

Dec. 9, 1941.

N. D. PRESTON

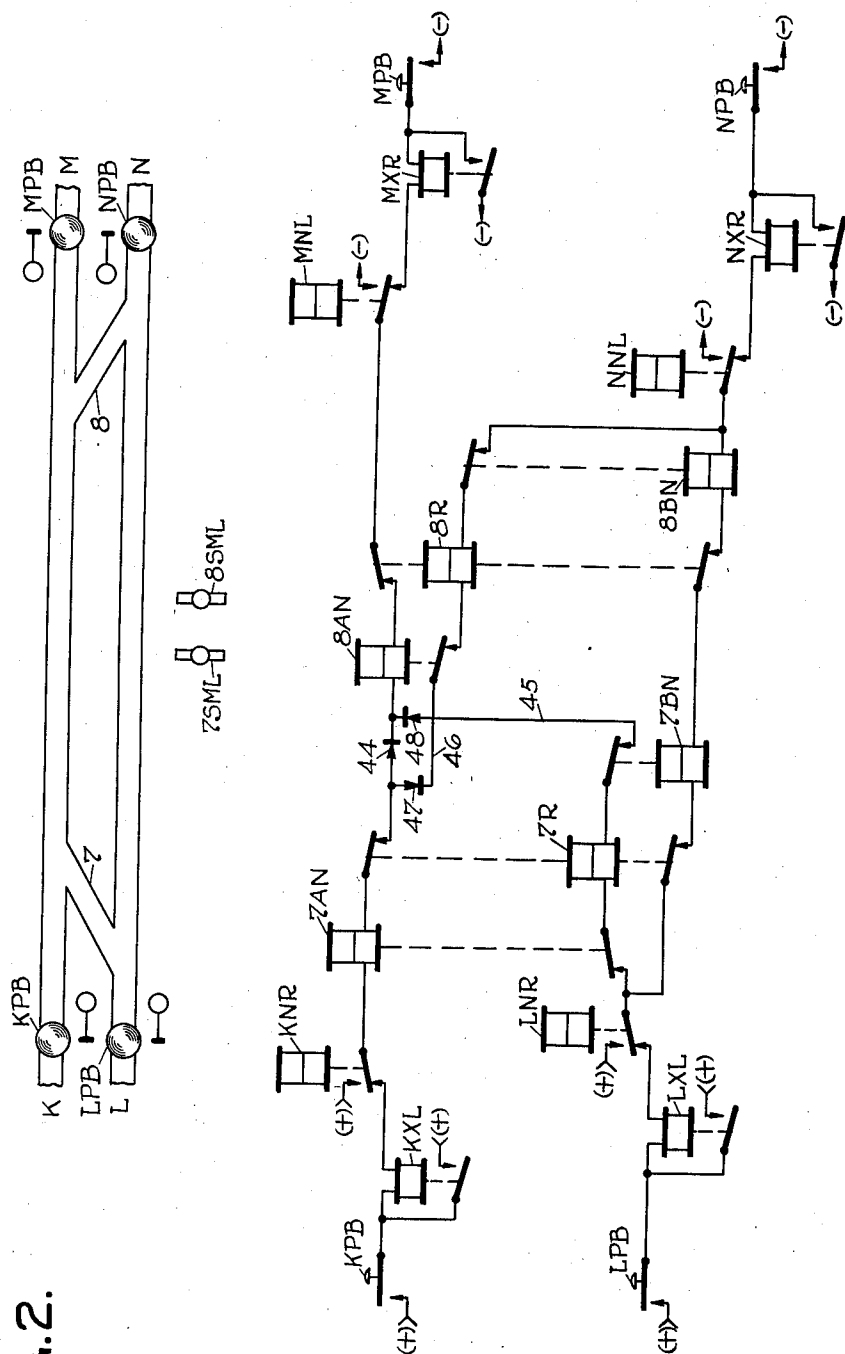
2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 2

Fig. 2.



INVENTOR

Neil H. Preston

Dec. 9, 1941.

N. D. PRESTON

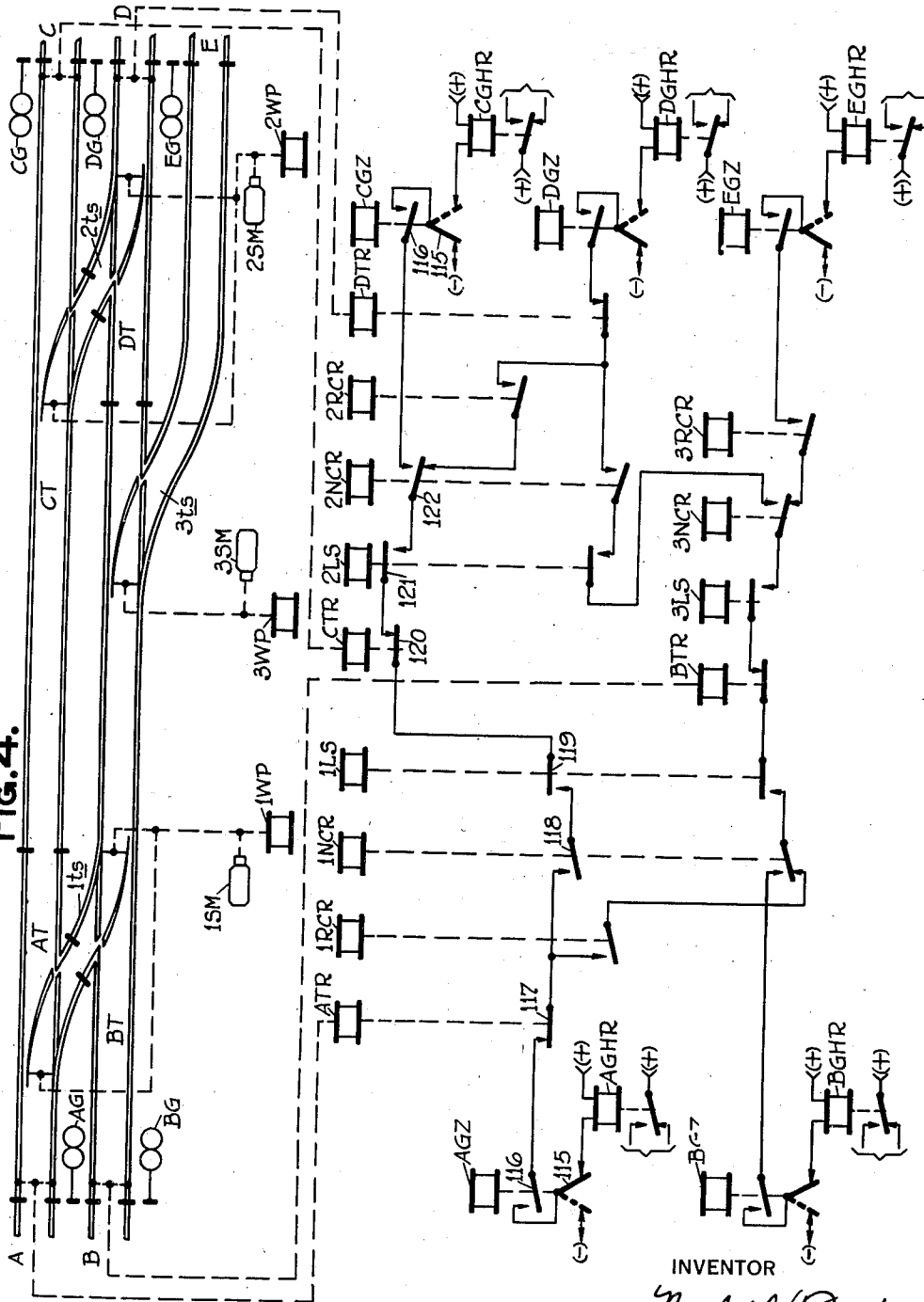
2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 4

Fig. 4.



INVENTOR

Neil D. Preston

Dec. 9, 1941.

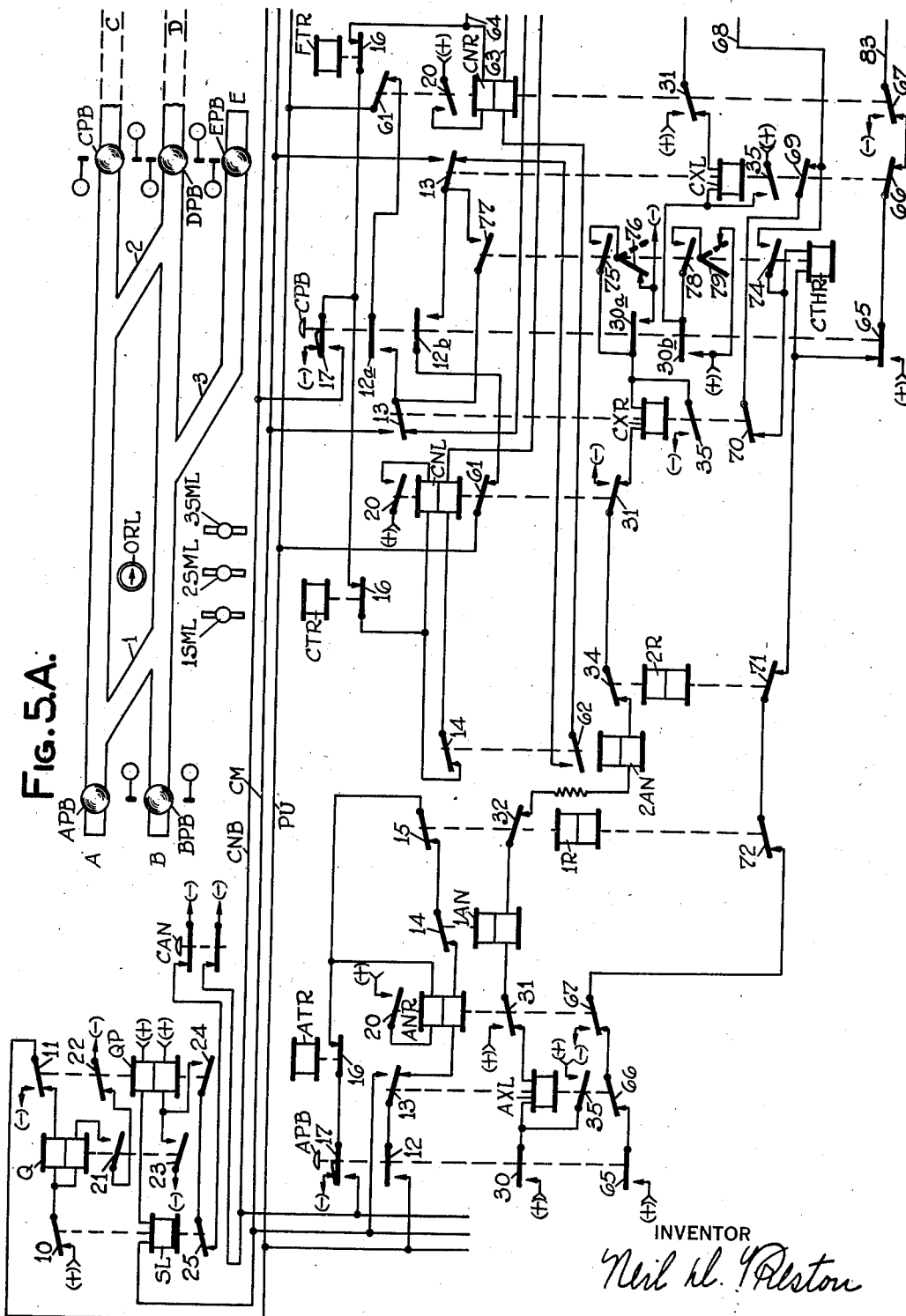
N. D. PRESTON

2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 5



Dec. 9, 1941.

N. D. PRESTON

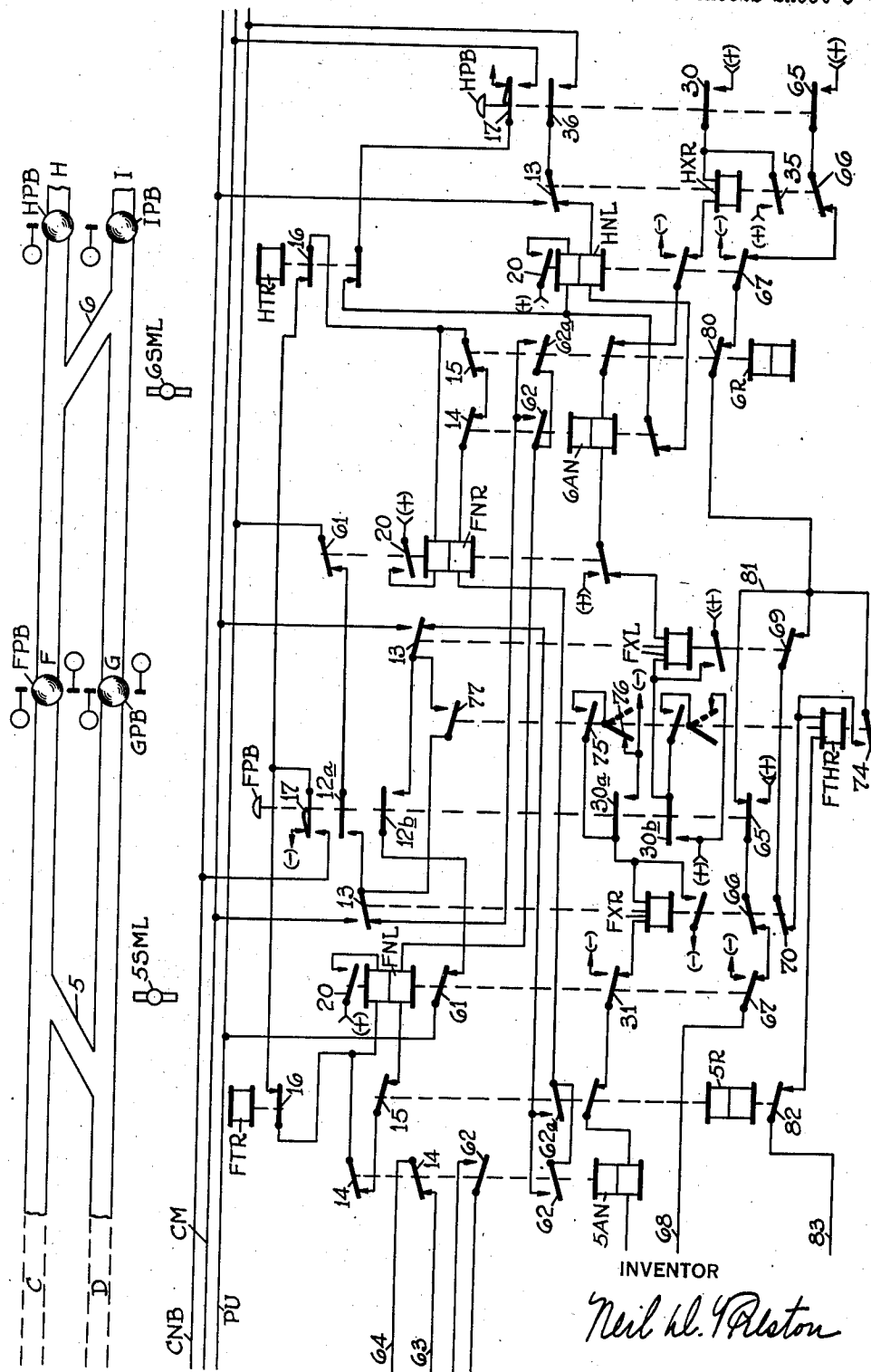
2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 6

Fig. 5.B.



