

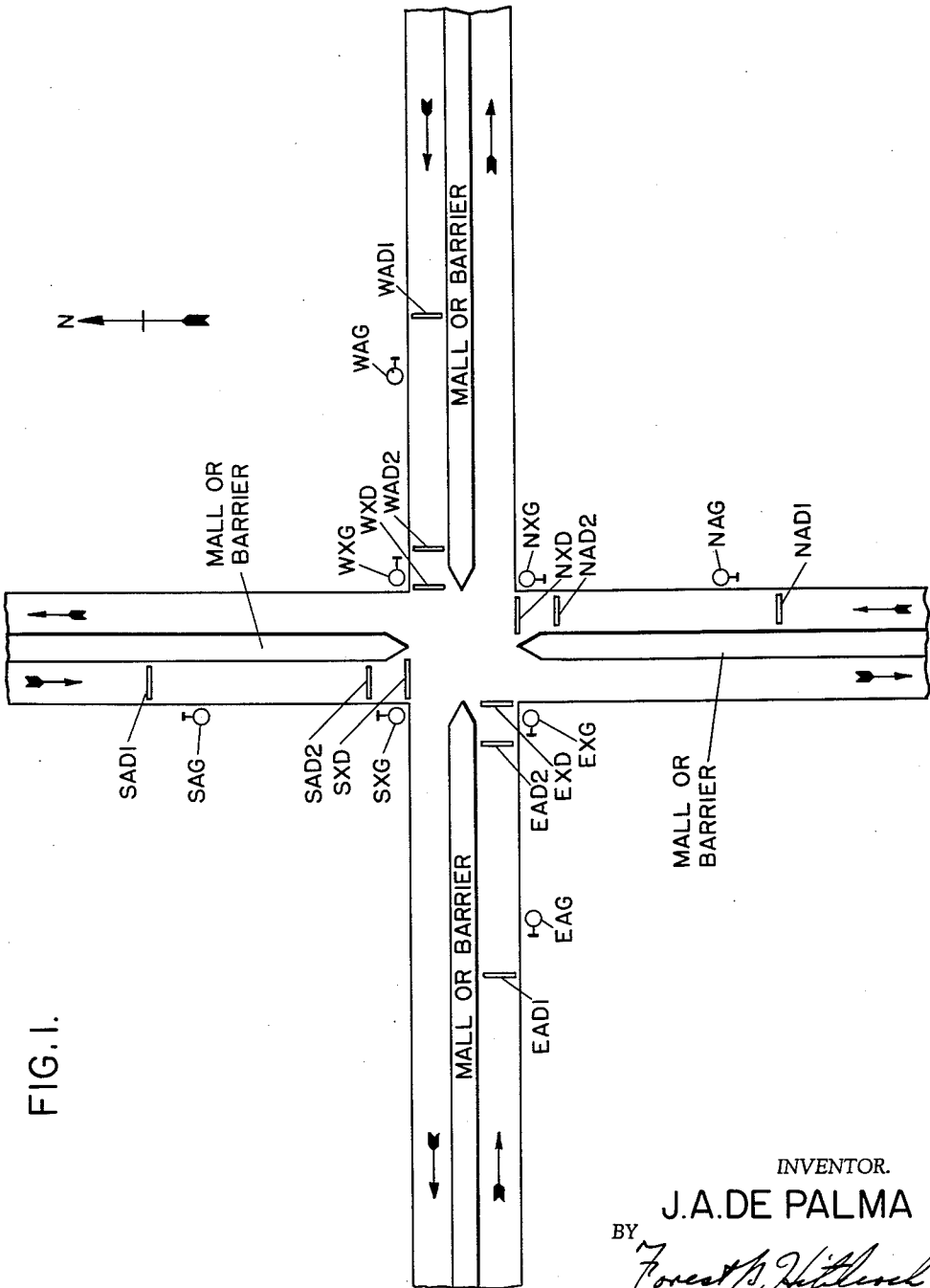
May 15, 1962

J. A. DE PALMA
HIGHWAY SIGNALLING SYSTEM

3,035,246

Original Filed June 8, 1954

4 Sheets-Sheet 1



INVENTOR.
J. A. DE PALMA
BY *Forest B. Hittler*
HIS ATTORNEY

May 15, 1962

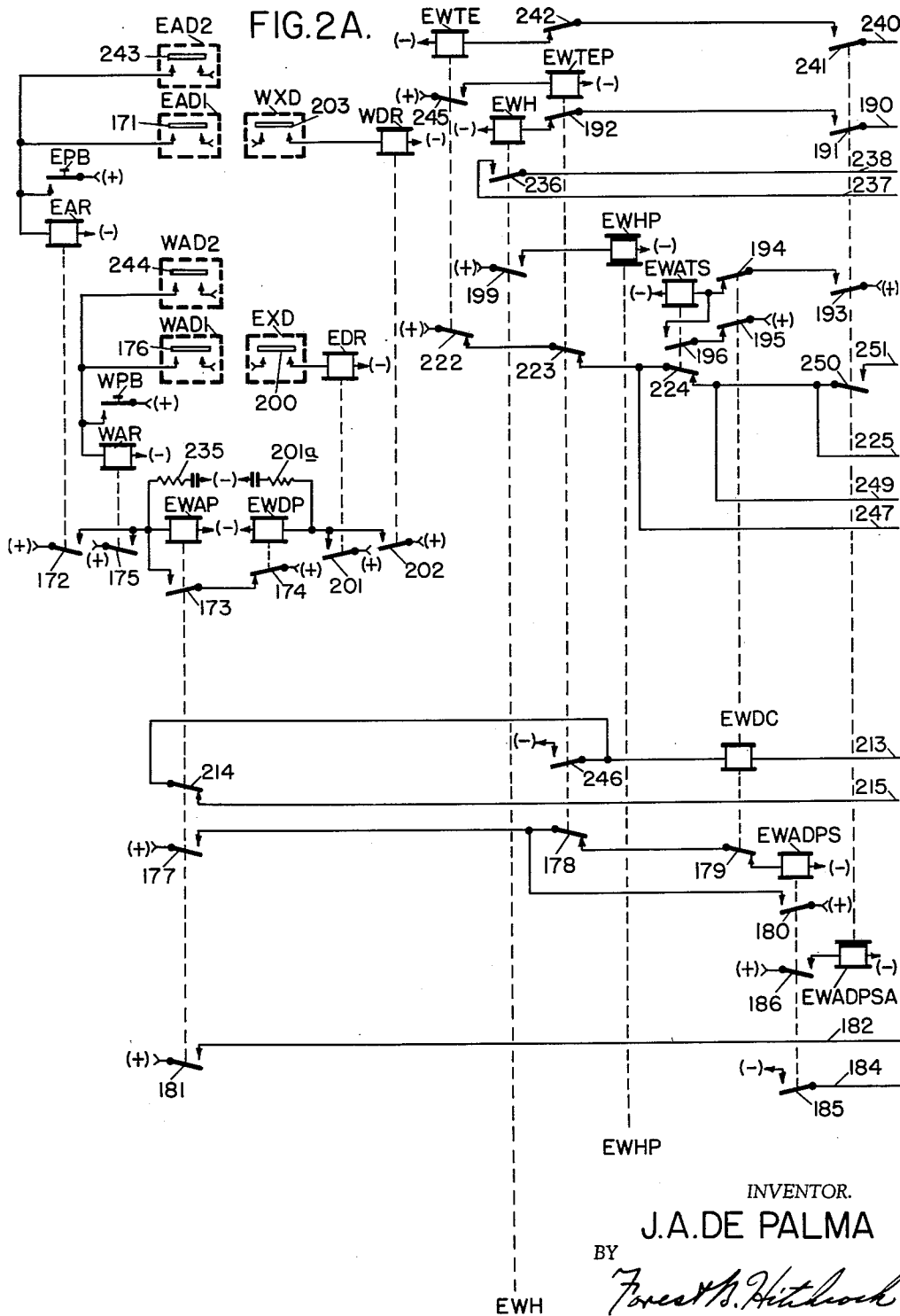
J. A. DE PALMA

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HIGHWAY SIGNALLING SYSTEM

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4 Sheets-Sheet 2



INVENTOR.

