation of a selected one of said switch devices, switching means for connecting said switch device to said motor, and a constantly operating time-controlled switch mechanism, associated with the master timer, for operating said switching means associated with each secondary timer to effect successive connections and disconnections of said switch devices, said switching means including one relay means operating when energized to connect one of said switch devices, another relay means operating when energized to disconnect said one of said switch devices and to connect another of said switch devices, the two relay means being arranged when both are deenergized to disconnect the last two mentioned switch devices and to connect a third switch device.

12. In a traffic control system comprising "stop" and "go" signals at a street intersection, a timer comprising a timing motor and a plurality of cycle dials operated thereby, switch devices associated with said cycle dials, adjustable means associated with each cycle dial for actuating said switch devices associated with each cycle dial and adjusted so that each switch device is thereby actuated with a different cycle division than the others, a rotary switch mechanism for changing the display of said signals, an electric motor for advancing said switch mechanism to a different position upon each actuation of said motor, switching means for connecting said switch device to said motor, and a constantly operating time-controlled switch mechanism for operating said switching means to effect successive connections and disconnections of said switch devices, said switching means including one relay means operating when energized to connect one of said switch devices to said motor, another relay means operating when energized to disconnect said one of said switch devices and to connect another of said switch devices to said motor, the two relay means being arranged when both are deenergized to disconnect the two last mentioned switch devices and to connect a third switch device to said motor.

13. In a traffic control system, including "stop" and "go" signals at a street intersection, a cycle timer, a plurality of cycle dials operated thereby, adjustable means associated with each cycle dial for actuating a switch device, a switch device associated with each cycle dial, said adjustable means being adjusted so that each switch device is actuated thereby with a different cycle division than the others, a rotary switch mechanism for changing the display of said signals, an electric motor operative to advance said switch mechanism upon actuation of one of said switch devices, time-controlled means to connect said motor to a selected one of said switch devices during pre-selected intervals of time during the day and thus cause a predetermined subdivision of the signal cycle to be effective for controlling traffic during a selected portion of the day.

14. In a traffic control system comprising "stop" and "go" signals at a succession of street intersections along a highway, the combination of

a master timer and a plurality of secondary timers, one of said secondary timers being located at each of the street intersections, synchronizing means for synchronizing the cycles of operation
5 of the secondary timers with the master timer, a plurality of cycle dials driven by each secondary timer, a switch device associated with each cycle dial, and adjustable means associated with each dial adapted to actuate said switch device, a
10 switch mechanism responsive to actuations of a switch device for controlling the display of said signals, and connecting means for selectively connecting said switch mechanism with one of said
15 switch devices so that each actuation of a selected one of said switch devices will advance said switch mechanism to a different position, a time-controlled means associated with the master timer for controlling said connecting means in each
20 secondary timer so that the switch device associated with one of said dials is rendered effective to cause its actuations of said switch device to be effective to control the signal display during predetermined portions of the day, said dial having

its adjusting means associated therewith set to initiate and terminate the display of the "go" signal governing traffic along the highway in such a relationship with the initiation and termination
5 of the "go" signals at other intersections that equal time and preference is given to traffic moving in each direction, the said time-control means for controlling said connecting means in each
10 secondary timer rendering effective a second one of said switch devices associated with another one of said dials to cause the actuations of the
15 said switch device to be effective to control the signal display during other selected portions of the day, said last mentioned dial having its adjustable means associated therewith set to initiate
20 and terminate the display of the "go" signal governing traffic along the highway in such a relationship with the initiation and termination of the "go" signals at other intersections that a preference is given to traffic moving in one direction along the highway.

HARRISON IRVING TURNER.
CARL LUDWIG ANDERSON.