Jan. 25, 1966 J. H. AUER, JR 3,231,856

REVERSIBLE LANE SIGNAL CONTROL SYSTEM

Filed Aug. 8, 1962 2 Sheets-Sheet 1

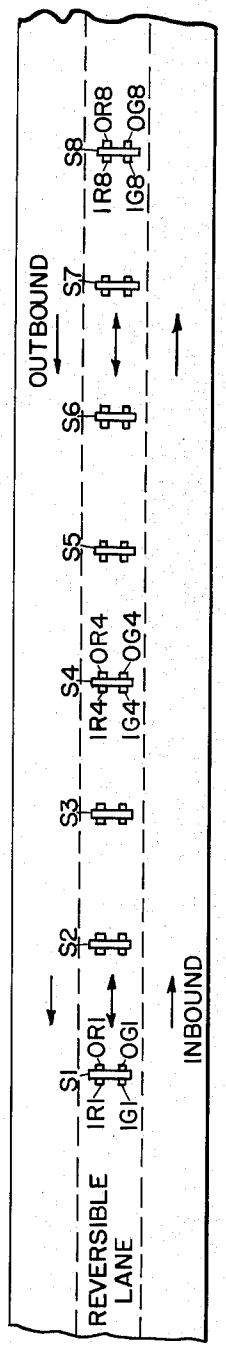


FIG. 1

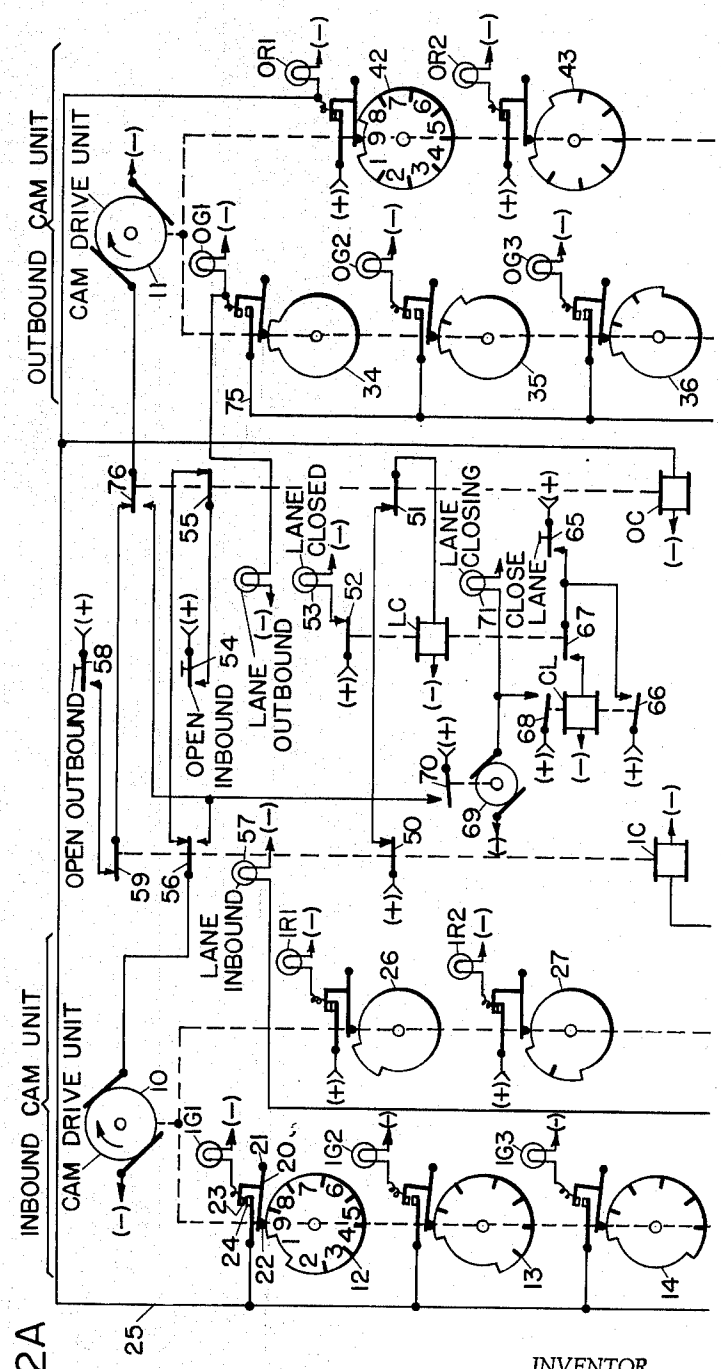


FIG. 2A

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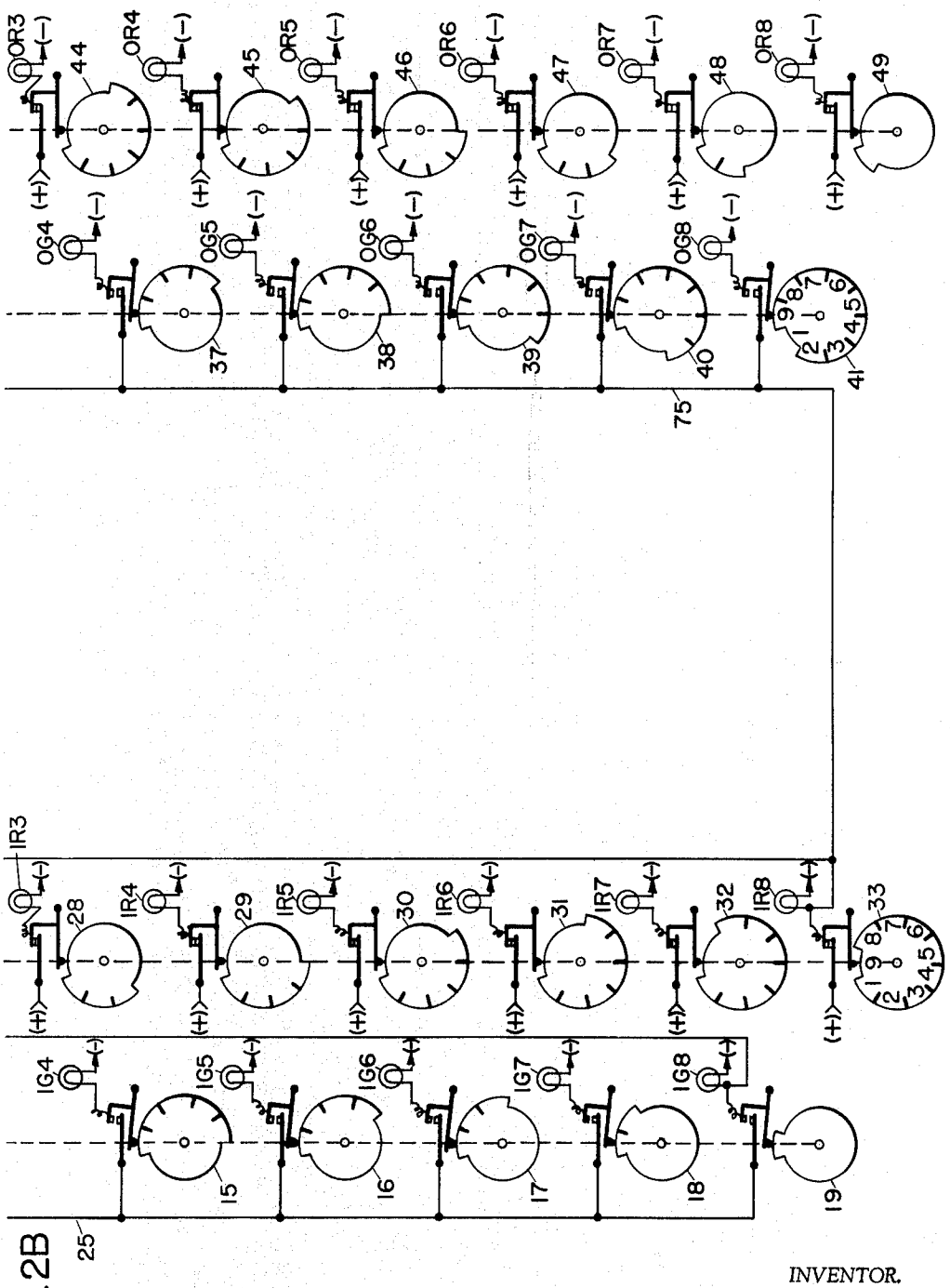


FIG. 2B

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United States Patent Office 3,231,856 Patented Jan. 25, 1966

3,231,856

REVERSIBLE LANE SIGNAL CONTROL SYSTEM

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Filed Aug. 8, 1962, Ser. No. 215,558
4 Claims. (Cl. 340—41)

This invention relates to a control system for the signals on a reversible traffic lane.