J.A. DE PALMA

BY

Forest B. Hitchcock

HIS ATTORNEY

May 15, 1962

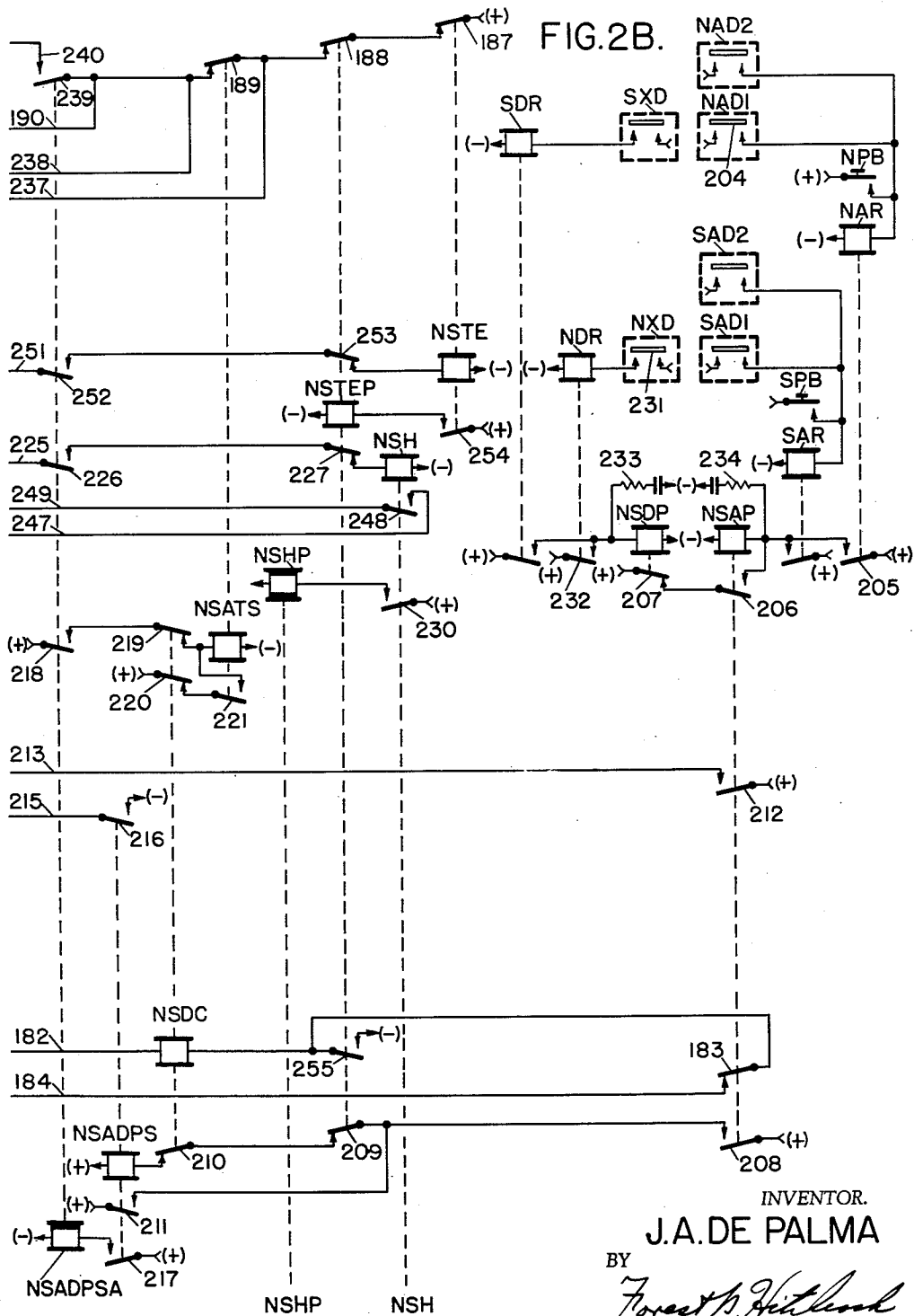
J. A. DE PALMA

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HIGHWAY SIGNALLING SYSTEM

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4 Sheets-Sheet 3



INVENTOR.
J.A. DE PALMA
BY
Forest B. Whitlock
HIS ATTORNEY

May 15, 1962

J. A. DE PALMA

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HIGHWAY SIGNALLING SYSTEM

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4 Sheets-Sheet 4

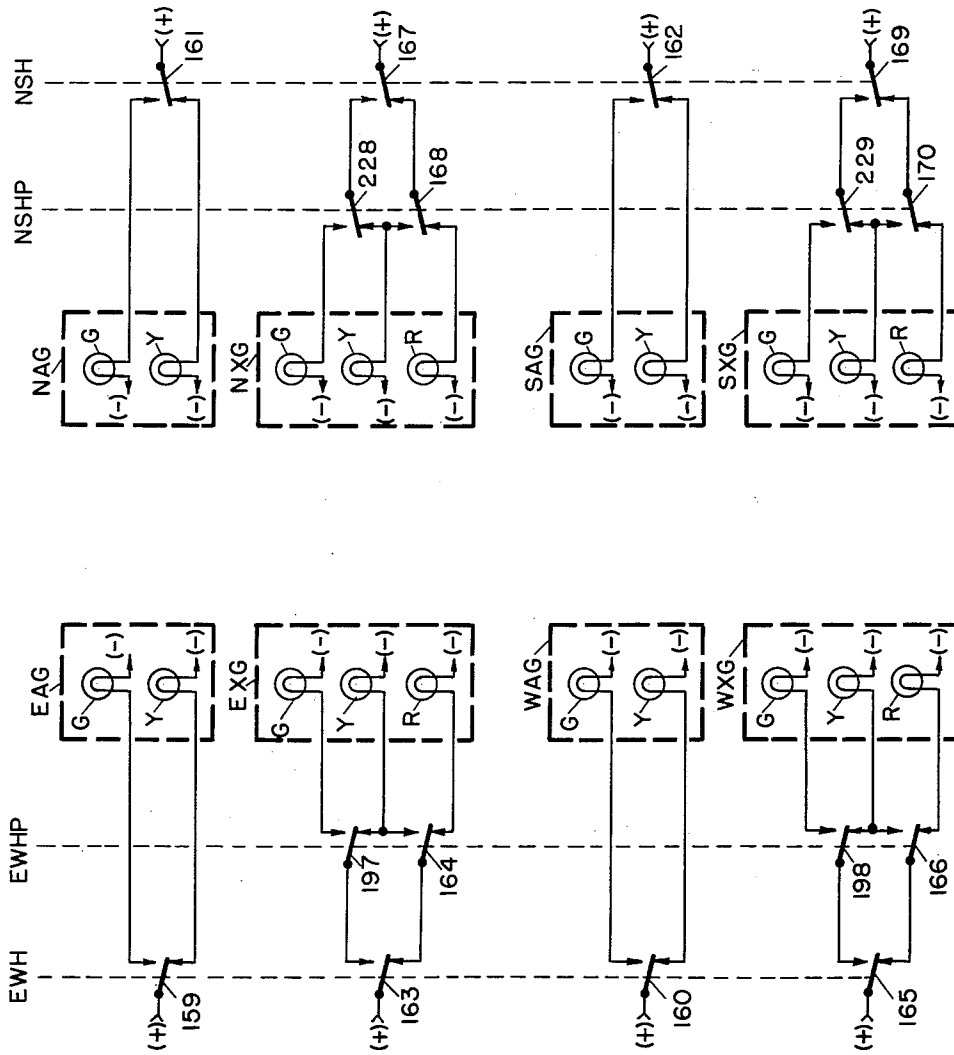


FIG. 2C.

INVENTOR.

J.A. DE PALMA

BY

Forest B. Withers

HIS ATTORNEY

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3,035,246

HIGHWAY SIGNALLING SYSTEM

James A. De Palma, Rochester, N.Y., assignor to General Railway Signal Company, Rochester, N.Y.

Original application June 8, 1954, Ser. No. 435,104, now Patent No. 2,874,367, dated Feb. 17, 1959. Divided and this application Mar. 27, 1958, Ser. No. 724,372 4 Claims. (Cl. 340—41)

This invention relates to a highway signaling system for governing automobile traffic and, more particularly pertains to a highway intersection signaling system.

The present application is a division of my copending application Ser. No. 435,104, filed June 8, 1954, now Patent No. 2,874,367, issued February 17, 1959, and no claim is intended to be made herein to subject matter claimed in such prior application.

One of the objects of this invention is to provide a highway signaling system for governing traffic at highway intersections, the highway signaling system being capable of detecting and governing traffic approaching an intersection from any direction.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

In the accompanying drawings:

FIG. 1 shows a highway intersection along with various traffic signals and traffic detection devices; and

FIGS. 2A—2C show diagrammatically the various traffic signals, detection apparatus and operating circuits for a highway intersection signaling system.