Dec. 9, 1941.

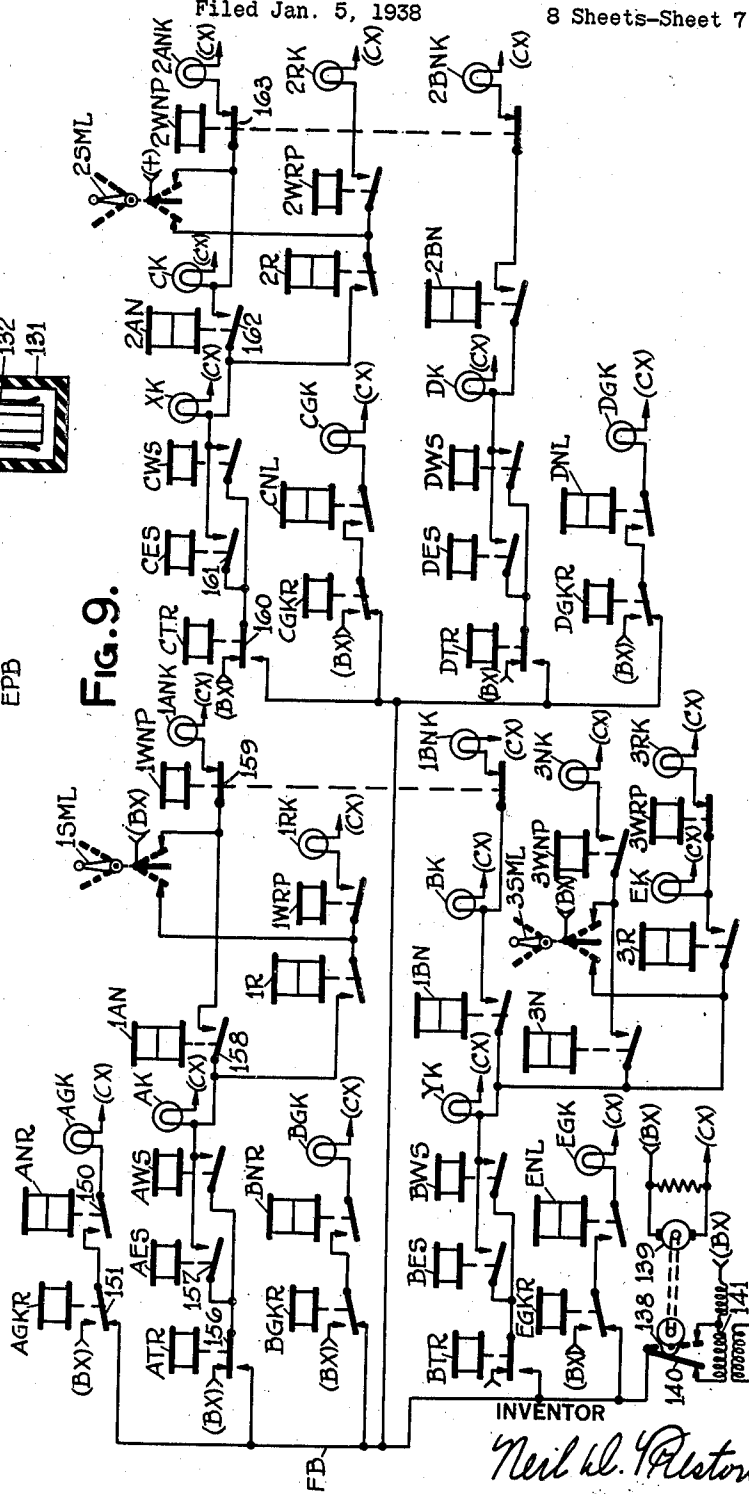
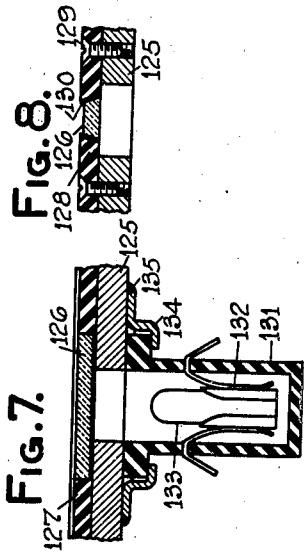
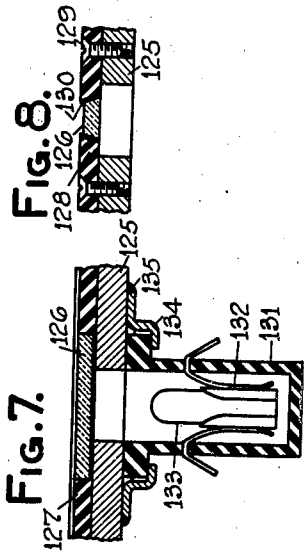
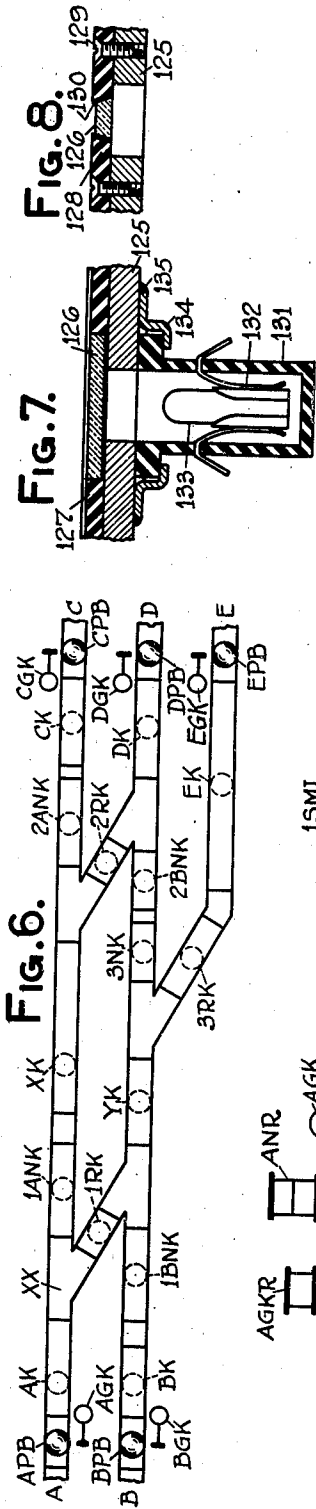
N. D. PRESTON

2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 7



INVENTOR
Neil D. Preston

Dec. 9, 1941.

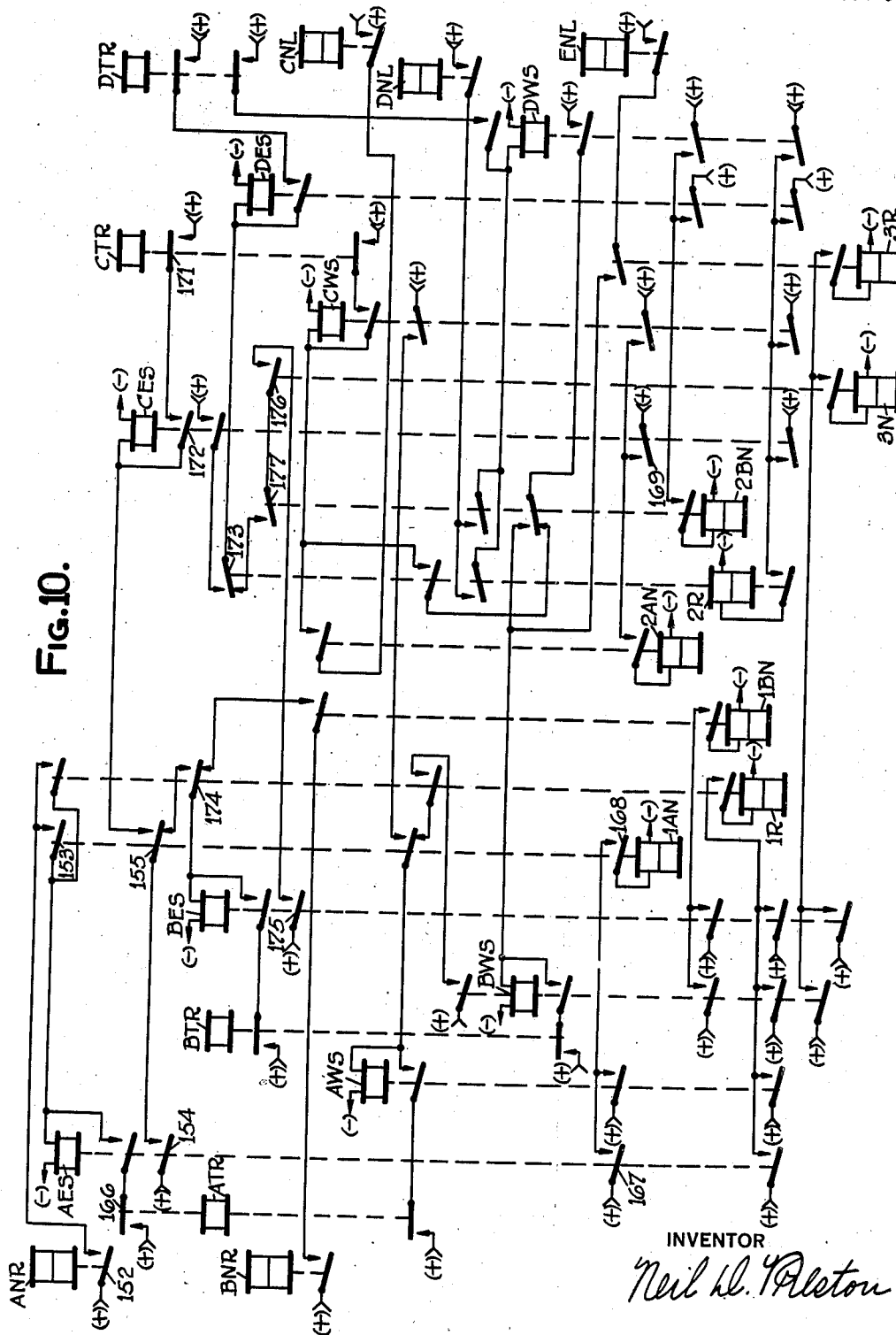
N. D. PRESTON

2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 5, 1938

8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

2,265,249

INTERLOCKING SYSTEM FOR RAILROADS

Neil D. Preston, Rochester, N. Y., assignor to
General Railway Signal Company, Rochester,
N. Y.

Application January 5, 1938, Serial No. 183,499

45 Claims. (Cl. 246—134)

This invention relates to a system for controlling the operation of power-operated track switches and the indications of the signals for a track layout at terminals or the like on railroads, and more particularly to a system of the type called an entrance-exit or NX system.

In the entrance-exit type of switch and signal control system, to which the present invention more particularly relates, the desired operation of the various track switches to the position required to set up the various routes through the track layout and the control of the clearing of the signals are accomplished by actuating manually operable buttons or like devices associated with the entrance and exit ends of the routes for train movement through the track layout from one signal to another signal in advance governing train movement in the same direction. In other words, in accordance with the operating principles of the entrance-exit type of switch and signal control system, as distinctive from the ordinary unit lever type, the operator may position all of the switches for a desired route and control the clearing of the signal for train movement in one direction or the other by merely operating a button belonging to the entrance end of that desired route and then a button at the exit end; and a suitable organization of relays and circuits responds to such joint actuation of these two buttons at the entrance and exit ends of the desired route to cause all of the track switches or crossovers involved to assume the normal or reverse position as required and also to control the clearing of the signal for train movement from the entrance end to the exit end of that route. In the preferred arrangement, these buttons are located adjacent the points on a miniature track diagram of the track layout on the control panel which correspond with the signal locations constituting the entrance or exit ends for the various routes.

A switch and signal control system of this entrance-exit type is disclosed, for example, in the prior application of S. N. Wight, Ser. No. 69,905, filed March 20, 1936, and in the prior application of A. Langdon, Ser. No. 119,641, filed January 8, 1937. The present invention is in the nature of a modification or improvement in the means employed in these and other prior applications for accomplishing the desired functions and results in such a type of system; and no claim is made herein to anything disclosed in such prior applications.