It is frequently desirable that one or more lanes of a highway, usually the center lane or lanes, be signalled so that traffic may flow thereon in one direction or the other according to which direction of traffic is favored at any particular time. Such an arrangement is frequently desired in the control of traffic on a bridge where it is desired that the signal system provide for the flow of outbound traffic on the reversible lane at certain times of the day when traffic is heaviest in the outbound direction and to provide for the inbound direction of traffic on that same lane at a different time of day when the inbound direction of traffic is heavier. In this way, the actual traffic handling capacity of the highway is very substantially increased.

It is contemplated by the present invention that a plurality of traffic signals be placed at spaced locations along the reversible lane and that at each such signal location the signal be of the type which can display at least a "lane open" or a "lane closed" indication for either direction of traffic. It is, of course, also within the scope of the invention to provide separate inbound and outbound traffic signals, each capable of displaying a "lane open" or a "lane closed" indication for the respective direction of traffic.

The traffic control system of this invention is so organized that one may, from a remote location, control all of the signals for each of the directions of traffic to display a "lane closed" indication so that the lane is, in effect, closed to all traffic. It is also contemplated that, once the lane has been closed, it may be opened for a selected direction of traffic by simultaneously controlling all of the signals to display a "lane open" indication to vehicles travelling in the selected direction.

To close any lane, the system of the invention provides that the signals heretofore displaying "lane open" indications to a selected direction of traffic will successively be controlled to display a "lane closed" indication starting first with the signal which is nearest the entering end of the lane for that particular direction of traffic. Thereafter, at spaced intervals, the signals for the selected direction are in succession controlled to display a "lane closed" indication so that all vehicles which were traveling on the lane in that particular direction will continue to receive the "lane open" indication as they travel along the lane but with the signals progressively controlled to display the "lane closed" indication behind such vehicles so that no further vehicles will be allowed to enter that lane. When all the signals have been controlled to display the "lane closed" indication in this manner, the lane will be closed. Only when this condition is met, can the signals be controlled to display "lane open" indications for the opposite direction of traffic.

In the description that follows, the "lane open" indication will, for convenience, be referred to as a green indication and the "lane closed" indication will similarly be referred to as the red indication.

An object of this invention is to provide a control system for the control of signals in a reversible traffic lane.

Another object of this invention is to provide a control system for a reversible traffic lane in which the lane which has heretofore been opened for a selected direction is closed by successively controlling the signals displaying green for the open direction to display red, with the order of change being the order in which the signals are encountered when travelling in the selected direction, and to further control the signals so that a green signal can be supplied for the opposite direction of traffic only when all of the signals display red for the selected direction.

Another object of the invention is to provide a control system for a reversible traffic lane using a standard traffic controller.

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

In describing the invention, reference will be made to the accompanying drawings in which:

FIGURE 1 is a diagrammatic illustration of a multilane highway having a reversible traffic lane provided with a number of traffic signals thereon;

FIGS. 2A and 2B form a circuit diagram of the signal control system of the present invention.

FIGURE 1 disloses a section of highway comprising three traffic lanes, one of which is designated as an inbound lane, the other as an outbound lane, and the center lane is a reversible lane over which traffic may flow in either direction depending upon the control exercised ever the signal system. Disposed along this reversible traffic lane are a plurality of traffic signals, of which eight are shown in FIG. 1. These are designated as signals S1–S8 respectively, and each is represented as having both a red and green signal lamp for both inbound and outbound directions of traffic. Thus, signal S1 is shown as having signal lamp IR1 and IG1 which represent respectively the red and green signal lamps of the signal S1 for the inbound direction. This same signal S1 also has signal lamps OR1 and OG1 which are the comparable red and green signal lamps of this signal and displayed to outbound traffic.

FIGURES 2A and 2B illustrate two multi-position, multi-cam switches, one for the inbound direction and used to control the selective energization of the inbound signals and the other similarly provided for the control of the outbound signals. Nine different rotational positions of the various cams are shown, one for each of the eight signals and with the ninth position being allotted for a "lane closed" control which is the normal position as shown in the drawing. The sixteen different cams illustrated for each cam switch will normally all be on the same axis and will thus rotate together in the clockwise direction shown by the arrow associated with the associated cam drive unit such as the cam drive unit **10** provided for cams **12–19** and **26–32**. Each cam drive unit operates the associated cams one step clockwise for each pulse of energy applied thereto.