In order to simplify the illustrations in the drawings and facilitate in the explanation of the fundamental characteristics of the invention, various parts and circuits have been shown diagrammatically in accordance with conventional symbols. Arrows with associated symbols (+) and (—) are employed to indicate connections of the circuits of the various relays and other apparatus to the opposite terminals of a suitable source of energy for the energization of such relays and apparatus; and the source of energy may be of any suitable characteristic for the purpose intended. The various contacts of the relays involved in the illustrations are shown conventionally as being in a lower or inclined position when the coil or winding of the associated relay is deenergized, and in a raised or horizontal position when the relay is energized; the contacts belonging to any given relay are shown connected to its coil or winding by dotted lines, and these contacts may be either below or above the illustration of the relay winding. The front and back contacts between which the movable contacts are operated by the different relays are shown conventionally as arrowheads, and the movable contacts are ordinarily of the type which have their contacts pulled downwardly by gravity or by spring action.

In FIG. 1, an east-west divided highway is shown intersecting a north-south divided highway. Arrows indicate the directions of traffic in the various lanes.

Crossing signals EXG, WXG, NXG and SXG are shown located in advance of the intersection to govern eastbound, westbound, northbound and southbound traffic, respectively. Approach signals EAG, WAG, NAG and SAG are shown on the approaches to the signals EXG, WXG, NXG and SXG, respectively. The purpose of the approach signals is to provide advance information to approaching traffic concerning the aspects displayed by the respective crossing signals. If, for example, crossing signal EXG displays a red aspect, approach signal EAG displays a yellow aspect to warn approaching eastbound vehicles that they must be prepared to stop at

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the intersection. Signal EAG displays a green aspect whenever crossing signal EXG displays a green aspect. It is assumed that the distance between any crossing signal and its respective approach signal is at least equal to the maximum braking distance for vehicles in accordance with highway speed considerations.