In the organizations heretofore proposed for performing the entrance-exit functions, separate

entrance and exit buttons are employed for the ends of the routes, and one or the other, or both, of these buttons is of a type which remains in its operation until restored manually. One object of the present invention is to provide an improved organization of relays and circuits in a system of this entrance-exit type in which a single self-restoring push button is all that is needed for each signal location constituting either the entrance or exit point for a route or routes, even for a double signal location. The same button acts at different times to perform the function of an entrance button or an exit button as the case may be, dependent upon the actuation of other buttons; and the direction of train movement over the given route is determined by the sequence or order in which the buttons for the ends of that route are manually actuated. In the case of a double signal location, constituting both the entrance end and the exit end of various routes for train movements in both directions, the single button at such location serves to perform the entrance function for either direction of train movement away from such double signal location and also the exit function for train movement in either direction toward such location.

Generally speaking, and without attempting to define the nature or scope of the invention, this object is attained by providing means so that, with the system in a normal condition, the first button actuated acts to perform the entrance function and renders all other buttons ineffective to act as entrance buttons, this condition persisting until another button for the exit end of an available route belonging to the first button is actuated to establish such route, whereupon the system is restored to its normal condition ready for the next operation of setting up a route by the joint and sequential actuation of two buttons belonging to the entrance and exit ends of an available route.

Another object of the invention is to provide what may be termed a series route circuit network as a means responsive to the joint and sequential actuation of the buttons at the ends of a given route to provide for the proper control of all of the switches involved in that route by energizing suitable normal or reverse switch control relays for each of said switches or crossovers. Generally speaking, the circuit network contemplated by this invention may be said to comprise feed points one for each signal location; and when operating potentials are applied to those feed points of the network corresponding with

the ends of the route defined by the buttons actuated, the normal or reverse switch control relays in that route are energized in series, rectifiers being included in certain portions of the network to block the flow of current through normal or reverse switch control relays for abnormal or alternative routes that would otherwise occur on account of the connections in the network required to energize the switch control relays for the desired routes. In this network, the energizing circuit for each normal switch control relay includes a back contact of the reverse switch control relay of the corresponding switch or crossover, and similarly the energization of each reverse switch control relay is dependent upon a back contact of the corresponding normal switch control relay, so that the complete series route establishing circuit for each route is interlocked with the route establishing circuits of all other conflicting routes. Consequently, whenever any given route is set up by the joint and sequential actuation of the associated buttons, no other route in conflict therewith may be set up by the actuation of other buttons, but parallel or non-conflicting routes may be established, such interlock being obtained in a simple way by the interlock of the control relays for individual switches.

Another object of the invention relates to those situations where optional or alternative routes between common entrance and exit points are provided by the track layout. In accordance with this invention, a separate optional route lever is provided in such cases to select between the optional routes, the route establishing circuit network being arranged so that with this lever in one position one of the optional routes is always obtained by the actuation of the corresponding entrance and exit buttons, and with this lever in the other position, the other of the optional routes is always obtained by the actuation of these same buttons. Provision is also made so that, if the preferred route corresponding to the usual position of the optional route lever is not available by reason of the establishment of another route in conflict therewith, the other inferior route will be automatically established by actuation of the corresponding entrance and exit buttons without changing the position of the optional route lever. In other words, it is contemplated that the selection between the optional routes will be under the manual control of the operator, as well as automatically depend upon conditions existing at the time the buttons for the common ends of the optional routes are actuated.

Another object of the invention is to organize the route establishing circuit network in such a way that certain through routes may be established over certain portions of track between signal locations in end-to-end relation past one or more intermediate signal locations by manual actuation of only the two buttons at the extreme ends of such through routes, at the same time permitting the routes for each of said portions of track between adjacent signals to be set up individually for either direction of train movement by the actuation of the corresponding buttons. In accordance with this invention, it is proposed to provide for such end-to-end or through route operation by means of a separate and additional circuit organization, to be used where desired, so that the through route operation is effective for only those possible through routes of the track layout where the through

route manipulation is helpful to the operator. It is considered that the through routes for the ordinary track layout for terminals, junctions, and the like, which can advantageously be established by actuation of the buttons at the extreme ends thereof are ordinarily limited to a few main routes and less than the possible number of through routes. Generally speaking, a through route relay is provided at the intermediate signal locations selected, and this relay responds to the actuation of the buttons at the extreme ends of the through routes or portions thereof past such intermediate signal location, and acts to produce the same controlling effect upon the route establishing circuit network at the point corresponding with such intermediate signal location as if the button therefor had been manually actuated.

Other objects and characteristic features of the invention relate to the means employed to enable the operator to cancel the setting of a route set up prematurely or by mistake by operation of a special cancel key in conjunction with the actuation of the button at the entrance end of the route to be cancelled; to provide for individual operation of any switch by manipulation of a separate auxiliary or emergency switch control lever; and to make provisions for the display of suitable and desirable visual indications of switch position, track occupancy, routes proposed and established, and signal clearing in a distinctive and arrestive manner on the track diagram to furnish the operator with the necessary information for the proper and efficient manipulation of the system.

The nature of the invention and the complexity of the structural organization and mode of operation makes it difficult to define the invention completely and yet briefly; and various other characteristic features, attributes, and advantages of the system embodying this invention will appear as the description progresses.

The accompanying drawings illustrate conventionally and diagrammatically certain specific embodiments of the invention applied to typical or representative track layouts, the parts and circuits being illustrated in a manner to facilitate an explanation and an understanding of the invention, rather than to show specifically how the various relays and devices might be arranged and structurally organized in practice, various symbols and nomenclatures being employed to simplify the illustration.

Fig. 1 shows diagrammatically a portion of a control panel, with its track diagram and associated buttons, for a relatively simple track layout typical of the arrangements of signals and crossovers found in practice, together with the entrance and exit relays responding to the actuation of the buttons, and the relays, circuit connections, and rectifiers constituting the route establishing circuit network for governing the energization of the normal and reverse switch control relays, and also one typical application of the principles of selection between optional routes both automatically and by an optional route lever.

Fig. 2 illustrates another track diagram and route establishing circuit network for another typical track layout involving two possible routes between common entrance and exit points, where one of these routes is a run-around movement over crossovers that is abnormal and not desired, this figure illustrating particularly how rectifiers are employed in accordance with this invention to avoid the flow of current in a series

network that would otherwise give such an abnormal or undesired route.

Fig. 3 illustrates a simple embodiment of control circuits suitable for governing the operation of a switch machine and its associated signals by the normal and reverse switch control relays and the entrance and exit relays of the route establishing circuit network.

Fig. 4 illustrates typical control circuits for the signals of a track layout like that of Fig. 1.

Figs. 5A and 5B, adapted to be arranged end-to-end, illustrate the organization of relays and circuits suitable for governing the entrance and exit relays at a double signal location by the operation of a single button, and a typical application of through route relays and their associated circuits for through route operation.

Fig. 6 illustrates diagrammatically the way in which the track diagram is preferably arranged to provide for the display of visual indications for the information of the operator.

Figs. 7 and 8 are fragmentary sections of the control panel to illustrate one typical construction for providing the desired visual indications.

Fig. 9 is a diagrammatic showing of the control means for the lighting circuits for the indicating lamps; and

Fig. 10 is a diagrammatic illustration of the circuits for governing the operation of certain east and west directional stick relays employed in the control of the switch control relays and the visual indications on the control panel.

General organization of the system.—In accordance with this invention, it is contemplated that the various switches and crossovers of the track layout will be equipped with a power operated switch machine in the usual manner, a switch machine of this character being disclosed, for example, in the patent to W. K. Howe, No. 1,466,903, dated September 4, 1923. This switch machine is provided with contacts, in accordance with the usual practice, which govern the energization of a switch repeater or position indicating relay WP, dependent upon the position and locked condition of the switch points.

It is also assumed that wayside signals of a suitable type will be provided at the various signal locations constituting the entrance and exit ends of the various routes through the track layout, and that these signals will be governed in accordance with usual practice to display the appropriate indications for high speed and low speed routes, in addition to the usual clear, caution, call-on and stop indications, these indications being controlled by track and line relays, and in accordance with the locked position of the track switches and indications of opposing signals, all in the manner characteristic of this type of system.

The track layout is also assumed to be provided with suitable detector track sections; and it is contemplated that the various switch control circuits, in addition to what is illustrated in this application, will be supplemented by suitable means and circuits to provide detector, approach, and sectional rear release route locking, such as common in the art and as disclosed in certain specific forms in the prior application of A. Langdon, Ser. No. 119,641, filed January 8, 1937, and the patent to O. H. Dicke, No. 2,045,900, June 30, 1936.

It is also contemplated that the control machine in the tower or control office will be provided with a control panel of suitable construction having thereon a miniature track diagram

of the track layout, with lines to indicate the track rails and switch points, together with such diagrammatic or symbolic representation of the signals, and letters or numbers to identify the switches, signals, and track circuits, as may be desired. Certain features in the construction of the track diagram for the purpose of providing visual indications will be considered more in detail later.

In accordance with this invention, the term "route" is used as applying to the portion of track, including one or more single switches or crossovers, between a signal and another signal in advance thereof governing train movement in the same direction. The arrangement of switches for various track layouts for terminals, junctions, and the like on railroads varies widely, but ordinarily comprises duplications of typical arrangements of single switches and crossovers connecting two or more parallel tracks; and the track layouts selected to illustrate the present invention are typical or representative of those encountered in practice to a degree that it will be obvious to any one skilled in the art how the principles and means constituting this invention may be adapted or extended to apply to any form of track layout. Also, the arrangement and location of signals varies in practice, depending upon the particular character of the track layout; but the embodiments of the invention illustrated and described herein for single and double signal locations, together with the provision for through route operation, are typical or representative of the conditions encountered in practice.

In the following discussion, the letters A, B, C, etc. are used for convenience to identify the signal locations constituting the ends of the various routes; and the manually operable push buttons, and other parts and relays more directly associated with or belonging to a particular signal location are identified by the same prefix letter.

Control office apparatus.—Referring particularly to Fig. 1, the manually operable self-restoring push buttons for the signal locations, such as APB, are preferably located on the track diagram on the lines representing the track adjacent the corresponding signal location. In accordance with this invention, there is only one such push button at each signal location, even at a double signal location like C in Fig. 5A where signals are provided for governing train movement to and from such location in both directions. Each push button is of the spring-return type of suitable construction, such as disclosed for example in the patent to Merkel, No. 2,091,155, August 24, 1937.

In addition to these push buttons, an optional route lever or rotary button ORL is preferably located on the control panel, as shown in Fig. 1, adjacent a point readily identifiable by the operator as distinguishing between the two optional routes that may be provided by the particular track layout, such as the routes from A to D in Fig. 1 by way of the crossover 1 in the reverse position, or by way of the crossover 2 in a reverse position. Also located on the control panel, at some convenient place as shown, is an auxiliary or an emergency switch lever or key SML for each of the track switches or crossovers, these levers being identified by suitable symbols marked on the panel with their respective switches.

The control machine is also provided with three buses, designated the pick-up bus PU, the can-

cel bus CNB, and the common bus CM, for the whole control panel; and in addition to these buses, there is a group of relays Q, QP, and SL, and a cancel key CAN, likewise common to the whole panel.

Associated with each push button, such as the button APB, is an entrance relay ANR and an exit relay AXL. For the purpose of identifying these relays, the first letter A, B, etc. refers to the signal location, the second letter N or R identifies the relay as an entrance relay or as an exit relay, and the third letter R or L identifies the relay as providing for train movement to the right or left.

The operation of each track switch to the normal or to the reverse position is primarily governed by a normal switch control relay N and a reverse switch control relay R. In the case of a crossover, such as the crossover I in Fig. 1, which connects two parallel tracks over which there may be non-conflicting or parallel routes, two normal control relays IAN and IBN for the opposite ends of this crossover are employed. The switch points at the ends of a crossover may be operated from the same switch machine, or by different switch machines simultaneously controlled in the same way.

Route establishing circuit network.—The control office apparatus also includes a route establishing circuit network for energizing the normal or reverse switch control relays for the various routes in response to the operation of the buttons at the ends of such routes. This circuit network may be considered as having feed points or ends, one for each signal location, and the operating potentials for the switch control relays are applied at these feed points by the operation of the entrance relays and buttons. The network comprises conducting paths or circuits, conveniently termed route establishing circuits, one for each of the routes, which energizes in series the normal or the reverse switch control relays of all of the switches involved in the corresponding route, rectifiers being included in certain circuit connections between these route establishing circuits, as explained more in detail hereinafter, to avoid the undesired and improper energization of switch control relays that might otherwise occur in a circuit network of this character. Suitable resistances are also included in certain of the route establishing circuits to balance the total resistance in the circuits and cause substantially the same energizing current for each of the various switch control relays. Another characteristic feature of this network is that the energizing circuit for each normal switch control relay includes a back contact of its associated reverse switch control relay, and vice versa, so that the necessary interlock between the route establishing circuits for the different routes is obtained by the interlock between the control relays individual to the switches.

Operation of establishing a route.—Briefly summarizing the general plan or scheme of operation, before explaining the circuits in detail, and assuming for example that the operator wishes to establish a route from A to C (Fig. 1), the manual actuation of the button APB at the entrance end of this desired route causes energization of the corresponding entrance relay ANR and at the same time renders the operation of any other button, such as CPB, ineffective to energize its corresponding entrance relay for the time being and until the equipment assumes its

normal condition. When the button CPB for the exit end of the desired route is actuated, the particular route establishing circuit corresponding with this route A—C is energized, together with the exit relay CXR, assuming that no conflicting route is set up. When the button CPB is released, the prevention means rendering the buttons ineffective to perform an entrance function is restored to normal, and the apparatus is ready for the operation of another button to constitute the entrance end for some other route.