The cams may be of the type which are formed of plastic and so molded that any of the segments thereof may be broken out to thereby give the desired configuration. Thus, cam **12** is shown as having only one segment, i.e., segment **1**, broken out; whereas, cam **13** has both segments **1** and **2** broken out. Cam **26**, on the other hand, has all of the segments broken out except segment **1**.

Associated with each cam is a movable contact finger such as contact finger **20** associated with cam **12**. This contact finger **20** rotates above pivot point **21** and has a roller or equivalent cam follower element **22** at its remote end which is in a raised position when opposite any cam segment not broken out, but is depressed when the cam is rotated to a position where the cam follower element **22** falls into the space left available by the broken out segment. The contact finger **20** carries a movable contact **23** which is open with respect to a fixed contact

member 24 as long as the cam follower element 22 is in a raised position, but these contacts 23 and 24 are closed whenever the contact finger 20 is allowed to move downwardly as when the cam follower element 22 moves into the space where a cam segment has been broken out. This diagrammatic illustration is, of course, only typical of the many which can be devised for this purpose and there is, of course, no intention to limit the present invention to the particular arrangement of the contact strucures shown in FIGURE 2.

Cams 12–19, inclusive, of the inbound cam unit control the signal lamps IG1 through IG8, respectively. Each of these cams has its segment 9 in place, and, since the normal position of each of these cams is that wherein segment 9 is in contact with the associated cam follower, then each of the contacts associated with the respective cams 12–19 is open and thus none of the signal lamps IG1–IG8 can be illuminated even though there may be energy at that time on the common wire 25.

Cams 26–33 control the energization of signal lamps IR1–IR8. On each of the these cams, segment 9 has been broken out so that each of the respective contacts is closed and thus energy is applied to each of the lamps IR1–IR8. Thus, inbound traffic encounters a red signal at each of the signal locations.

With respect to the outbound cam unit and signals, the situation is the same. Thus, each of the cams 34–41 has its segment 9 in place so that the contacts associated therewith are all open, thus ensuring that each of the various signal lamps OG1–OG8 will all be extinguished. On the other hand, each of the cams 42–49 has its segment 9 broken out so that each of the contacts associated with these cams is closed and, therefore, all of the signals OR1–OR8 are illuminated. Thus, each of the outbound signals displays a red aspect.

It is only when all of the cams 26–33 of the inbound unit are in their 9 position that all of the signal lamps IR1–IR8 are energized. Of these various signal lamps, lamp IR8 is energized only on the 9 position so that the presence of energy on this lamp is an assurance that all of the signal lamps IR1–IR8 are energized. For this reason, the winding of relay IC, the "inbound closed" relay, is connected in parallel with IR8 and thus energization of relay IRC provides an indication that the reversible lane is closed to inbound traffic. Relay OC is similarly energized, and thus this "outbound closed" relay provides by its energization an indication that the lane is closed for traffic in the outbound direction. If both these relays IC and OC are energized, this is an indication that the lane is closed to all traffic. Under these circumstances energy is provided through closed front contact 50 of relay IC and also contact 51 of relay OC to energize the winding of the "lane closed" relay LC. With this relay picked up, energy is applied through its front contact 52 to energize the "lane closed" indication lamp 53, thereby providing an indication at a control office that the lane is closed to all traffic. In this connection, it will be appreciated that each of the various indication lamps such as lamp 53 for example will be provided, together with the cam units, push-buttons, et cetera at a central or control office from which controls may be sent out to selectively energize the various signal lamps.

Assume now that the lane has been closed so that all of the signals are displaying a red aspect in both the inbound and outbound directions and that it is now desired to open the lane for inbound traffic. To accomplish this, it is merely necessary to momentarily actuate the "open inbound" push button 54. When this is done, energy is applied through this closed push-button contact and through front contact 55 of relay OC and front contact 56 of relay IC to cam drive unit 10. This momentary energization of the cam drive unit operates each of the various cams associated therewith one step in the clockwise direction so that, on each cam, position 1 is moved into place opposite the cam follower.