Approach detection devices EAD1, WAD1, NAD1, and SAD1 are shown located in advance of approach signals EAG, WAG, NAG and SAG, respectively. The purpose of the approach detection devices is to detect traffic approaching the intersection and to actuate a circuit network which controls the various signals to govern traffic approaching and crossing the intersection. The circuit network controls the various signals to permit the alternate crossing of the intersection by traffic traveling on the east-west highway and traffic travelling on the north-south highway. Since signal controls are initiated by cars passing the various approach detection devices, the distance between each detection device and its associated approached signal must be great enough to allow any change in signal aspects to occur before the car reaches the approach signal so that the car approaching may be governed in advance of signals EXG, WXG, NXG or SXG.

Additional approach detection devices EAD2, WAD2, NAD2 and SAD2 are shown located in advance of signals EXG, WXG, NXG and SXG, respectively; and the detectors function to detect traffic waiting to enter the intersection.

Crossing detection devices EXD, WXD, NXD and SXD are shown ahead of the crossing signals EXG, WXG, NXG and SXG, respectively. The purpose of the crossing detection devices is to indicate to the circuit network that traffic is entering the intersection from a particular direction.

Referring now to FIGS. 2A through 2C, a more detailed description of signal, detection device and circuit operation can be given.

The various detection devices are assumed to be of the self-restoring treadle type, although photoelectric cells or other electronic detection devices can be used. The various detection devices are shown in block form, particular attention being given only to electrical contactors included in each device. Signals are also shown in block form, their various colored lamps being indicated as red R, yellow Y, and green G.

Approach relays EAR, WAR, NAR and SAR are provided to repeat actuations of the approach detectors EAD1 and EAD2, WAD1 and WAD2, NAD1 and NAD2, and SAD1 and SAD2, respectively, in response to passing traffic. Similarly, detection relays EDR, WDR, NDR and SDR are provided to repeat operations of the crossing detectors EXD, WXD, NXD and SXD, respectively.

Approach repeater relays EWAP and NSAP are provided to indicate the detection of approaching traffic on the east-west and north-south highways, respectively. The relays EWAP and NSAP are energized upon the detection of approaching vehicles and are subsequently deenergized by the detection of the same vehicles crossing the intersection.

Detection repeater relays EWDP and NSDP are provided to indicate the detection of traffic crossing the intersection along the east-west and north-south highways, respectively.

Signal control relays EWH and EWHP are provided for controlling the signals EAG, EXG, WAG and WXG to govern traffic on the east-west highway. Similar relays NSH and NSHP are provided to control signals NAG, NXG, SAG and SXG on the north-south highway. A time element relay EWTE is provided to measure

a predetermined time interval during which signals EXG and WXG may permit the crossing of the intersection by eastbound and/or westbound traffic after conflicting traffic is detected approaching on the north-south highway. A similar time element relay NSTE is provided to measure a time interval during which signals NXG and SXG may permit traffic on the north-south highway to cross the intersection after traffic is detected approaching on the east-west highway. The time intervals measured for the crossing signals EXG, WXG, NXG and SXG also apply to the approach signals EAG, WAG, NAG and SAG, respectively, since the approach signals give advance information concerning the conditions of the respective crossing signals. Relays EWTE and NSTE are repeated by relays EWTEP and NSTEP, respectively, each repeater relay indicating the completion of a timing operation. The time element relays EWTE and NSTE are assumed to be similar to that disclosed in Field Patent No. 2,378,293, dated June 12, 1945; wherein the back contacts of each relay open when the relay is energized and the front contacts of each relay close after the relay completes a timing operation.

A directional control relay EWDC is provided to initiate signal controls to restrict eastbound or westbound traffic when traffic is detected on the north-south highway. Similarly, a directional control relay NSDC initiates signaling restrictions against northbound or southbound traffic when traffic is detected on the east-west highway.

An approach detection repeater stick relay EWADPS is provided to initiate controls over signals on the east-west highway in response to the detection of approaching traffic either on the east-west highway alone or on the east-west highway and the north-south highways in succession. A slow-acting repeater relay EWADPSA is provided to repeat relay EWADPS. Similar relays NSADPS and NSADPSA are provided to indicate the approach of northbound or southbound traffic under similar conditions.

An approaching traffic stick relay EWATS is provided to prevent the signals governing traffic on the north-south highway from displaying proceed aspects while the signals governing traffic on the east-west highway are displaying proceed aspects. A similar relay NSATS is provided to prevent the signals on the east-west highway from displaying proceed aspects while proceed aspects are displayed by the signals on the north-south highway.

The various relays are all shown deenergized, such conditions existing whenever energy is removed from the system for any reason whatsoever and subsequently restored.

Under these conditions, the yellow Y lamps of the approach signals EAG, WAG, NAG and SAG are energized by circuits including, respectively, back contacts 159 of relay EWH, 160 of relay EWH, 161 of relay NSH, and 162 of relay NSH. The red lamp R of signal EXG is energized by a circuit including back contact 163 of relay EWH and back contact 164 of relay EWH; and the red R lamp of signal WXG is energized by a circuit including back contact 165 of relay EWH, and back contact 166 of relay EWH. Similarly, the red R lamp of signal NXG is energized by a circuit including back contact 167 of relay NSH and back contact 168 of relay NSH; and the red R lamp of signal SXG, is energized by a circuit including back contact 169 of relay NSH and back contact 170 of relay NSH.

Assume that an eastbound car (or cars) passes over the approach detector EAD1. Approach relay EAR is alternately energized and deenergized by the successive closings and openings of contact 171 of detector EAD1 in response to actuations of detector EAD1 by car wheels. Relay EWAP is then energized by the closing of front contact 172 of relay EAR; and relay EWAP is held energized by a stick circuit including front contact 173 of relay EWAP and back contact 174 of relay

EWDP. It can be seen that relay EWAP can also be energized initially by the closing of front contact 175 of the westbound approach relay WAR when that relay is energized by closings of contact 176 of the westbound approach detector WAD1.

Relay EWADPS is now energized by a pick-up circuit extending from (+), including front contact 177 of relay EWAP, back contact 178 of relay EWTEP, back contact 179 of relay EWDC, and relay winding EWADPS, to (-); and stick contact 180 of relay EWADPS closes. Relay NSDC is energized by a pick-up circuit extending from (+), including front contact 181 of relay EWAP, wire 182, relay winding NSDC, back contact 183 of relay NSAP, wire 184, and front contact 185 of relay EWADPS, to (-); but the energization of relay NSDC has no effect on circuit operation at this time.