Considering now in detail the circuits and contacts by which this plan of operation is carried out, for convenience corresponding contacts on the buttons, entrance and exit relays, track relays and the like for different routes are given the same reference numbers. Assuming the parts in the normal condition shown, with no conflicting route established, the actuation of the button APB to set up a route originating at the signal location A, causes energization of the lower winding of the entrance relay ANR from the pick-up bus PU over a circuit which may be traced from positive (+), through the back contact 10 of relay SL, upper winding of relay Q, back contact 11 of relay QP, bus PU, through back contact 12 of button APB, back contact 13 of exit relay AXL, lower winding of relay ANR, back contact 14 of relay IAN, back contact 15 of relay IR, front contact 16 of the track relay ATR, back contact 17 of button APB, connection to the cancel bus CNB, and through normally closed contact 18 of cancel key CAN, to (—).

Relay ANR, when thus energized is held up by a stick circuit from (+), through its front contact 20, its upper winding, and contact 16 of the track relay ATR and contact 17 of the push button the same as in its pick-up circuit. When this button APB is released and returns to its normal position, the stick circuit for relay ANR is connected directly to (—) through the front or normally closed contact 17 of this button, the front and back contacts 16 being make-before-break as indicated conventionally, in order that the flow of current through the relay ANR is not interrupted during the movement of the button.

At the same time that current is supplied through the lower winding of the relay ANR, current flows in the upper winding of relay Q, so that this relay Q picks up in series with the relay ANR and at the same time. Relay Q is stuck up temporarily by a stick circuit from (+), through back contact 10 of relay SL, lower winding of relay Q, its front contact 21, and back contact 22 of relay QP. The energization of relay Q and closure of its front contact 23 energizes directly the lower winding of relay QP, which sticks up from (+), through its lower winding, its front contact 24, back contact 25 of relay SL, and contact 26 of cancel key CAN to (—).

This energization of relay QP disconnects at its back contact 11 the supply of current from (+) to the bus PU and connects this bus to (—); and the opening of the back contact 22 of relay QP breaks the stick circuit for relay Q and allows this relay to assume its normally deenergized condition.

In this way, concurrent with the picking up and sticking of the entrance relay ANR, the positive potential is disconnected from the pick-up bus PU, and it is connected to negative potential, so that the operation of any other button on the control panel is ineffective to cause energization

of its associated entrance relay, and this condition persists until restoration of the relay QP, in the manner presently explained.

After the operator has thus defined the entrance point of the desired route A—C under consideration by picking up and sticking the entrance relay ANR, he next operates the button CPB for the exit end of that route. This closes the contact 36 of this button which would otherwise tend to energize the entrance relay CNL from the pick-up bus PU; but this bus is now connected to (—) instead of (+), so that such energization does not occur. The closure of the contact 30 of the button CPB, however, closes and energizes the route establishing circuit for the route A to C, which may be traced from (+), through front contact 31 of relay ANR, normal switch control relay 1AN for the crossover 1, back contact 32 of the reverse switch control relay 1R for the same crossover, a balancing resistance 33, normal control relay 2AN for crossover 2, back contact 34 of reverse control relay 2R, back contact 31 of entrance relay CNL, exit relay CXR, and contact 30 of the button CPB, to (—).

Thus, the two switch control relays 1AN and 2AN for the crossovers 1 and 2 involved in the route A to C are energized in series, together with the exit relay CXR. The energization of this exit relay CXR closes its front contact 35 and establishes a shunt for the contact 30 of the button CPB, thereby holding up CXR over the route establishing circuit after the button CPB is released.

When the exit relay CXR picks up, the bus CM is connected to the bus PU through front contact 13 of the relay CXR, and contact 36 of the button; and since the bus PU is now connected to (—) at the front contact 11 of relay QP, current flows from (+), through the upper winding of relay QP, relay SL, bus CM, to bus PU to (—), thereby energizing relay SL to open its back contact 25 and break the stick circuit holding up relay QP, which is still maintained energized, however, by the flow of current in its upper winding. When the button CPB is released, and its contact 36 opens, the upper winding of relay QP is deenergized and this relay drops before the relay SL, which is slow releasing, can close its back contact 25 and establish the stick circuit for relay QP. When relays QP and SL are thus both deenergized, the parts are restored to the normal condition, with the pick-up bus PU connected to (+), ready for the next operation of a button for the entrance end of another route.

If the operator, instead of desiring to set up a route for train movement from A to C, wishes to move a train from C to A, the button CPB is actuated first and then the button APB, with the result that the entrance relay CNL and the exit relay AXL are energized along with the switch control relays 1AN and 2AN. In this way, the sequence or order in which the same buttons associated with the ends of a route are actuated determines the direction of train movement over that route; and since the same button is used for performing both the entrance and exit functions, rather than different buttons, it is not necessary to provide buttons for entrance and exit purposes which are distinguishable by their shape or method of operation, nor is the operator so likely to make a mistake in his manipulation by actuating an entrance button instead of an exit button, or vice versa.

The operation of establishing other routes for train movement in either direction desired by the actuation of the buttons associated with the ends of the routes is the same as that described for the route between A and C; and similar circuits are involved.

One characteristic feature of the operation of setting up routes in accordance with this invention is that the first button actuated under normal conditions of the system defines the entering end of the route by picking up a corresponding entrance relay; and until an available route originating at such entrance point is actually established by the actuation of the proper exit button and the energization of an exit relay, subsequent operation of other buttons is not effective to perform an entrance function. In other words, a route attempted by the actuation of a button and the energization of its corresponding entrance relay must be completed, or the entrance relay restored to normal in the manner presently to be explained, before the entrance end for some other route can be determined. This provides a check against careless manipulation by the operator in leaving an entrance relay energized without completing a route, and perhaps get an unexpected or unintended route by the subsequent actuation of some other button intended for the entrance end of another route. Suitable indications of proposed or established routes are displayed on the control panel in the manner to be explained later to provide the operator with adequate information with regard to the buttons which have been actuated.

Another feature of the network is that the switch control relays are energized by applying a positive potential to the feed points of the network at one end, the left as shown, and the other negative potential at the other end. Consequently, the current through the N and R switch control relays flows in the same direction for both directions of train movement over a route. This permits the relays to be held up by stick circuits through their upper windings in the manner later explained, and also avoids improper energization of switch control relays by the abnormal operation of buttons for the two entrance ends of routes on parallel tracks, such as the buttons APB and BPB.

Each route establishing circuit, when energized in the manner explained, is maintained energized so long as the corresponding entrance relay is held up, which is until a train enters the route, or the entrance relay is manually restored. In the case of the route A—C, for example, when a train enters the first track section AT of this route (see Fig. 4) and deenergizes the track relay ATR, the stick circuit for the entrance relay ANR is broken at the front contact 16 of this track relay ATR. Consequently, the route establishing circuit is automatically restored by the train, and no special manipulation is required on the part of the operator to break down the route establishing circuit after the train has accepted the signal, in order to be able to set up another route. Although the entrance relay ANR and the exit relay CXR are deenergized by the dropping of the track relay ATR, the switch control relays 1AN and 2AN in the route in question are held in a manner later explained until the train has cleared in turn the track sections AT and CT. This maintains the electric interlocking between the conflicting routes and preventing what may

be termed preconditioning for a route conflicting with a route while that route is occupied.

There may be cases when the entrance relay is energized by mistake for a route not available, or when a route prematurely set up should be cancelled; and the operator should be able to deenergize any entrance relay manually. In accordance with this invention, the operator can deenergize any entrance relay, and also the corresponding route establishing circuit if energized, by operating the cancel key CAN to open its contact 18 and disconnect the cancel bus CNB from negative, and by also simultaneously actuating the button for the entrance relay to be deenergized. For example, if the button APB is operated while the cancel key CAN is in its operated position, the entrance relay ANR is deenergized, since its stick circuit through the normally open contact 17 of the button is broken by the key CAN, and the stick circuit through the normally closed contact 17 of the button is broken by the actuation of the button. It can be seen that this operation will not effect any other entrance relays that may then be energized, since these other relays will be held up by their stick circuits through the normally closed contact 17 of their respective buttons. The operation of the cancel key CAN also opens at its contact 26 the stick circuit for the relay QP, in order that this relay may be deenergized and restore normal conditions if the entrance relay being manually deenergized happens to be one for a route which is not available, so that the exit relay thereof cannot be picked up to drop relay QP and restore normal conditions in the usual way.

Interlock between conflicting routes.—With regard to the desirable interlock between conflicting routes, it will be noted that the route establishing circuit for the route A—C, above traced, includes the back contact 32 of the reverse switch control relay 1R, and also a back contact 34 of the relay 2R; and it will be evident that any route in conflict with the route A to C will necessarily require either the crossover 1 or the crossover 2 to be in the reverse position. If such a conflicting route should be set up, relay 1R or 2R would be energized and open the route establishing circuit for the route A to C. In other words, by thus electrically interlocking the normal and reverse switch control relays for each switch in the circuit network, the desired electric interlock between conflicting routes is obtained in a simple and effective manner. Such interlock does not prevent setting up parallel or non-conflicting routes such as B to D, for example, since the energization of relays 1AN and 2AN for the route A to C will not prevent the energization of relays 1BN, 3N and 2BN for the route B to C, as can be seen by tracing the circuit from the front contact 31 of the entrance relay BNR through relays 1BN, 3N and 2BN, and the exit relay DXR to the contact 30 of the button DPB.

The route establishing circuit above traced for the route A to C includes a compensating or balancing resistance 33, because this circuit includes only two switch control relays 1AN and 2AN, in addition to an exit relay; whereas, some of the other route establishing circuits, such as for the route B—D, include three switch control relays and with the same operating potential for all circuits, it is desirable to employ this compensating resistance 33, so that the same current flows through the switch control relays regardless of the number in series. The same scheme of

including a compensating resistance is employed in other route circuits, as may be required.

Rectifiers in circuit network.—In the track layouts commonly used there are various arrangements of switches and crossovers which provide different routes between the same entrance and exit signal locations. Some of these alternative routes are useful or desirable options to be used as required, and some are abnormal or undesired routes, such as a run-around movement over a pair of crossovers, as illustrated in Fig. 2. Also, from the standpoint of the circuit connections in a network suitable for energizing the normal or reverse switch control relays for the various desirable routes, there are frequently different conducting paths or partial circuits for the flow of current through different switch control relays between common entrance and exit points; and since these circuit paths are in multiple and closed at the same time, there is a tendency to energize simultaneously the switch control relays for the normal or proper route and those for an abnormal or impossible route. Although such multiple circuit paths each include back contacts of relays in the other, and also generally include a different number of relays, so that the relays at these paths are energized with different current intensities, it is desirable to avoid any race or conflict in the energization of the relays for the proper route and for the impossible route.

With these considerations in mind, in accordance with this invention rectifiers, preferably of the well-known copper-oxide type, are employed in the network at the appropriate points to allow the flow of current through the switch control relays for the routes desired, and block the flow of current through the switch control relays for other undesired routes, whether these undesired routes are optional, undesirable run-around movements over crossovers, or are impossible routes.

For example, referring to the track layout of Fig. 1, it can be seen that there are two desirable optional routes between the signal locations A and D, one over the crossover normal and the crossover 2 reverse, and the other over crossover 1 reverse and crossover 2 normal. Either of these routes may be used to advantage under certain conditions. This is a typical instance of useful optional routes; and provision is made as presently described for the manual and automatic selection between these optional routes, a rectifier being employed to block the flow of current through switch control relays that would interfere with such selection.

Referring to the track layout of Fig. 2, which is a typical arrangement of a pair of crossovers frequently found in practice, it can be seen that there are two possible routes between the signal locations L and N, one over the crossovers 7 and 8 in their normal positions, and the other a run-around movement over these crossovers reverse. This run-around movement is one which is not ordinarily used, and there is no need for manual or automatic selection between these alternative routes. This is a typical example of possible but undesired routes which is adapted to the use of rectifiers in the circuit network to prevent the improper energization of such control relays, as later explained more in detail.

There is still another situation with regard to what may be termed impossible routes, that is, routes which a train cannot take, but which may be established by the energization of normal or reverse switch control relays in a circuit network.

Referring to the track layout of Fig. 1, and considering the routes between the signal locations A and E, it can be seen that the circuit connections of the network to provide for the other desired routes terminating at said signal locations gives, in addition to the proper route over crossover 1 and switch 3 reverse, current conducting paths for the energization of switch control relays as if the train could move from A to E over crossover 1 normal, crossover 2 and switch 3 reverse. In other words, the circuit connections shown in Fig. 1 for providing the various desired routes affords a circuit path over relays 1AN, 2R, 2BN, 3N and 1BN in multiple with relay 1R between the feed points in the circuit energized by the actuation of the buttons APB and EPB. This is a typical example of an impossible route which the circuit network tends to establish; and in accordance with this invention, a rectifier 41 is provided and poled in such a direction as to allow the free flow of current through relays 1BN, 3N and 2BN for the route from B to D but block the flow of current through the abnormal circuit path above noted.

Referring to Fig. 2, in which the control circuits for the entrance and exit relays have been omitted for the sake of simplicity, it is evident that this network of Fig. 2 should provide for setting up routes between K and N and between L and M for both directions, but the run-around movement over crossovers 7 and 8 reverse for train movement between L and N should be avoided. For this reason, the rectifier 44 is included in the route establishing circuit between K and M, this rectifier being poled in a direction to permit the flow of current in this circuit; and the connections 45 and 46 for the routes L—M and K—N in the network are made on opposite sides of this rectifier. Thus, the rectifier 44 blocks the flow of current through relays 1R and 8R in multiple with relays 7BN and 8BN when the buttons LPB and NPB are actuated to apply opposing potentials to the feed points for the route between L and N.

The route establishing circuits for the routes between K and N and L and M include rectifiers 47 and 48 so poled that current may flow in these circuits for the desired route, but may not flow through a switch control relay for impossible routes. The rectifier 47 blocks the flow of current through relays 7BN and 8BN and 8R in multiple with the circuit through relay 1R when the route between L and M is set up; and similarly, the rectifier 48 blocks the flow of current in the circuit through relays 1R, 7BN, and 8BN in multiple with the proper path through relay 3R for the route between K and N.