On each of the cams 12–19, position 1 is broken out and this necessarily means that each of the contacts associated with these cams will now be closed. Since cam drive unit 11 has not been energized, all of the cams associated therewith remain in the position shown and already described, and this means that cam 42 continues in its 9 position so that the contact associated with this cam 42 remains closed and wire 25 remains energized. Therefore, current is applied through the respective contacts associated with cams 12–19 to energize signal lamps IG1–IG8.

At the same time, each of the cams 26–33 moves its segment 1 opposite the associated cam follower so as to open the associated contact and thereby extinguish each of the signal lamps IR1–IR8. Thus, this one clockwise step of each of the cams associated with cam drive unit 10 causes the opening of the reversible lane to inbound traffic since each of the signals now displays a green aspect and all of the red signal lamps facing inbound travel are extinguished. To display this condition at the central office, a lane inbound lamp 57 is provided and connected in parallel with signal lamp IG8 so that illumination of this lamp 57 provides an indication that the lane is open to inbound traffic.

Relay IC, whose energization has provided an indication that the lane is closed to inbound traffic will now be de-energized since it is connected in parallel with lamp IR8 and this signal lamp, as just described, is now de-energized.

The apparatus at the control office includes an "open outbound" push-button 58 similar to the corresponding push-button 54 provided to open the lane to inbound traffic. Under the present state of affairs where the lane is open to inbound traffic, this lane cannot possibly be opened to outbound traffic. More specifically, if the "open outbound" push-button 58 were now actuated, it would be impossible to energize the outbound cam unit 11 since, with relay IC dropped away, its front contact 59 is open so that a circuit cannot possibly be completed to cam drive unit 11. Since the energization of the inbound cam unit 10 is similarly dependent upon both relays IC and OC being picked up, it is obvious that the lane cannot be opened to either direction of traffic unless it has first been closed to both directions of traffic.

Assuming that the reversible lane has been open to inbound traffic for some time, but that it is now desired to reverse the direction of traffic on this lane. The first step is to close the lane to inbound traffic. This cannot satisfactorily be done by merely displaying suddenly a red aspect on all of the signals facing the inbound direction of traffic. This would confuse drivers and would induce many of them to change lanes which should be avoided since this is a frequent cause of accidents. To counteract this, it is contemplated by the present invention that the signals shall be progressively changed from green to red in an order corresponding to the direction of traffic so that additional vehicles are deterred from entering the lane which is being closed, but vehicles which did initially encounter a green signal and are travelling in that lane will continue to encounter green signals as they progress along the lane so that they will be free to travel in that lane. The rate of changeover of the signals is made sufficiently slow to ensure that those vehicles which properly entered the reversible lane will have an opportunity to pass each successive signal location before that signal turns red in the progressive closing of the lane.

Referring to FIGURES 2A and 2B, and assuming that the reversible lane has been open to inbound traffic and that it is now desired to reverse the direction of travel on that lane, the lane is first closed to the inbound direction by actuation of the "close lane" push-button 65. When this happens, energy is applied through back contact 67 of relay LC to the winding of the "close lane" relay CL which, when it picks up, closes its front contact 66 so that stick circuit energy is applied through back contact

of the relay LC, thereby maintaining relay CL energized for as long as relay LC is deenergized. With relay CL picked up, energy is then applied also through its closed front contact **68** to the dial control unit **69**. The function of this dial control unit is to momentarily close its contact **70** at intermittent intervals such as perhaps once each thirty seconds or once each minute, as desired. Simultaneously with the energization of this unit **69**, the lane closing lamp **71** is energized to indicate at the control office that a lane closing operation is under way.

Each intermittent closure of contact **70** causes energy to be applied to one or the other of the cam drive units **10** or **11**, dependent upon whether relay IC or OC is dropped away at that time. In this case, it is being assumed that the lane has been open to inbound traffic and this means that relay IC must be dropped away, whereas relay OC must be picked up. Therefore, energy is applied under these circumstances through back contact **56** of relay IC to cam drive unit **10**.