Repeater relay EWADPSA is energized by the closing of front contact 186 of relay EWADPS, relay EWADPSA being slow-acting in picking up for reasons to be explained.

At this time, relays EWH and EWATS are energized; relay EWH being energized by a pick-up circuit extending from (+), including back contact 187 of relay NSTE, back contact 188 of relay NSTEP, back contact 189 of relay NSATS, wire 190, front contact 191 of relay EWADPSA, back contact 192 of relay EWTEP, and relay winding EWH, to (-); relay EWATS being energized by a circuit extending from (+), including front contact 193 of relay EWADPSA, back contact 194 of relay EWDC, and relay winding EWATS, to (-); and relay EWATS is held energized by a stick circuit including back contact 195 of relay EWDC and front contact 196 of relay EWATS.

The energization of relay EWH results in the deenergization of the yellow Y lamps of the approach signals EAG and WAG by the opening of back contacts 159 and 160, respectively, of relay EWH; and the green G lamps of signals EAG and WAG are energized by the closing of front contacts 159 and 160, respectively, of relay EWH. The red R lamps of the crossing signals EXG and WXG are deenergized by the opening of back contacts 163 and 165, respectively, of relay EWH. The yellow Y lamp of signal EXG is energized by a circuit including front contact 163 of relay EWH and back contact 197 of relay EWH; and the yellow Y lamp of signal WXG is energized by a circuit including front contact 165 of relay EWH and back contact 198 of relay EWH. At the same time, slow-acting relay EWH is energized by the closing of front contact 199 of relay EWH. When relay EWH picks up its armature the yellow Y lamps of signals EXG and WXG are deenergized by the opening of back contacts 197 and 198 respectively, of relay EWH; the green G lamps of signals EXG and WXG being energized by the closing of front contacts 197 and 198, respectively, of relay EWH. It can now be seen that the reason for causing relay EWH to have slow pick-up characteristics is to cause signals EXG and WXG to display yellow aspects for a preceptable period of time. In other words, in changing from red to green indications and signals display an intermediate indication of yellow, in accordance with common traffic signaling practice.

When the eastbound car passes over the crossing detector EXD, contact 200 of detector EXD closes to energize detector relay EDR. Relay EWDP is now energized as the result of the closing of front contact 201 of relay EDR. A resistor and a capacitor 201a in series are connected in parallel with relay winding EWDP to introduce slow-release characteristics into the operation of relay EWDP for reasons to be explained later. It can be seen that relay EWDP can also be energized by the closing of front contact 202 of relay WDR when that relay is operated in response to actuations of contact 203 of detector WXD by westbound traffic.

The stick circuit for relay EWAP is opened by back

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contact 174 of relay EWDP resulting in the deenergization of relay EWAP. The subsequent opening of front contact 181 of relay EWAP causes the deenergization of relay NSDC.

When the car completely passes detector EXD relay EDR is deenergized by the opening of contact 200 of detector EXD. Front contact 201 of relay EDR opens the pick-up circuit for relay EWDP, relay EWDP releasing its armature in accordance with its slow release time.

At this time, the circuit network is so aligned that relays EWADPS, EWADPSA, EWATS, EWH and EWHP are energized; signals EAG, WAG, EXG and WXG display green aspects; and signal NAG and SAG display yellow aspects while signals NXG and SXG display red aspects.

If other eastbound or westbound cars approach the intersection at this time, the signals EAG, EXG, WAG and WXG all display green aspects. As the cars advance through the intersection, relays EAR or WAR, EWAP, NSDC, EDR or WDR and EWDP operate as previously described; and relays EWADPS, EWADPSA, EWATS, EWH and EWHP remain energized throughout.

It can be seen from the drawings that a comparable network for the north-south highway is provided; and this circuit network is similar to that described above for the east-west highway. Thus, northbound or southbound cars traveling initially through the highway intersection produce similar circuit operations resulting in the energization of relays NSADPS, NSADPSA, NSATS, NSH and NSHP and causing signals NAG, NXG to display green aspects; signals EAG and WAG displaying yellow aspects while signals EXG and WXG display red aspects.

In view of the preceding description, it can be seen that relays associated with one or the other of the two highways are always energized except when energy is removed from and then restored to the system.

Assume now that a northbound car is detected approaching the intersection after an eastbound or westbound car passes through the intersection, it being also assumed that no other approaching eastbound or westbound cars are detected. As previously described, relays EWADPS, EWADPSA, EWATS, EWH and EWHP are energized, signals EAG, WAG, EXG and WXG display green aspects, and signals NAG and SAG display yellow aspects while signals NXG and SXG display red aspects.

When the northbound car passes over the approach detector NAD1 contact 204 of detector NAD1 is alternately closed and opened resulting in the alternate energization and deenergization of relay NAR. Relay NSAP is energized by the closing of front contact 205 of relay NAR; and relay NSAP is held energized by a stick circuit including front contact 206 of relay NSAP and back contact 207 of relay NSDP.

Relay NSADPS is now energized by a pick-up circuit extending from (+), including front contact 208 of relay NSAP, back contact 209 of relay NSTEP, back contact 210 of relay NSDC, and relay winding NSADPS, to (-); and front contact 211 of relay NSADPS closes a stick circuit for relay NSADPS.

Relay EWDC is energized by a pick-up circuit extending from (+), including front contact 212 of relay NSAP, wire 213, relay winding EWDC, back contact 214 of relay EWAP, wire 215, and front contact 216 of relay NSADPS, to (-).

The energization of relay EWDC results in the deenergization of relays EWATS and EWADPS; relay EWATS being deenergized by the opening of its pick-up and stick circuits by back contacts 194 and 195, respectively, of relay EWDC; relay EWADPS being deenergized by the opening of its stick circuit at back contacts 179 of relay EWDC.

Relay EWADPSA is now deenergized by the opening of front contact 186 of relay EWADPS. Relay EWH is subsequently deenergized by the opening of front contact 191 of relay EWADPSA.

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The deenergization of relay EWH causes approach signals EAG and WAG to change their aspects from green to yellow, and further causes crossing signals EXG and WXG to change their aspects from green to yellow. The green G lamps of signals EAG and WAG are deenergized by the opening of front contacts 159 and 160, respectively, of relay EWH; and yellow Y lamps of the signals EAG and WAG are energized by the closing of back contact 159 and 160, respectively, of relay EWH. The green G lamps of signals EXG and WXG are deenergized and the yellow Y lamps of the signals are energized by the opening of front contacts 163 and 165, respectively, of relay EWH and the closing of back contact 163 and 165, respectively, of relay EWH.