Thus, by the use of rectifiers in the manner exemplified by these typical examples, a network with common feed points for the various routes to energize circuits through the switch control relays in series is provided, without obtaining an improper flow of current through switch control relays for impossible or undesired routes. This reduces the number of contacts required at the feed points or other complications necessary to isolate the circuits or conducting paths for the authorized routes from the impossible or undesired routes.

Optional route control.—In many instances, the track layout provides two or more optional routes between the same signal locations, both of which should be available as circumstances may require. In the track layout shown in Fig. 1, for example, there are two routes from A to D, one

over the crossover 1 normal and the crossover 2 reverse, and the other over crossover 1 reverse, and crossover 2 normal; and under some conditions it may be more expedient to use one of these optional routes, and under other conditions the other route.

In the case of such optional routes, it is proposed to provide an optional route lever ORL which, as it is moved from one position to the other, changes the connections of the circuit network to give a corresponding one of the two optional routes upon actuation of the buttons APB and DPB. In the case assumed, with the optional route lever ORL in the position shown, and an optional route relay ORR controlled thereby deenergized, this circuit network is in condition to set up the route A to D (or D to A) over the crossover 1 normal and the crossover 2 reverse. If the operator actuates APB and DPB, under these conditions, the route establishing circuit is from (+), through front contact 31 of relay ANR, relay 1AN, back contact 32 of relay 1R, resistance 33, back contact 50 of relay ORR, back contact 51 of relay 2AN, relay 2R, back contact 52 of relay 2BN, back contact 31 of relay DNL, relay DXR, and contact 30 of button DPB, to (—). The flow of current over the circuit through relays 1R, 1BN, 3N and 2BN is blocked by the rectifier 42.

The route from A to D over crossover 1 normal and crossover 2 reverse may be considered to be the preferred or superior route, since it would not conflict with the route B to E, which it might be desirable to use for some other train movement while the route A to D is established. If, however, the operator desires to use the inferior route from A to D over crossover 1 reverse, perhaps in anticipation of using the crossover 2 or a part of the superior route for some subsequent train movement (assuming other switches or crossovers not shown are available for such purpose), he can do so by shifting the optional route button ORL from the position shown to the other dotted position, thereby energizing the optional route relay ORR by a circuit from (+), through lever ORL in dotted position, relay ORR, back contact 53 of relay 2R, to (—). Under these conditions, when the buttons APB and DPB are actuated, relays 1R, 3N and 2BN are energized in series by a circuit from (+), front contact 31 of relay ANR, back contact 54 of relay 1AN, relay 1R, back contact 55 of relay 1BN, through the front contact 56 of relay ORR, relay 3N, back contact 57 of relay 2R, relay 2BN, back contact 31 of relay DNL, relay DXR, and contact 30 of button DPB, to (—), while the circuit through relays 1AN and 2R is broken at the back contact 50 of this relay ORR.

The relay ORR is preferably provided with a stick circuit through its own front contact 58 and the front contact 59 of relay 1R, so that it is maintained energized so long as the inferior route establishing circuit is energized, and independently of the optional route lever ORL, so that the operator may not break down such inferior route after it is once established by operating lever ORL by mistake or otherwise. The pick-up circuit for the optional route relay ORR also preferably includes the back contact 53 of the relay 2R, so that if the superior route over the crossover 2 reverse should be set up, and the operator by mistake should move the optional route lever ORL, the relay ORR cannot be operated to break down the superior route established.

In addition to the manual selection between optional routes, typically exemplified by the two alternative or optional routes from A to D, provision is also preferably made to shift automatically from the superior route normally in use to the other inferior route when some route in conflict with the superior route has been established, and the inferior route is the only one possible, this automatic shift avoiding the need for the operator to use the optional route lever ORL under such circumstances. Assume that the crossover 2 in its normal position is included in some route over a switch not shown which is not in conflict with the route from A to D over crossover 1 reverse, so that the superior route from A to D over crossover 2 reverse is not available on account of such conflict, but the inferior route from A to D over crossover 1 reverse is available. Under such conditions, the energization of relay 2AN by the establishing of the conflicting route in question and the closing of its front contact 60 energizes the relay ORR with the lever ORL in the normal position, thereby automatically shifting to the inferior route. The relay ORR, if once thus energized is stuck up through the front contact of relay 1R in this inferior route, independently of the front contact 60 of the relay 2AN, so that this inferior route is maintained even after the conflict in question ceases.

The optional route relay ORR is thus energized at the time a route is established on the upper track over the cross over 2 normal, on the assumption that this represents a condition where a route in conflict with the superior route exists and yet the inferior route is available; but unless the inferior route is set up to energize relay 1R, the optional route relay ORR drops back to its normal position when relay 2AN drops, and the superior route will then be the one subsequently obtained by the actuation of the buttons APB and DPB.

Double signal locations.—In some instances in the various arrangements of track switches and signals encountered in practice, there may be two signals opposite one another at a signal location governing train movement in opposite directions; and such a signal location may constitute both an entrance point and an exit point for train movement in opposite directions.

In accordance with this invention, a special arrangement of relays and circuits is provided for such a signal location, in order that the same button may be employed to perform both the entrance and exit functions for both directions, although separate buttons may be used if desired. Such an arrangement is illustrated for the signal location C and its push button CPB in Fig. 5A. There is an entrance relay CNL for train movement to the left, and an entrance relay CNR for train movement to the right. Similarly, there are exit relays CXR and CXL for train movement to the signal location C from the right and from the left respectively.

If the operator sets up a route from A to C, the exit relay CXR is energized in the same manner previously explained upon actuation of the button CPB to close its contact 30a. In a similar way, if the operator sets up a route from F to C, the exit relay CXL is energized through the contact 30b of the button CPB. In other words, if the signal location C is used as an exit point, some other button A or F will have been previously operated, and the operation resulting from the actuation of the button CPB is similar

to that already explained, the possibility of the button CPB causing energization of an entrance relay CNL or CNR being prevented by the prevention means in the same way already described.

When, however, the button CPB at the double signal location C is actuated to define the entrance point of a route, there are other operating conditions to be considered; and additional contacts are provided in the circuits to take care of the different contingencies. Assume, for instance, that the operator sets up the route from A to C for the movement of a train, and later wishes to advance this train over some other route from C, say to F. Under these conditions, the switch control relay 2AN is energized, and at the time the button CPB is operated, the pick-up bus PU is energized with positive potential, and the entrance relay CNR is energized over a circuit from the bus PU, back contact 61 of entrance relay CNL, contact 12b of the button, back contact 13 of relay CXL, front contact 62 of relay 2AN, lower winding of relay CNR, wire 63, back contact 14 of relay 5AN, wire 64 through front contact 16 of track relay FTR, and contact 17 of the button to (—). The other entrance relay CNL is not energized under these conditions because its pick-up circuit is broken at the back contact 14 of the relay 2AN and also the front contact 62 of relay 5AN.

When the button CPB, having been previously used to perform an exit function, is thus actuated for the second time for performing the entrance function for a new route, it can be seen that the exit relay CXR is already energized at the second time the button is actuated by reason of the first actuation of the button CPB for the route from A to C. To prevent the energization of relays QP and SL that would otherwise occur, the connection between the contact 12a of the button and the bus PU includes the back contact 61 of the entrance relay CNR. Consequently, when this relay CNR picks up upon the second operation of the button CPB, the connection between the bus CM and the bus PU is broken before there is time to energize relays Q, QP and SL, and restore the prevention means to the normal condition, thereby leaving the bus PU energized with the negative potential to prevent energization of an entrance relay by the subsequent operation of another button.

Under ordinary operating conditions, a route leading up to a double signal location, such as C, is necessarily established before and at the time the corresponding button CPB is actuated for the purpose of setting up some other route leading away from said signal location; and a switch control relay, such as relay 2AN, in the established route is energized to close its contact 62 in the pick-up circuit for the proper entrance relay CNR, and open its back contact 14 in the energizing circuit for the other entrance relay. In this way, the successive operations of the same button CPB at a double signal location perform the desired entrance and exit functions.

In connection with this control of the energizing circuits for the entrance relays at a double signal location, it can be seen that in the case of the location C the track layout is such that the crossover 2 must be normal and relay 2AN energized for any route leading to the location C from the left; and similarly the crossover 5 must be normal and its relay 5AN energized for any route leading to the signal location C from the right. In other cases, as for example, at the

signal location F in Fig. 5B, the track layout may be such that a crossover may be in either position for a route terminating at such location; and in this case the contacts of both the normal and reverse switch control relays of the adjacent crossovers are included in the energizing circuits for the entrance relays. For example, the pick-up circuit for the entrance relay FNL includes in multiple front contacts 62 and 62a of the relays 6AN and 6R, since the crossover 6 may be either in the normal or reverse position for train movement toward the signal location F. Similarly, the pick-up circuit for this entrance relay FNL includes in series back contacts 14 and 15 of the relays 5AN and 5R.

The control of the entrance relays at a double signal location is such that the operator may make a switching movement as well as a straight through train movement. For example, assume the operator wishes to advance a train from C to F and then back from F to D. The first actuation of the button FPB, following operation of the button CPB, establishes the route from C to F, energizing the relay 5AN and exit relay FXR, but neither entrance relay is energized at this time while the button FPB is operated, because the bus PU is connected to the negative potential until the button is released to allow relay QP to drop, as previously explained. In order to advance the train beyond the signal location F for the switching movement under consideration, button FPB is operated a second time and followed by operation of button HPB. When the button FPB is thus actuated the second time, the bus PU is connected to positive potential, and relay 5AN being energized, the entrance relay FNR is energized by a circuit similar to that previously described for the energization of entrance relay CNR; and upon actuation of the button HPB the route F—H is established and the right-hand signal at F cleared for the train to move. In this connection, it should be understood that the relay 5AN is stuck up while the train is in the route C—F by the operation of the relays and circuits illustrated in Fig. 10 and later explained. When the train passes the signal F, the entrance relay FNR is deenergized by the dropping of the track relay HTR, but the switch control relay 6AN is stuck up. When the train clears the route C—F, relay 5AN drops; and when under these conditions the button FPB is again actuated, the entrance relay FNL is energized, relay 5AN being down to close its back contact 14, and relay 6AN being energized to close its front contact 62. When the button DPB is subsequently operated for the desired switching movement, the route F to D is set up in the usual way, the left-hand signal at F clears, and the train may complete the desired switching movement.

If the operator should for any reason happen to operate the button CPB at a double signal location without having set up previously a route leading toward that location, neither entrance relay CNL or CNR is energized, because their respective pick-up circuits are broken at the open front contact 62 of the switch control relays 2AN and 5AN. In other words, an abnormal or improper actuation of a button at a double signal location, prior to establishing a route for train movement up to that location, is an ineffective and idle manual operation, which does not produce any undesired control in its relays.

Through route operation.—There are fre-

quently situations in the various track layouts encountered in practice where through routes from one signal location past one or more other intermediate signal locations should be established for a through train movement; and while the operator can at any time set up routes through the track layout to any extent desired by operating in succession the buttons at the ends of the separate stretches or portions of track between adjacent signal locations, it is desirable to enable the operator to be able to establish such through routes past one or more signal locations by actuating only the buttons at the extreme ends of such through route. It is considered that the need for such through route manipulation is ordinarily confined to certain parts of the complete track layout, such as the through main tracks, or tracks into and out of station platforms, and similar situations; and since the facility for through route operation is provided to reduce the number of manual actuations required of an operator, and is unnecessary unless the through route is commonly used, it is proposed in accordance with this invention to provide for through route operation for only such signal locations as desired by means of a separate circuit organization, including a through route relay for the intermediate signal location or locations in the desired through route.

The principles and mode of operation of the means for providing for through route operation are exemplified for the upper track in Figs. 5A and 5B, where through routes A—F, A—H, or C—H may be set up at will by the operator, while at the same time permitting him to establish the routes A—C, C—F, and F—H, individually at any time. For this purpose, through route relays CTHR and FTHR are provided for the intermediate signal location C and F, and these through route relays are energized by the actuation of the buttons at the extreme ends of the through routes and produce at their respective intermediate signal locations the same controlling effect upon the route establishing circuit network as if their corresponding buttons CPB and FPB had been operated in conjunction with the buttons at the entrance ends of the through route. These through route relays are of the usual neutral-polar type, and are energized for opposite polarities for opposite directions of train movement.

As a typical example of such through route operation, assume that the operator desires to set up a through route from A to F past the intermediate double signal location C. He first operates the button APB to pick up the entrance relay ANR, and then the button FPB; and assuming the parts in the normal condition with no conflicting routes established, the through route relays CTHR is energized by a circuit which may be traced from (+), contact 65 of button FPB, back contact 66 of exit relay FXR, back contact 67 of entrance relay FNL, wire 68, back contact 69 of exit relay CXL, back contact 70 of exit relay CXR, relay CTHR, back contacts 71 and 72 of relays 2R and 1R, and front contact 67 of entrance relay ANR, to (—).

In this way, the through route relay CTHR is energized with one polarity assumed to position its polar contacts to the left. The closing of the front contact 74 of this relay CTHR shunts the back contacts 69 and 70 of the exit relays CXL and CXR, so that said relay CTHR may be maintained energized independently of the ener-

gization of these exit relays. The closure of the front contact 75 and polar contact 76 of the relay CTHR establishes a by-pass or shunt around the contact 30a of the button CPB, thereby closing the route establishing circuit for route A to C, the same as if the button CPB were manually actuated subsequent to the actuation of button APB. Relay CTHR also closes its front contact 77; and when the exit relay CXR picks up, the positive potential applied to the CM bus through the upper winding of relays QP in series with the relay SL causes current to flow through the front contact 13 of relay CXR, front contact 77 of relay CTHR, and back contact 13 of relay CXL, through the energizing circuit for the entrance relay CNR previously described.