According to the assumed conditions, the various cams of the inbound cam unit have all been in position 1 and thus the first input pulse applied to cam drive unit **10** operates all the cams one step clockwise so that all now assume the 2 position. One effect of this is to cause the contacts **23** and **24** associated with cam **12** to open since segment **2** of cam **12** has not been broken out. Simultaneously, the contacts associated with cam **26** are closed since cam segment **2** has been broken out, and this means that lamp IR1 is now illuminated. Thus, the result of this first pulse has been to alter the indication displayed by signal S1 from green to red. Since this is the first signal on the reversible lane encountered by traffic travelling in the inbound direction, further vehicles will be diverted away from the reversible lane into one of the other inbound lanes. However, since more of the other signals encountered by traffic in the inbound direction have been altered, any vehicles which still remain on the reversible lane and are travelling in an inbound direction are not at all affected and the drivers of these vehicles will, in fact, have no knowledge that the reversible lane is being closed behind them.

When the next input pulse is applied to cam drive unit **10**, all of the various cams associated therewith are operated to the 3 position. In this position, cam **13** opens its associated contact since its cam segment **3** has not been broken out, thereby extinguishing lamp IG2. With respect to cam **12**, this cam will retain its associated contact open in the 3 position and in all subsequent positions so that signal lamp IG1 will remain extinguished as successive pulses advance the cams from one position to the next. However, with respect to cam **14**, its segment **3** has been removed so that in this position 3, its asosciated contact will remain closed and thereby maintain signal lamp IG4 illuminated. With respect to the red signal lamp, cam **27** has its segment **3** removed so that when this cam has been operated to position 3, the associated signal lamp IR2 will be illuminated. As for cam **26**, on each of the various positions other than position 1 its segments have been removed so that lamp IR1 will continue to display a red signal. However, as to cam **28**, it is not until the various cams have all moved to position 4 that cam **28** will cause signal lamp IR3 to be energized.

The contact arrangement is thus such that, on each further input pulse applied to cam drive unit **10**, a successive one of the signal lamps has its green signal extinguished and its red signal lamp illuminated, and the order of progression is in the direction of traffic flow to which the lane has heretofore been open.

When the various cams associated with the inbound cam unit finally reach position 9, all of the inbound facing signals display a red aspect. It is only when the cams reach this position that signal lamp IG8 is extinguished, and it is only then that the indication lamp **57** is extinguished to indicate at the control office that the lane is no longer available to inbound traffic. In other words, the lane is still indicated at the control office as being assigned to inbound traffic until all of the signals for inbound traffic have changed from green to red. When this latter condition has been reached, both lanes will be closed so that both relays IC and OC will be energized and, under these conditions, as already described, relay LC will be energized and the "lane closed" lamp **53** illuminated.

It is also only when the cams associated with the inbound cam unit are in the 9 position that lamp IR8 is energized and that energy is then applied to wire **75**. If, thereafter, the "open outbound" push-button **58** is momentarily actuated, energy will be applied through front contact **59** of relay IC and front contact **76** of relay OC to cam drive unit **11**. This will operate each of the various cams associated with this unit from the normal 9 position to the 1 position. Each of the various cams **34–41** has the **1** segment removed and thus operation of these cams to the 1 position causes each of the various contacts associated with these cams to close. Since energy has been previously applied to wire **75**, this means that each of the various lamps OG1–OG8 will now be illuminated and, therefore, the reversible lane will now instantaneously be signalled to permit traffic to travel in the outbound direction. With respect to the cams **42–49**, each has its segment **1** present so that each of the various contacts associated therewith will now instantly be opened so that all of the red signals will be extinguished. Thus, this one actuation of the cam drive unit **11** has extinguished all of the red signals for outbound traffic and illuminated all of the green signals.

If it is now desired to close the lane to traffic, either for the purpose of merely prohibiting any flow of traffic on this lane for a time or to make it available to inbound traffic, the lane must in either event first be closed to outbound traffic. This is done by actuation of the "close lane" push-button **65**. As before, this results in the actuation of "close lane" relay CL which then energizes the cam unit **69** so that intermittent pulses are applied through contact **70**. Under the presently assumed circumstances wherein the lane has been opened to outbound traffic, relay OC will be deenergized and not relay IC so that these intermittent energy pulses will now be applied through back contact **76** of relay OC to cam drive unit **11**.