The previous energization of relay NSADPS results in the energization of the slow-acting relay NSADPSA by the closing of front contact 217 of relay NSADPS. When relay NSADPSA picks up its armature, relay NSATS is energized by a pick-up circuit extending from (+), including front contact 218 of relay NSADPSA, back contact 219 of relay NSDC, and relay winding NSATS, to (-); and relay NSATS is held energized by a stick circuit including back contact 220 of relay NSDC and front contact 221 of relay NSATS. At the same time, relay NSH is energized by a pick-up circuit extending from (+), including back contact 222 of relay EWTE, back contact 223 of relay EWTEP, back contact 224 of relay EWATS, wire 225, front contact 226 of relay NSADPSA, back contact 227 of relay NSTEP, and relay winding NSH, to (-).

The yellow Y lamps of signals NAG and SAG are now deenergized by the opening of back contacts 161 and 162, respectively, of relay NSH; and the green G lamps of these signals are energized by the closing of front contacts 161 and 162, respectively, of relay NSH. The red R lamps of signals NXG and SXG are deenergized by the opening of back contacts 167 and 169, respectively, of relay NSH. The yellow Y lamp of signal NXG is energized by a circuit including front contact 167 of relay NSH and back contact 228 of relay NSHP; and the yellow Y lamp of signal SXG is energized by a circuit including front contact 169 of relay NSH and back contact 229 of relay NSHP.

At this time, the slow-acting relay NSHP is energized by the closing of front contact 230 of relay NSH. Relay EWHP, being previously deenergized by the opening of front contact 199 of relay EWH, releases its armature at this time. Signals EXG and WXG change their aspects from yellow to red, the yellow Y lamps of signals EXG and WXG being deenergized by the opening of front contacts 164 and 166, respectively, of relay EWHP; and the red R lamps of these signals are energized by the closing of back contacts 164 and 166, respectively, of relay EWHP. Relay NSHP now picks up its armature causing signals NXG and SXG to change their aspects from yellow to green. The yellow Y lamps of signals NXG and SXG are deenergized by the opening of back contacts 228 and 229, respectively, of relay NSHP; and the green G lamps of these signals are energized by the closing of front contacts 228 and 229, respectively, of relay NSHP. The reason for causing relay NSADPSA to have slow pick-up characteristics is now apparent. Since energizations of relay NSADPSA result, under the described conditions, in the energization of signal control relay NSH, signals NAG, NXG, SAG and SXG are operated to display less restrictive aspects. Such signal operations should be delayed until signals EAG, EXG, WAG and WXG are operated by the deenergization of relay EWH to display more restrictive aspects. The pick-up time of relay NSADPSA is adjusted to accomplish such a mode of signal operation.

The condition of the various signals at this time is such that traffic is restricted on the east-west highway while proceed indications are given to traffic on the north-south highway. Thus, it can be seen that the de-

tection of approaching cars on the north-south highway immediately initiates the clearing of the signals governing traffic on that highway under the conditions that no further approaching traffic is detected on the east-west highway.

When the northbound car passes over the detector NXD, contact 231 of detector NXD alternately closes and opens in response to the passage of car wheels, resulting in successive energizations and deenergizations of relay NDR. Relay NSDP is energized by the closing of front contact 232 of relay NDR; and the resultant opening of back contact 207 of relay NSDP removes energy from the stick circuit for relay NSAP.

Relay EWDC is now deenergized by the opening of front contact 212 of relay NSAP. A pick-up circuit for relay EWATS is now restored by the closing of back contact 194 of relay EWDC.

When the northbound car passes detector NXD to enter the intersections, relay NDR is deenergized by the opening of contact 231 of detector NXD. Subsequently, relay NSDP is deenergized by the opening of front contact 232 of relay NDR. A resistor and capacitor 233 are connected in parallel with relay winding NSDP to produce slow-release characteristics in this relay in accordance with speed and normal car spacing considerations for the highway. In other words, the slow-release time of relay NSDP is such that relay NSDP is responsive to groups of cars rather than to individual cars. Relay EWDP is made slow-acting, as previously noted, for the same purpose.

If other northbound or southbound cars should pass over approach detector NAD1 before relay NSDP drops away, relay NSAP is energized as previously described, but its stick circuit is open at back contact 207 of relay NSDP. A resistor and capacitor 234 are connected in parallel with relay winding NSAP to produce slow-acting characteristics in relay NSAP so that relay NSAP is not responsive to the passage of individual cars but rather to the passage of groups of cars. In this way, unnecessary operations of relay NSAP are prevented when its stick circuit is open. A similar resistor and capacitor 235 are connected in parallel with relay winding EWAP for the same purpose.

The release times of relays EWAP and NSAP are assumed to be not greater than the release times of relays EWDP and NSDP, respectively. If, for example, a northbound car approaches the intersection, causing the energization of relays NSAP and NSDP in the manner previously described, the stick circuit for relay NSAP is opened by back contact 207 of relay NSDP. After the car passes detector NXD, relay NSDP is deenergized resulting in the closing of its back contact 207 in the stick circuit for relay NSAP. To render this stick circuit ineffective, front contact 206 of relay NSAP must be open before back contact 207 of relay NSDP closes; and such is the case if the release time of relay NSAP is not greater than that of relay NSDP. If relay NSAP were to be held energized under the conditions stated, a timing delay is produced in the operation of signals on the east-west highway should eastbound or westbound cars be detected. The nature of the timing delay can be seen in a subsequent description of circuit operation when conflicting traffic groups are detected.

In order to describe the operation of the highway intersection signaling system under heavy traffic conditions, thus illustrating the ability of the system to permit the alternate use of the intersection by traffic on the two highways, assume that long lines of cars approach the intersection from all directions. It can be noted that since the circuit network does not differentiate between eastbound traffic and westbound traffic or between northbound traffic and southbound traffic, spaced groups of cars travelling in opposite directions on one highway produce the same effects in circuit operation as are produced by an unbroken line of cars travelling in one direction.