In this way, the entrance relay CNR is energized, and the button FPB being held down, the route establishing circuit for the route C to F, and including the exit relay FXR, is energized in the same manner previously explained. The energization of the exit relay FXR opens at its back contact 66 the energizing circuit for the through route relay CTHR, thereby causing that relay to assume its normal deenergized condition, and when the button FPB is released, the flow of current through relays QP and SL ceases, whereupon the relay QP drops and applies the positive potential to the pick-up bus PU, ready for the next operation.

The operation for establishing a through route in the other direction from F to A is similar to that just described. In this case, the entrance relay FNL is energized, and when the button APB is actuated to close its contact 65, the through route relay CTHR is energized with the other polarity, thereby shunting by its neutral contact 78 and polar contact 79 the contact 30b of the button CPB to pick up the exit relay CXL, which in turn causes energization of the entrance relay CNL, in the same manner as described, in turn governing the energization of the route establishing circuit network with button APB actuated to set up the route C—A.

The same plan of operation may be employed for establishing through routes past two or more intermediate signal locations by arranging the circuits to provide for the energization of the through route relays at such locations upon actuation of the buttons at the extreme ends. Assume, for instance, that the operator desires to set up a through route from A to H past the intermediate signal locations C and F. In this case, the through route relay CTHR is energized by a circuit from (+), through the contact 65 of button HPB, back contact 66 of relay HXR, back contact 67 of entrance relay HNL, back contact 80 of relay 6R, wire 81, normally closed contact 65 of button FPB, back contact 66 of exit relay FXR, and thence over the same circuit previously traced through contact 67 of entrance relay ANR, to (-). The through route relay FTHR at the signal location F is at the same time energized in multiple with relay CTHR over a circuit starting at wire 81, through back contacts 69 and 70 of exit relays FXL and FXR, relay FTHR, back contact 82 of relay 5R, wire 83, back contact 67 of entrance relay CNR, back contact 66 of exit relay CXL, normally closed contact 65 of button CPB, and thence along the same circuit path previously traced to (-) through the contact 67 of the entrance relay ANR. The energization of relay FTHR closes its neutral contact 75 and shifts its polar contact 76 to the left, thereby shunting the contact 30a

of the button FPB, and permitting the establishing of the route C—F the same as if button FPB had been actuated; and this is followed by the energization of the entrance relays FNR in the same manner previously explained for the energization of entrance relay CNR, whereupon the route F—H is set up.

It can also be seen that actuation of the buttons CPB and HPB will cause energization of the through route relay FTHR and enable through routes C—H or H—C to be established in accordance with the same plan of operation for the through routes A—F and F—A. It is contemplated that the same organization of circuits and plan of operation will be provided for the lower track in Figs. 5A and 5B, or for such through routes from one track to the other, as may be desired.

It is evident that such through route operation should be prevented when a part of the route has been individually established. For example, if the operator has set up the route A—C, and then actuates button FPB for the purpose of setting up routes F—D, F—H or F—I, the through route relay CTHR should not be energized in such a case, otherwise the route C—F might be set up contrary to the wishes of the operator. For this reason, the back contacts 69 and 70 of the exit relays CXR and CXL are included in the initial energizing circuit for the relay CTHR; and in the case just stated, relay CTHR is not energized by actuation of button FPB with the entrance relay ANR up, because exit relay CXR is up on account of the established route A—C. In other words, if the intermediate signal location such as C, constitutes the exit point of a route already established, and the exit relay CXR and CXL for such location is energized, the through route relay CTHR cannot be energized.

The energizing circuits for the through route relays also preferably include back contacts of certain switch control relays. For example, the energizing circuit for CTHR includes the back contacts 71 and 72 of the switch control relays 1R and 2R. If any route is established in conflict with the route A—C, either relay 1R or 2R is energized, since any such conflicting route must be over crossover 1 or the crossover 2 reverse; and under these conditions no through route operation is possible and relay CTHR should not be energized.

Switch control.—Having explained the operation of the apparatus and equipment in the control office to provide for setting up any desired route through the track layout by operation of the buttons at the ends of such routes, insofar as involves the energization of the switch control relays, and the entrance and exit relays, consideration may now be given to the way in which these relays control the operation of their associated track switches and the clearing of the signals.

Fig. 3 illustrates in a simplified and diagrammatic manner one suitable organization of circuits for governing the operation of a switch machine by its associated normal and reverse switch control relays 1N and 1R; and it is contemplated that the same circuit organization will be employed for controlling the various other switch machines operating single switches or cross-overs in the complete track layout.

The switch machine for operating the locking and switch points 1TS is assumed to be of the typical well-known construction, and comprises the usual motor M and cut-off contacts 90, with

suitable point detector contacts (not shown) for operating the switch repeater or position indicating relay IWP. The operating circuits for the switch machine motor are controlled by normal and reverse relays IWN and IWR; and the application of power to the switch machine, and the energization of the relays IWN and IWR is subject to a lock stick relay ILS, controlled by the detector track relay ATR and a lock relay IL. It is contemplated and assumed that the lock relay IL will form a part of a circuit organization suitable for providing the desired approach and rear release route locking, such as disclosed for example in the patent to O. H. Dicke, No. 2,045,900, June 30, 1936. Such approach and route locking circuits, with the necessary track circuit and time element release, form no part of the present invention; and while it should be understood that a suitable means of this character is to be employed, such locking means for the switch may take any suitable form, and has not been illustrated.

The operation of the switch machine is primarily controlled by a neutral-polar relay IWZ, which in turn is governed in a suitable manner by the corresponding switch control relays IN and IR of the route establishing circuit network. In the simplified arrangement shown in Fig. 3, it is assumed that the relay IWZ is directly controlled over a line circuit by the relays IN and IR.

As a typical example of the operation of the switch control circuits of Fig. 3, assume that the switch points are to be operated from the normal position shown to the reverse position. If the detector track section is not occupied, or the lock relay IL deenergized, so that the switch machine may be properly operated, the lock stick relay ILS is energized by a circuit from (+), through back contact 91 of relay IWZ, front contact 92 of track relay ATR, front contact 93 of relay IL, relay ILS, to (-). The switch repeater relay IWP is also energized to position its polar contacts to the right. When the switch control relay IR is energized to reverse the switch, relay IWZ is energized from one terminal (B-) of a split battery to back contact 94 of relay IN, front contact 95 of relay IR, line wire 96, relay IWZ to (CN), indicating the mid-tap of such a battery. This energization of the relay IWZ closes its neutral front contacts and positions its polar contact to the left. Since the polar contact 97 moves to the left-hand position before the neutral contact 91 opens its back contact in the pick-up circuit for relay ILS, the correspondence relay INCR is not even momentarily energized, and the lock stick relay ILS is held up by its stick circuit through its front contact 98 and the back contacts 99, 100 of the correspondence relays INCR and IRCR. With the lock stick relay ILS energized and its front contact 101 closed, the energization of relay IWZ establishes an energizing circuit for relay IWR through front contact 102 of relay IWZ and its polar contact 103 to the left. This operation of the relay IWR closes the reverse operating circuit for the switch machine motor, and causes the switch machine to operate to its reverse position in the well known manner. In this connection, it will be noted that the operating circuits for the switch machine motor include front contacts 104 and 105 of lock stick relay ILS, so that no power can be applied to the switch machine when this lock stick relay is deenergized.

When the switch machine assumes its over and locked reverse position, the contacts 90 shift and

open the motor circuit; and the relay IWP is energized with its polar contact 107 to the left. This establishes an energizing circuit for the correspondence relay IRCR through front contact 106 of relay IWP, its polar contact 107 to the left, relay IRCR, polar contact 97 of relay IWZ to the left, and neutral contact 91 of this relay. The resultant energization of the correspondence relay IRCR breaks at its back contact 99 the stick circuit for the lock stick relay ILS, and its pick-up circuit being broken at the back contact 91 of relay IWZ, this lock stick relay drops to cut off power from the switch machine, to deenergize relays IWN and IWR, and further close contacts of the signal clearing circuit later to be explained. In other words, when the switch machine completes its intended cycle of operation, the lock stick relay ILS is deenergized to prevent operation of the switch to the other position; and this desired locking of the switch occurs before a signal can be cleared for train movement over the switch.

In connection with the display of indications on the control panel, as later described, it is desirable to indicate the position and locked condition of each switch or crossover of the track layout in the control office; and in the simplified arrangement shown in Fig. 3, the relay IWP controls the energization of repeater relays IWNP and IWRP in the control office over line circuits by the closing of the neutral and polar contacts 108 and 109 of this relay IWP.

There may be occasions where it is desirable for the operator to cause the power operation of a switch from one position to the other, without clearing a signal. For example, it may be expedient to move a switch back and forth to clear it of an obstruction, to keep it clear of snow, to facilitate maintenance or repair, or the like. Accordingly, auxiliary or emergency individual switch levers SML are preferably provided on the control panel for governing the energization of the corresponding relay WZ, independently of the switch control relays N and R of the route establishing circuit network. Fig. 3 illustrates how such an auxiliary switch lever ISML is preferably connected through the back contacts 110 and 95 of relays IN and IR to the control circuit for relay IWZ, movement of this lever to one extreme position or the other energizing the relay IWZ with currents of opposite polarities to cause corresponding operation of the switch machine. It will be noted that this auxiliary lever ISML is not effective unless the corresponding switch control relays IN and IR are both deenergized. In other words, if a route has been established by an entrance-exit operation, careless or accidental movement by the operator of the auxiliary switch lever for any of the switches involved in that route will not break down this route.

Signal control.—It is contemplated that the signals, governing train movement over the various routes and shown diagrammatically in the accompanying drawings, will be multiple aspect semaphore or color-light signals of the type commonly used in interlocking practice, and will be provided with suitable control circuits in accordance with established practice to give the desired indications. In the various forms of signal control circuit organizations suitable for governing train movement over the various routes of a track layout in accordance with this invention, there is usually a relay or relays for each signal which constitutes the primary controlling agency to cause that signal to display the appropriate

proceed indications; and Figs. 3 and 4 illustrate one typical arrangement of circuits for controlling such a relay by the entrance and exit relays of the route establishing circuit network of this invention, the detail control circuits for the signals to provide the necessary caution, low or high speed, or call-on indications being assumed to be of the usual type and being omitted in the interests of simplicity.

Referring to Fig. 3, the energization of the entrance and exit relays, such as ANR and AXR, for each signal governs the energization of a neutral-polar signal control relay AGZ over a direct or unit-wire connection 111, or the like, as will be apparent from the drawings. Fig. 4 shows how these signal control relays GZ, in co-operation with the track relays, switch correspondence relays, and lock stick relays, operate to govern the energization of the corresponding signal clearing relay GHR. It would appear to be unnecessary to trace and explain the circuits for all of the various signals and routes, since these are organized on the same plan, and an explanation of these circuits for the control route is typical of all of the others.

Referring to Fig. 4, and considering the route between A and C, when this route is set up in the control office by the energization of the entrance relays ANR and the exit relay CXR, the energization of the relay ANR causes energization of the corresponding relay AGZ (see Fig. 3) to position its polar contact 115 to the right, and similarly the energization of relay CXR operates the polar contact 115 of its associated relay CGZ to the left. Under these conditions, and assuming the track sections AT and CT unoccupied, the crossovers 1 and 2 in the normal position, and the lock stick relays 1LS and 2LS for these crossovers deenergized, the circuit to energize the signal clearing relay AGHR for causing the associated signal AG to display a suitable proceed indication may be traced from (+), relay AGHR, polar contact 115 of relay AGZ to the right, its neutral contact 116, contact 117 of track relay ATR, front contact 118 of the normal correspondence relay 1NCR for the crossover 1, back contact 119 of lock stick relay 1LS, front contact 120 of track relay CTR, back contact 121 of lock stick relay 2LS, front contact 122 of normal correspondence relay 2NCR, front neutral contact 116 of relay CGZ, and its polar contact 115 to the left, to (-).

If the same route between C and A is established by energization of the entrance relay CNL and the exit relay AXL, the relay CGHR for the signal C is energized by a circuit similar to the one just traced through the polar contact 115 of relay CGZ to the right and the polar contact 115 of relay AGZ to the left. The circuits for governing the clearing of the other signals for other routes are similar to those just described, and need not be individually discussed.

This arrangement of circuits utilizes the same contacts on the switch correspondence relays, track relays, and lock relays for the various routes in such a way as to reduce the number of relays and contacts required to obtain the necessary selection of the signal control circuits for opposite directions of train movement and for the different positions of the switches.

Display of indications.—The desired visual indications on the control panel for the information of the operator may be displayed in various ways; but in the interests of simplicity and economy in space on the control panel, these indications are

preferably displayed by lighting various miniature lamps as illustrated diagrammatically in Figs. 6 to 10.

In connection with these indications, since the buttons by which the switches and signals are governed for the various routes are self-restoring and do not show by their position what routes have been attempted or completed, it is important in the entrance-exit type of system characterizing this invention to provide on the track diagram suitable indications to show the routes attempted and established, together with suitable indications of the operated position of the track switches and track occupancy, in order that the operator may have adequate information to guide him in his manipulation; and for this purpose various miniature lamps are provided on the track diagram and controlled by an organization of circuits shown in Figs. 9 and 10 to visually display this indication in an effective and arresting manner which the operator can easily understand and interpret.

Referring to Figs. 7 and 8, which are fragmentary sections illustrating certain constructional features of the control panel and visual indicating means, the panel preferably comprises a metal supporting plate 125 with holes therein to receive the push buttons APB, BPB, etc., and at the various points where the indicating lamps should be located to conform with the particular track layout. The lines of the track are represented on the panel by strips or bars of glass 126 and adjoining spacers or connecting pieces 127 of a suitable opaque material, which are preferably held in place on the face of the metal plate 125 (see Fig. 8) by blocks or strips 128 of the appropriate shape fastened to the panel plate by screws 129 or the like, the edges of the glass strips 126 and adjoining spacer pieces 127 being preferably beveled as shown and provided with a yieldable gasket 130 of suitable material.