The first input pulse applied to cam drive unit **11** operates each of the various cams **34–41** and **42–49** from the 1 to the 2 position. This has no effect upon the contacts associated with any of the cams **34–40** but does affect the contact associated with cam **41** since its segment **2** is in place. Therefore, the associated contact will be opened and signal lamp OG8 will be extinguished. Similarly, there will be no change with respect to any of the contacts associated with cams **42–48** since each of these has its cam segment **2** in place and the associated contact will, therefore, remain open. However, with respect to the contact associated with cam **49**, its segment **2** has been removed so that operation of this cam to its 2 position will result in closure of the associated contact and energization of lamp OR8.

Each successive input pulse applied to the cam drive unit **11** will operate the various cams to a successive position. Thus, the very next input pulse will drive the cams to the 3 position and, from the contact cam arrangement shown, it is evident that this will open the contact associated with cam **40** and close the contact associated with cam **48** so that, with regard to signal S7 which is the second signal encountered by outbound traffic, this signal will now display a red aspect. In a similar manner, each successive input pulse to the cam control unit **11** alters the display presented by a successive signal S6, S5, S4, et cetera, causing each to extinguish the green signal and illuminate the red signal.

Eventually, when the various cams all arrive at the 9 position, cam **42** will close its associated contact thereby not only energizing signal lamp OR1 but also energizing

relay OC so that relay LC in turn can be energized and the lane closed lamp **53** illuminated.

Having described a signal control system for a reversible traffic lane, I desire it to be understood that various modifications, adaptations and alterations may be made to the specific forms shown without in any manner departing from the spirit or scope of this invention.

What I claim is:

1. In a signalling system for a reversible traffic lane to permit travel alternatively in an inbound or outbound direction, a plurality of signals located at spaced intervals along said lane with each being operable to display either a "lane-closed" or a "lane-open" indication to vehicles travelling over said lane in an inbound direction, multi-position contact means, said contact means in a first position controlling each of said plurality of signals to display a "lane-open" indication, said contact means on successive positions after the first controlling a successive signal of said plurality of signals, starting with the first encountered by inbound traffic, to display a "lane-closed" indication, means for actuating said contact means from said first position to said successive positions in turn to thereby progressively close said lane at spaced time intervals, a second plurality of signals located along said lane and being also each operable to display either a "lane-closed" or a "lane-open" indication to vehicles travelling along said lane in an outbound direction, means for controlling the indication displayed by each of said second plurality of signals, said last-named means being actuated by said multi-position contact means to control each of said outbound signals to display a "lane-open" indication after said multi-position contact means has controlled the last-encountered signal of said first plurality of signals to display a "lane-closed" indication.

2. The system of claim **1** in which said signal last encountered by inbound traffic includes a signal lamp which is energized by said contact means when such last-encountered signal is controlled to display said "lane-closed" indication, and electrical control means connected in parallel with said signal lamp of said last-encountered signal for energizing any of said second plurality of signals to display a "lane-open" indication.

3. In a signalling system for a reversible traffic lane to permit travel alternatively in an inbound or outbound direction, a plurality of signals located at spaced intervals along said lane with each being operable to display either a "lane-closed" or a "lane-open" indication to vehicles travelling over said lane in an inbound direction, multi-position contact means, said contact means in a first position controlling each of said plurality of signals to display a "lane-open" indication, said contact means on successive positions after the first controlling a successive signal of said plurality of signals, starting with the first encountered by inbound traffic, to display a "lane-closed" indication, means for actuating said contact means from said first position to said successive positions in turn to thereby progressively close said lane at spaced time intervals, timing means for actuating said multi-position contact means from any one position to the next with a time interval therebetween which at least equals the expected travel time of vehicles between the respective signals which are successively controlled to display "lane-closed" indications on said one position and said next position respectively.

4. In a system for the control of traffic on a reversible lane, the combination comprising a first plurality of signals at spaced intervals along said lane for alternatively displaying "lane closed" and "lane open" signals to traffic proceeding in one direction on said lane, a second plurality of signals at spaced intervals along said lane for alternatively displaying "lane closed" and "lane open" signals to traffic proceeding in the opposite direction on said lane, means effective only when each of the signals of one of said plurality is displaying a "lane closed" indication for controlling all the signals of the other plurality of signals to display a "lane-open" indication, and means for controlling the signals of either said plurality to display "lane-closed" indications, said last-named means operating said signals one at a time in order starting with the signal first encountered by a vehicle moving along said lane in a corresponding direction, and timing means controlling said last-mentioned means to operate the successive signals with an interval therebetween at least equaling the expected travel time of vehicles over the distance separating said successive signals.

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