Assume that the first car to be detected is travelling on the east-west highway; and further assume the east-west highway to be the last used by previous traffic. In other words, relays EWH, EWHP, EWATS, EWADPS and EWADPSA are energized, signals along the east-west highway display proceed aspects and signals along the north-south highway display restrictive aspects at the time when the first car is detected approaching on the east-west highway.

When either approach detector EAD1 or WAD1 is actuated, relay EAR or WAR is energized in response to the respective closing of contact 171 of detector EAD1 or contact 176 of detector WAD1. Relay EWAP is then energized by the closing of either front contact 172 of relay EAR or front contact 175 of relay WAR; and contact 173 of relay EWAP closes the stick circuit for relay EWAP.

The closing of front contact 181 of relay EWAP energizes relay NSDC; and relay NSDC remains energized until traffic is detected on the north-south highway.

At this time, assume that traffic is detected approaching on the north-south highway by detector NAD1 or SAD1, causing relay NAR or SAR to be energized in the manner previously described. Relay NSAP is then energized following the energization of either relay NAR or SAR; and front contact 206 of relay NSAP closes the stick circuit for relay NSAP. The opening of back contact 183 of relay NSAP causes relay NSDC to be deenergized, while the closing of front contact 208 of relay NSAP causes the energization of relay NSADPS.

Relay NSADPSA is now energized by the closing of front contact 217 of relay NSADPS, relay NSADPSA being slow-acting in picking up its armature.

The time element relay EWTE and relay NSATS are energized, relay EWTE starting a timing operation. Relay NSATS is energized upon the closing of front contact 218 of relay NSADPSA, causing back contact 189 of relay NSATS to open in the previously described pick-up circuit for relay EWH. However, front contact 236 of relay EWH, connected in parallel with back contact 189 of relay NSATS by wires 237 and 238, is closed to maintain energization of relay EWH. Relay EWTE is energized by a pick-up circuit extending from (+), including back contact 187 of relay NSTE, back contact 188 of relay NSTE, wire 237, front contact 236 of relay EWH, wire 238, front contact 239 of relay NSADPSA, wire 240, front contact 241 of relay EWADPSA, back contact 242 of relay EWTEP, and relay winding EWTE, to (-). Back contact 222 of relay EWTE opens in the pick-up circuits for relays NSTE and NSH.

The signals governing traffic on the east-west highway continue to display proceed aspects, allowing traffic on that highway to proceed across the intersection.

When cars are detected passing over either detector EXD or WXD relay EDR or WDR is energized in response to respective closings of contact 200 of detector EXD or contact 203 of detector WXD. Relay EWDP is then energized by the closing of either front contact 201 of relay EDR or front contact 202 of relay WDR. Back contact 174 of relay EWDP opens the stick circuit for relay EWAP. It can be noted there that if relay EWAP is deenergized the closing of its back contact 214 allows the energization of relay EWDC; and energization of relay EWDC results in the deenergization of relays EWATS, EWADPS, EWADPSA, EWH and EWHP in succession. The signals governing traffic on the east-west highway would then be operated to display restrictive aspects. Since this condition is not desirable at this time, energization of relay EWAP is maintained through the action of detectors EAD2 and WAD2, these detectors being located at a predetermined distance in advance of signals EXG and WYG, respectively, so that one of these detectors is certain to be actuated by approaching traffic whether or not such traffic enters the intersection. It can be seen that contact 243 of detector EAD2 is con-

nected in parallel with contact 171 of detector EAD1, the closing of either contact 171 or 243 causing the energization of relay EAR. Similarly, contact 244 of detector WAD2 is connected in parallel with contact 176 of detector WAD1, the closing of either contact 176 or 244 causing the energization of relay WAR. Thus, either the pick-up or the stick circuit for relay EWAP is closed at any time under conditions of heavy traffic. Detectors NAD2 and SAD2 are provided on the north-south highway for a similar reason.

At some instant, relay EWTE completes its timing operation closing its front contact 245 which causes the energization of relay EWTEP.

At this time, relays EWTE, EWH and EWADPS become deenergized while relay EWDC becomes energized. The opening of back contact 242 of relay EWTEP causes the deenergization of relay EWTE while the opening of back contacts 178 and 192 of relay EWTEP causes the deenergization of relays EWADPS and EWH, respectively; relay EWDC being energized by a pick-up circuit including front contact 212 of relay NSAP and front contact 246 of relay EWTEP.

The deenergization of relay EWH causes signal EAG, EXG, WAG and WXG to change their aspects from green to yellow, thereby restricting traffic on the east-west highway.

Relay EWTEP is now deenergized by the opening of front contact 245 of relay EWTE. At the same time, relay EWATS is deenergized by the opening of back contacts 194 and 195 of relay EWDC.

When relay EWTEP is deenergized, the opening of its front contact 246 causes the deenergization of relay EWDC; and subsequent closings of back contacts 178 and 223 of relay EWTEP cause the energization of relays EWADPS and NSH, respectively. Relay NSH then opens its back contacts and closes its front contacts to cause signals NAG and SAG to change their aspects from yellow to green, while causing signals NXG and SXG to change their aspects from red to yellow.

At this time, the slow-acting relay EWHP, deenergized by the opening of front contact 199 of relay EWH, releases its armature causing signals EXG and WXG to change their aspects from yellow to red.

Relay EWADPSA, being energized by the closing of front contact 186 of relay EWADPS, picks up its armature to cause the energization of relays EWATS and NSTE. Relay EWATS is energized by the closing of front contact 193 of relay EWADPSA; and relay NSTE is energized by a pick-up circuit extending from (+), including back contact 222 of relay EWTE, back contact 223 of relay EWTEP, wire 247, front contact 248 of relay NSH, wire 249, front contact 250 of relay EWADPSA, wire 251, front contact 252 of relay NSADPSA, back contact 253 of relay NSTEP, and relay winding NSTE, to (-).

Slow-acting relay NSHP picks up its armature at this time causing signals NXG and SXG to change their aspects from yellow to green. The signals governing traffic on the north-south highway now display proceed aspects while the signals governing traffic on the east-west highway display restrictive aspects. Circuit and relay operations are assumed to be such that a synchronism exists between operations of the signals on the two highways. For example, at instants when signals NXG and SXG display red, yellow or green aspects signals EXG and WXG display green, yellow or red aspects, respectively. Similarly, when signals NAG and SAG display yellow or green aspects signals EAG and WAG display green or yellow aspects, respectively.