Behind each of the glass strips 126 is secured a lamp socket 131 comprising a cylindrical shaped housing of a suitable moulded plastic material, fiber, or the like, which carries contact springs 132, with the ends thereof constituting soldering tips for attaching wires, with which the base of a miniature lamp 133 of the usual type and construction engages. This socket 131 is formed with a base having a detachable bayonet-type connection with ears or flanges of a ring 134 fastened to the back of the metal plate, preferably by spot welding as indicated at 135.

The glass strips 126 are preferably made of a kind of glass, as for example the kind known commercially as Pyrex, characterized by a high degree of internal reflection from its surfaces; and the lower face of the strip is ridged or roughened preferably by sand blasting, so as to break up this internal reflection, so to speak, and give the whole glass strips the effect of a lighted strip or streak when the lamp 133 is lighted.

The various glass strips 126 are of such length and arranged with their adjoining spacer pieces 127 in accordance with the track layout, as shown in Figs. 6 for the same track layout of Figs. 1 and 4, so that there is a bar or strip, such as AK, adjacent each signal location, other bars or strips such as 1ANK and 1RK for the normal and the reverse position of each switch or crossover, and other intermediate bars, such as XK, for such portions of track between the switches necessary to give the effect of a substantially continuous line or streak of light. The

construction of all these strips, such as AK, IANK and XK is as discussed in connection with Figs. 7 and 8, while the control of the lamps is shown in Figs. 9 and 10.

The lighting circuits for the various lamps are controlled by directional stick or indication control relays, such as AES and AWS, two for each track section and one for each direction of train movement; by the track relays of the track sections; and by the relays, such as IWNP and IWRP of Fig. 3, controlled in accordance with the position and locked condition of each switch or crossover.

For indications of the condition of the signals, the conventional symbols of these signals on the track diagram are preferably provided with bull's-eye lamps, such as AGK, which are controlled by the associated entrance relay ANR, and the signal indication relay AGKR repeating the corresponding signal clearing relay AGHR as shown in Fig. 3.

The various lamps, in addition to being lighted or extinguished, are arranged to be intermittently lighted, preferably with a variable intensity so as to be alternately dim and bright, for the purpose of giving an additional distinctive visual indication under different operating conditions as will later be described in detail. A flashing bus FB is provided for the whole control panel, and this bus is intermittently energized with different potentials by a cam device 133 operated continuously by a suitable electric motor 139 or the like, this cam operating a contact 140 to connect the bus FB to different portions of the secondary of a lighting transformer 141. The flashing bus FB may be intermittently energized and wholly de-energized, if desired; but it is preferred to vary the lighting voltage to cause the lamp or lamps connected to such flashing bus to be alternately bright and dim or pulse at a relatively slow rate.

Considering the general plan of operation of the indication display arrangement, when the operator actuates a button, say APB, and the corresponding entrance relay ANR is energized to define the entrance end of a proposed route, the signal indication lamp AGK alone is intermittently lighted brightly and dimly to give a flashing indication, which shows that a button for the corresponding signal location has been operated. When another button, say the button CPB, is actuated by the operator for the exit end of an available route, and the route establishing circuit energizes the corresponding switch control relays IAN and 2AN, as previously described, certain track circuit controlled directional stick relays, such as AES and CES, for each of the track circuits involved in this route are energized, and steadily light lamps AK and CK at the ends of this route and any intermediate lamp XK, thus marking out or outlining the proposed route independently of the switch positions. When the switches involved assume the required positions, the indicating lamps IANK and 2ANK for these switches are steadily lighted. When the signal clears, the flashing or pulsing of the signal indicating lamp AGK changes to a steady light.

In this way, the desired route is outlined by bands or streaks of steady light as soon as the controlling condition for establishing that route is set up with a flashing indication at the entrance to the route, and the whole route is lighted up by a substantially continuous strip of steady light as soon as all of the switches in that route

have operated to the required position and the signal at the entrance to the route has cleared. A switch in the route, which does not operate to the normal or reverse position required, leaves a blank or dark space in the strip lighting of the route; and this enables the operator to tell readily what particular switch, if any, fails to operate for the intended route. Any signal indicator, such as lamp AGK, continues to flash instead of changing to a steady lamp so long as a switch fails to operate or for some other cause the route fails to be set up so that the signal at the entrance to the route cannot clear.

This visual indicating arrangement provides the operator with the important and desirable information he needs for efficient manipulation of the control board. Whenever he operates a button to define the entrance end of a route, there is a flashing indication informing him of this manipulation; and if the actuation of the button was premature or erroneous, he is reminded by this flashing light that the entrance relay at the corresponding signal location should be de-energized or cancelled, in the manner previously explained, before proceeding further in the manipulation of the buttons. The entrance and exit ends of a proposed route are shown up by lighting the lamps, such as AK and CK, and this effectively tells the operator what routes have been attempted, and what manipulation consistent therewith can be made. In this connection, it is evident that the lighting up of a route as a substantially continuous streak or strip of light makes it easy for the operator to avoid any attempt to get any conflicting route, since buttons on the same side of such lighted strip may be operated, but not buttons on opposite sides for the ends of a route which crosses or conflicts with the one established.

With regard to the indication of track occupancy, when a train enters an established route say from A to C, the entrance relay ANR is automatically de-energized and the signal indicating lamp AGK extinguished, and also the lighting of the strips AK and IANK constituting the track circuit occupied by the train are changed from a steady to a flashing light. When the train leaves the detector track section, the lamps AK and IANK are extinguished. Thus, the portion of track occupied by a train is shown by a flashing indication, and an unoccupied section is dark.

The relays, such as AES and CES, controlling the lamps of the route are controlled in such a manner, later to be explained, so that the route ahead of the train is maintained steadily lighted. In other words, the portion of an established route ahead of the train is maintained lighted to show what non-conflicting routes may be set up, but is dark behind the train. This enables the operator to take advantage of the sectional rear release of the route locking. For example, if the route A to C is set up, a conflicting route A to D or A to E may be established as soon as the train has cleared the detector locking section for the crossover I; and the operator is informed when this is possible by the change in the flashing indication for this track section to a dark indication.

Operation of indication display.—Considering now the organization of circuits by which this desired control of the indicating lamps is obtained, the parts and circuits for lighting the lamps are shown in Fig. 9, and the circuits for the control of the east and west directional stick relays involved in this control of the lamps are

shown in Fig. 10. These various circuits represent repetition or duplication of the same principles and plan of control, and a discussion of the operation for typical examples will be sufficient to make clear the principles and mode of operation of the invention without discussing and describing the circuits in detail for all of the various routes.

As a typical example, assume that the operator sets up the route from A to C. When the entrance relay ANR is energized, the signal indicating lamp AGK is connected to the flash bus FB through a front contact 150 of relay ANR and a back contact 151 of the signal indicating relay AGKR. When the button CPB for the exit end of the route in question is actuated, the switch control relays 1AN and 2AN are energized in the manner previously explained. Referring to Fig. 10, the energization of relay 1AN establishes a pick-up circuit for the east stick relay AES for track section AT from (+), through front contact 152 of entrance relay ANR, front contact 153 of relay 1AN, through relay AES to (-). The energization of relay AES closes a pick-up circuit for the east stick relay CES for the track section CT from (+), through front contact 154 of relay AES, front contact 155 of relay 1AN, relay CES to (-).

Referring to Fig. 9, the energization of relay AES lights the indicating lamp AK from (BX), through front contact 156 of track relay ATR, front contact 157 of relay AES, lamp AK to (CX). Also, with relay 1AN energized, if the crossover 1 is in the normal position, or as soon as it assumes that position, current is supplied through front contact 158 of 1AN and front contact 159 of relay 1WNP to the lamp 1ANK. The energization of relay CES closes a circuit through front contact 160 of track relay CTR, front contact 161 of relay CES to light the lamp XK; and relay 2AN being energized, its front contact 162 is closed to light lamp CK; and if and when the crossover 2 assumes its normal position, the lamp 2ANK is lighted through the front contact 163 of relay 2WNP. When relay AGHR (see Fig. 3) is energized to clear the signal AG, the relay AGKR is energized and this disconnects the lighting circuit for the signal indicating lamp AGK from the flash bus FB to a steady potential through the front contact 151 of relay AGKR.

When the train passes the signal AG and enters the track section AT, its front contact 16 (see Fig. 1) opens the stick circuit for the entrance relay ANR, which drops and extinguishes the signal indicating lamp AGK; but before this occurs the back contact 166 of the track relay ATR is closed (see Fig. 10) and establishes a stick circuit for relay AES readily traced on the drawings which holds up this relay and also the relay CES. The back contact 156 of the track relay ATR, (see Fig. 9) connects the flash bus FB to the lighting circuit for lamps AK and 1ANK, so that these lamps are pulsed to indicate the presence of a train, while the lamps XK, 2ANK and CK for the route in advance of the train are still steadily energized.

Also, although the entrance relay ANR is thus deenergized by the entrance of a train, and the route establishing circuit through the lower windings of relays 1AN and 2AN (see Fig. 1) is broken, these relays are maintained energized by stick circuits through their upper windings controlled by the relays AES and CES as shown in Fig. 10. The stick circuit for relay 1AN may be traced through front contact 167 of relay AES,

front contact 168 of relay 1AN through its upper winding to negative; and similarly the stick circuit through the upper winding of relay 2AN is closed by the front contact 169 of the relay CES. This serves to maintain the electric interlock between conflicting routes, and also renders the actuation of the buttons APB or CPB ineffective to pick up corresponding entrance relays, as previously explained.

When the train advances through the route A—C under consideration into the track section CT, a stick circuit for relay CES through the back contact 171 of its track relay CTR and a front contact 172 of the relay CES is established as shown in Fig. 10; and at the same time the contact 160 of this track relay CTR connects the lighting circuits for the lamps XK, 2ANK and CK to flashing bus FB as shown in Fig. 9, thereby indicating that the train has advanced into this track section. When the train leaves the track section AT, the relay AES drops, since its pick up circuit is open at the front contact 152 of the entrance relay ANR now deenergized, and its stick circuit is open at the back contact 166 of the track relay ATR. This opens the lighting circuits for lamps AK and 1ANK shown in Fig. 9 and puts out these lamps, and also opens the stick circuit for relay 1AN shown in Fig. 10. This change in indication informs the operator that another route, such as A—D may be set up, and the dropping of relay 1AN renders ineffective the electric locking between the route establishing circuits to permit setting up another route such as A—D.

When the train leaves the track section CT, relay CES drops, extinguishes the lamps for this portion of the route, and releases relay 2AN to permit setting up another route.

For train movement in the other direction over the route from C to A, the operation is similar to that described for train movement from A to C. In this case, the button CPB is operated first and the entrance relay CGK is lighted and flashed to define C as the entering point of the proposed route. When relays 1AN and 2AN pick up to establish this route, the west stick relay CWS for the track section CT is energized by a circuit similar to the one already described for relay AES and readily traced on Fig. 10, and this relay CWS in turn energizes a west stick relay AWS for the track section AT, as can be readily seen in Fig. 10. The lamps defining the route from A to C are lighted in the same manner described; and as a train passes through this route, the flashing indication of track occupancy is provided, and relays CWS and AWS are de-energized in turn as this train clears their respective track sections.

In the case of the signal location A and D, there are two alternative or optional routes; and since one or the other may result from the actuation of the buttons APB and DPB, dependent upon the position of the optional route lever ORL or the automatic selection between the optional routes previously explained, the circuits of Figs. 9 and 10 are arranged to provide the proper indications for both of these optional routes. If the route from A to D is over crossover 1 normal and crossover 2 reverse, the switch control relays 1AN and 2R are the ones which are energized. Relays AES and CES pick up, the same as before explained, but relay 2R being energized, the picking up of the relay CES energizes through its front contact 173 the east stick DES for the track section DTR, as well as the relay CES. Under these conditions, lamps

AK, XK, and DK are lighted to mark out the route, and lamps 1ANK and 2RK are lighted when the crossovers 1 and 2 are in the normal and reverse positions respectively.

If the other optional route is established from A to D over crossover 1 reverse, switch 3 and crossover 2 normal, relay AES is energized the same as before, but relay 1R being energized and relay 1AN de-energized, the relay BES is picked up through the front contacts 155 and 174 of these relays respectively; and with relays 3N and 2BN picked up, the relay DES is energized through the front contact 175 of relay BES, front contact 176 of relay 3N, front contact 177 of relay 2BN, and back contact 173 of relay 2R. Under these conditions, the lamp AK is energized by relay EAS, the lamp YK by energization of relay BES, and the lamp DK by energization of the relay DES, so that the route is marked out; and when the switches assume the required positions, the lamps 1RK, 3NK, and 2BNK are lighted by circuits which can be readily traced on Fig. 9 to complete the strip lighting of the route.

In the case of the optional routes between A and D above mentioned, and also in the case of routes between A and E, three of the directional stick relays, such as DES, are energized one by another in turn, and are dropped in succession by the movement of a train through the route.

In connection with the auxiliary or emergency switch levers hereinbefore discussed, when any one of these levers, such as 1SML, is moved from its middle or inactive position to either the normal or reverse position, operating potential is applied to the lighting circuits for the corresponding indicating lamps 1ANK and 1RK, as can be readily seen in Fig. 9, so that these lamps serve the purpose of indicating switch position when an auxiliary switch lever is operated.

From the foregoing it can be seen that this indicating arrangement comprises a simple and effective organization for displaying on the control point panel the indications needed by the operator to guide him in the manipulation of the system. The routes proposed and established, the operated position of the track switches, the condition of signals, and the occupied or unoccupied condition of the track circuits are shown in a distinctive manner which the operator can interpret with the minimum chance of mistake. The preferred construction of the lamps and glass strips illuminated by internal reflection is merely typical or representative of an arrangement well adapted for the purpose; but bull's-eye lamps, or transparent pieces in front of lighted compartments, or any other construction may of course be employed.