Cars travelling on the north-south highway are permitted to cross the intersection until relay NSTE completes its timing operation, the completion of a timing operation by relay NSTE resulting in the energization of relay NSTEP through the closing of front contact 254 of relay NSTE.

When relay NSTEP is energized relays NSTE, NSH, and NSADPS are simultaneously deenergized by the opening of back contacts 253, 227 and 209, respectively, of relay NSTEP; and relay NSDC then is energized when front contact 255 of relay NSTEP closes.

The deenergization of relay NSH causes signals NAG, SAG, NXG and SXG to change their aspects from green to yellow, restricting traffic on the north-south highway.

When relay NSDC becomes energized relay NSATS is deenergized by the opening of back contacts 219 and 220 of relay NSDC. At the same time, relay NSTEP is deenergized by the opening of front contact 254 of relay NSTE.

The deenergization of relay NSTEP results in the deenergization of relay NSDC by the opening of front contact 255 of relay NSTEP and further results in the energization of relays EWH and NSADPS by the closing of back contacts 188 and 209, respectively, of relay NSTEP.

The energization of relay EWH causes signals EAG and WAG to change their aspects from yellow to green while causing signals EXG and WXG to change their aspects from red to yellow.

Slow-acting relay NSHP, deenergized by the opening of front contact 230 of relay NSH, now releases its armature causing signals NXG and SXG to change their aspects from yellow to red.

Upon the energization of relay NSADPS, its front contact 217 closes to energize relay NSADPSA. Subsequently, time element relay EWTE and relay NSATS are energized by the closing of front contacts 239 and 218, respectively, of relay NSADPSA. Back contact 189 of relay NSATS opens but front contact 236 of relay EWH is closed maintaining a pick-up circuit for relays EWTE and EWH.

Slow-acting relay EWHP now picks up its armature causing signals EXG and WXG to change their aspects from yellow to green. Signal operations are now complete for permitting traffic on the east-west highway to proceed while restricting traffic on the north-south highway.

Repeated circuit operations occur as described above, permitting the alternate use of the intersection by traffic on the two highways, as long as traffic is detected approaching on the two highways.

In the preceding descriptions of circuit operation, it was assumed that traffic on the east-west highway was detected before traffic on the north-south highway was detected, any previous traffic having been assumed to travel along the east-west highway. Similar circuit operations result regardless of the direction in which detected traffic is moving.

A further condition must be described, however, in which approaching traffic on the east-west highway and approaching traffic on the north-south highway are detected simultaneously. Assume, for example, that previous traffic travelled on the east-west highway, resulting in the energization of relays EWH, EWHP, EWATS, EWADPS and EWADPSA.

In view of the preceding descriptions of circuit operation, it can be seen that relays EAR or WAR, EWAP, NAR or SAR, NSAP, NSADPS and NSADPSA can be energized in response to the detection of traffic. Relays EWDC and NSDC cannot be energized, however, since back contact 214 of relay EWAP and back contact 183 of relay NSAP are open in the respective pick-up circuits for relays EWDC and NSDC. Since relay EWDC cannot be energized, its back contact 195 cannot open to deenergize relay EWATS. Consequently, relays NSTE and NSH are held deenergized by the open back contact 224 of relay EWATS. Relay NSATS is energized, however, opening its back contact 189 in the energizing circuit for relays EWH and EWTE; but front contact 236 of relay EWH is closed shunting back contact 189 of relay NSATS. Therefore, relay EWH remains energized along with its repeater relay EWHP; and

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relay EWTE starts a timing operation which, when completed, produces circuit and signal operations as previously described.

Similar circuit operations can be described for simultaneous detections of approaching traffic on the two highways after previous traffic crosses the intersection from the north-south highway, in this case, the traffic on the north-south highway is allowed to proceed. Thus, in the case of simultaneous detections of conflicting traffics, the circuit network is biased in favor of the traffic travelling on the highway last used by previous traffic, as indicated by the energization of either relay EWATS or relay NSATS.

Push buttons EPB, WPB, NPB and SPB shown in FIGS. 2A and 2B incorporated into the signaling system for use by pedestrians or for testing purposes; and the push buttons are assumed to be located at or near signals EXG, WXG, NXG and SXG, respectively. Push button EPB, for example, is connected in parallel with approach detectors EAD1 and EAD2 so that a depressing of push button EPB closes a circuit to energize relay EAR. Thus, push button EPB initiates circuit operations which are identical to those initiated by actuations of detectors EAD1 or EAD2 by passing cars.

Having described a highway signaling system as one specific embodiment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume; and it is to be further understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention.

What I now claim is:

1. A system for operating multiple aspect signals to govern highway traffic at an intersection of a pair of conflicting highways to permit vehicles to enter the intersection from only one of said highways at a time, comprising detecting means effective to detect the presence of vehicles in a predetermined section of each highway at the approach to the intersection, signal control means effective to cause said signals to display a proceed aspect for vehicles approaching the intersection on one of said pair of highways when a vehicle is detected entering said predetermined section of said one highway and no vehicle is detected in the predetermined section of the other of said pair of said highways, timing means effective when activated to commence a timing period of predetermined duration to cause said signals to display proceed aspects at the end of said timing period to permit vehicles to enter

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the intersection from said other highway, timing circuit means including said detecting means effective to activate said timing means to commence the timing period when a vehicle is detected entering the predetermined section of said one highway while the predetermined section of said one highway is occupied, and circuit means including said timing circuit means and said signal control means and said detecting means effective to render said timing means inactive thereby to terminate said timing period upon the vacating by vehicles of said section of said one highway before the end of said timing period to cause said signals to display proceed aspects for said other highway.

2. A system as claimed in claim 1 wherein said timing means includes a timer for each of said highways, and said timing circuit means is effective at the end of the time period of one timer to commence the timing period for the other timer as long as a vehicle is detected in said section of both said highways.

3. A system as claimed in claim 1 wherein each said detecting means includes a first and second detector spaced longitudinally apart in its associated highway to determine the ends of said section, said first detectors being effective to activate said timing means and said second detectors being effective to render said timing means inactive.

4. A system as claimed in claim 3 wherein a third detector is positioned in each said highway between said first and second detectors adjacent said second detector, thereby to cause said signal control means to cause said signal to display a proceed aspect when a vehicle passes said third detector of one of said highways and no vehicle is detected in said predetermined section of the other of said highways.

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