In connection with all of the foregoing description and explanation, it should be understood that the particular organizations of relays and circuits illustrated and described are merely typical illustrations of the principles, preferred structure and mode of operation characterizing the invention, and that various additions, modifications and adaptations may be made without departing from the invention.

What I claim is:—

1. An entrance-exit switch and signal control system comprising, a control panel having thereon a miniature track diagram of a railway track layout, a single self-restoring manually operable button on said control panel adjacent each point corresponding to a signal location at the end of one or more routes through the track layout, a

self-restoring manually operable push button for each end of each of the various routes through a railway track layout, an entrance relay for each button, means for energizing the entrance relay for the button first operated under normal conditions, prevention means operatively associated with all of the buttons and electrically responsive to the energization of an entrance relay and effective until restored to normal to prevent energization of any other entrance relay by operation of its button, a route establishing circuit for each route energizable by operation of a button at either end of such route if the entrance relay at the other end of that route is then energized, contacting means operated by the energization of a given route circuit for opening such route circuits for all conflicting routes, and means responsive to the initial energization of a route establishing circuit for restoring said prevention means to normal only after the second operated button completing such circuit has also been restored.

2. In a switch and signal control system of the character described, a control panel having a miniature diagram of a railway track layout providing various routes over track switches between signal locations, a single self-restoring push button on said track diagram for each of the signal locations constituting the end of one or more routes, an entrance stick relay for each button, a pick-up bus normally energized with energy adapted to energize an entrance relay, a pick-up circuit for each entrance relay including said pick-up bus and a contact of the corresponding button, prevention means effective upon the initial energization of any entrance relay by the actuation of its button for deenergizing said bus to prevent energization of any other entrance relay by a subsequent actuation of any other button, and route establishing means rendered effective by the actuation of a button for one end of an establishable route at the time the entrance relay for the other end of that route is energized, said route establishing means governing the operation of all of the track switches in such route and the clearing of a signal at the end of such route corresponding with the end to which the energized entrance relay belongs, said route establishing means when initially rendered effective permitting restoration of said preventing means to normal.

3. In a switch and signal control system of the character described, manually operable buttons for the entrance and exit ends of the various routes over a track layout, normal and reverse switch control relays for each track switch for governing the operation thereof to the normal or reverse position, a circuit network including a plurality of route establishing circuits one for each route, each of said route establishing circuits for routes not in conflict with routes already established being energized by the actuation of the two buttons at the ends of the corresponding route and acting to energize in series the normal or reverse switch control relays as required for all of the switches in that route, and rectifiers included in said network to block the flow of current through normal and reverse switch control relays inconsistent with a particular route to be established by the actuation of the buttons at the ends thereof.

4. In an entrance-exit type of switch and signal control system for railroad track layouts, a manually operable self-restoring button for each signal location constituting the entrance

or exit point for the route or routes through said layout, there being only one button for each signal location, normal and reverse switch control relays for each track switch for governing the operation thereof to the normal or the reverse position, a circuit network including route establishing circuits one for each route, each route establishing circuit including in series the normal or reverse switch control relays of all of the switches in that route and being connected to feed points of said network corresponding with the signal locations at the ends of that route, means responsive to the actuation of the buttons for the opposite ends of a given route for applying operating potentials to the corresponding feed points of said network, and rectifiers in said network to restrict the flow of current in the circuit paths formed by the network to those switch control relays for one particular route only between the signal locations corresponding with the buttons actuated.

5. In a switch and signal control system of the character described, a track layout including between signal locations two parallel tracks connected by crossovers to provide a run-around movement over said crossovers in addition to the straight route between certain signal locations, normal and reverse switch control relays for each crossover for governing the operation thereof to the normal or reverse position, a circuit network having entrance and exit feed points corresponding to the signal locations of said track layout and including connections between said feed points to energize in series the normal or reverse switch control relays as required for the various routes between the signal locations upon application of operating potential to the feed points corresponding to the ends of such routes, and rectifiers included in said connections to block the flow of current through the switch control relays for said crossovers to avoid said run-around movement upon application of operating potential to the feed points of said network corresponding to said certain signal locations.

6. In an entrance-exit switch and signal control system of the character described, for governing the operation of power-operated track switches and signals of a railway track layout providing a plurality of routes between signal locations at the ends of such route, a single manually operable spring returned push button associated with each signal location at the ends of each route, a normal and a reverse switch control relay for each switch, a circuit network comprising a route circuit for each route energized by the operation of the two buttons alone for the ends of that route, each route circuit including in series the normal or reverse switch control relays for all of the switches involved in such route as may be required, each route circuit when energized also controlling the clearing of a signal at one end or the other of such route dependent upon the sequence in which said buttons for that route are manually operated, and rectifiers at points in said network blocking the flow of current through switch control relays for undesired routes.

7. In a traffic controlling system of the character described, a control machine having a miniature diagram of the railway track layout over which traffic is to be controlled, said track layout providing a plurality of routes over track switches in different positions between signal locations at the ends of such routes, a manually operable self-restoring push button on said diagram at each point corresponding with said sig-

nal locations at the ends of the routes, a normal and a reverse switch control relay for each switch, route establishing means including a route circuit for each route adapted when energized to cause energization in series of the normal or reverse switch control relays of the various switches in such route as required to establish such route, each route circuit being energizable by the joint actuation only of the two buttons alone at the ends of such route, each route circuit including contacts of normal or reverse switch control relays energized to establish one or more of the conflicting routes, rectifiers at points in said network permitting flow of current through the switch control relays of the desired routes between upon actuation of buttons for the ends thereof but blocking the flow of current through switch control relays for undesired or impossible routes, and means responsive to the sequence of operation of the buttons for a route for governing the clearing of the signal at one end or the other of such routes dependent upon which button is first operated.

8. In a switch and signal control system of the character described, a control panel having thereon a miniature track diagram of a railroad track layout, manually operable self-restoring buttons mounted on said panel adjacent the points on said track diagram corresponding with signal locations there being only one button for each signal location, an entrance relay and an exit relay for each button, normal and reverse switch control relays for each track switch for governing the operation thereof to the normal or reverse position, a circuit network including a plurality of route establishing circuits one for each route, each route establishing circuit energizing in series the normal or reverse control relays of all of the switches in that route as required, means responsive to the actuation of the first button manually operated under normal conditions for energizing the corresponding entrance relay and applying operating potential to a feed point of said network associated with the corresponding signal location, prevention means rendered effective temporarily by the initial energization of an entrance relay for preventing the energization of any other entrance relays by manual operation of any other buttons so long as said prevention means is effective, said prevention means being controlled by said exit relays so as to be restored to its normal ineffective condition upon energization of an exit relay while its corresponding button is actuated, means responsive to the actuation of another button for the end of an available route originating at the signal location corresponding with the first button actuated for energizing the corresponding exit relay in series with the route establishing circuit of said network belonging to that particular route, and contacts operated by said entrance and exit relays for shunting the contacts of the corresponding buttons, whereby said entrance and exit relays may be maintained energized independently of the restoration of their respective buttons to the normal condition.

9. In an entrance-exit switch and signal control system of the character described for governing train movement over various routes between signal locations of a railway track layout, manually operable buttons associated with said signal locations, an entrance relay for each signal location, normal and reverse switch control relays for each switch and governing the operation thereof to the normal or reverse position,

route establishing circuits one for each route, each route establishing circuit being energized by the actuation of a button for one end of a given route when the entrance relay for the other end is energized and acting to energize the normal or reverse switch control relays of all of the switches in that route as required, stick circuit means for maintaining energized the switch control relays of the switches in an established route while occupied by a train, and an energizing circuit for each entrance relay including contacts of the associated button and back contacts of the switch control relay or relays of an adjacent switch which must be energized for train movement to or from the corresponding signal location, whereby the operation of a button is ineffective to energize its associated entrance relay if a route is established to or from the corresponding signal location.

10. In a switch and signal control system of the entrance-exit type for governing train movement over a railroad track layout, including track switches or crossovers and having detector track circuits for each switch or end of a crossover, a miniature track diagram of the track layout, manually operable buttons associated with the signal locations represented on said diagram, an entrance relay for each signal location adapted to be energized by the operation of its associated button, normal and reverse switch control relays for each switch for governing the operation thereof to the normal or reverse position, route establishing circuits one for each route, each route establishing circuit being energized by the operation of a button for one end of the corresponding route when the entrance relay for the other end is energized, each route establishing circuit acting to energize the normal or reverse switch control relays of all of the switches in the corresponding route as required, each route establishing circuit through the normal or reverse switch control relays for a given switch including a back contact of the other switch control relay, two directional stick relays for each detector track circuit one for each direction of train movement, stick circuits for said directional stick relays closed upon occupancy of the corresponding track circuit, energizing circuits for said directional stick relays governed by said entrance relays and by said normal or reverse switch control relays, and stick circuits for said switch control relays for each switch closed by the energization of a directional stick relay belonging to the associated detector track circuit, whereby the switch control relays in an established route are held up in advance of a train in that route but are released behind that train as it moves successively through the detector track sections in that route.

11. In a system of the character described for governing train movement over a track layout providing a number of routes between signal locations over track switches in different positions, certain of such routes being disposed end to end so as to constitute through routes, a manually operable button associated with each signal location, route establishing means for each route between the signal locations at the ends thereof and rendered effective by the joint actuation of the two buttons for the entrance and exit ends of such route, said route establishing means for a route controlling the position of the switch or switches involved in that route and also governing the clearing of a signal at the entrance end of that route, electro-responsive means associated with certain buttons for initiating oper-

ation of the corresponding route establishing means in the same manner as the manual operation of the corresponding button, and control circuits separate from said route establishing means for each of said electro-responsive means governed by buttons at the ends of through routes, whereby the actuation of the buttons at the extreme ends of certain through routes will cause operation of the electro-responsive means belonging to the one or more intermediate buttons and act to control the switch positions and signal clearing throughout such through route the same as if all of the buttons involved in such through route had been operated.

12. A switch and signal control system of the entrance-exit type for governing train movement over various routes between signal locations of a railway track layout, said track layout providing at least one through route which comprises a plurality of adjoining routes each extending between signal locations at their respective ends, said system comprising a single self-restoring push button associated with each signal location, route establishing means for each route operable by the actuation of the two buttons for the ends of that route to govern the position of all of the switches in that route, and to control the clearing of the signal at one end or the other of such route depending upon which of the two buttons was first actuated; electro-responsive means associated with the button for each signal location intermediate between the extreme ends of said through route and acting when energized to initiate operation of the route establishing means to set up routes originating and terminating at that intermediate signal location the same as if the button for that signal location had been manually actuated; and circuit means for governing the energization of said electro-responsive means by the operation of the buttons for the extreme ends of said through route.

13. In a switch and signal control system of the character described for governing train movement over a railroad track layout having a plurality of routes between signal locations and which includes one or more through routes comprising a plurality of adjacent routes associated end to end with their signal locations providing one or more intermediate signal locations, a single manually operable self-restoring button for each signal location, an entrance relay and an exit relay for each button, means responsive to the operation of the two buttons belonging to the signal locations at the ends of a given route for energizing the entrance relay for the first button operated and the exit relay for the other button, route establishing means governed by said entrance relays and said buttons for governing upon the operation of the two buttons at the opposite ends of any given route the operation of all of the track switches of such given route to the normal or reverse position as required to establish such route and for also clearing the signal at the location corresponding to the first button operated, and means responsive to the actuation of the two buttons for the extreme ends of a through route for causing the energization of the same entrance and exit relays associated with one or more intermediate buttons the same as if those buttons had been manually actuated, whereby a through route past one or more intermediate signal locations may be established by the actuation of only the two buttons for the extreme ends of that through route.

14. In an entrance-exit type of switch and

signal control system for railroad track layouts having power-operated track switches to set up different routes between signal locations including one or more double signal locations and two or more single signal locations, two entrance relays for each double signal location, a single entrance relay for each single signal location, a single manually operable button for each signal location including each double signal location, route establishing means responsive to the energization of an entrance relay at one end of a given route followed by the actuation of a button for the opposite end of that given route for governing the position of the track switches and the clearing of a signal for that route, and means responsive to the actuation of the button at a double signal location and governed by said route establishing means for energizing a selected one of the entrance relays for such double signal location to conform with the route established for train movement over one or the other of the portions of track on opposite sides of such double signal location, whereby the operation of the single button at the double signal location energizes the appropriate entrance relay for train movement away from such signal location in an opposite direction from the route established on one side or the other of such signal location.

15. In a system of the character described, manually operable self-restoring buttons for the signal locations of a railroad track layout, an entrance relay for each button, a source of energy, a cancel bus normally connected to said energy source, a stick circuit for each entrance relay connected to said energy source through a normally closed contact of the corresponding button and to said cancel bus through a normally open contact of that button, and a manually operable cancel key common to all of the buttons for disconnecting said cancel bus from said energy source, whereby actuation of any button while said cancel key is in its operated position causes de-energization of the stick circuit of the corresponding entrance relay without affecting the stick circuits of any other entrance relays that may then be energized.

16. In an indication display arrangement for control panels of switch and signal control systems of the character described, a track layout having track switches to form routes between signal locations, a miniature track diagram of the railroad track layout, manually operable self-restoring buttons on said diagram adjacent the signal locations, a plurality of indicating lamps on said track diagram one for each of the various portions of track included in the various routes through the track layout, means for steadily lighting the lamp for a given portion of track in response to the operation of the buttons at the ends of a route including that portion, a flash bus intermittently energized, detector track circuits for the various switches, an indication device for each detector track circuit responsive to the occupied or unoccupied condition thereof, and means governed by each indication device for connecting the lamps for the portions of track included in the corresponding detector track circuit to said flash bus during occupancy of that track circuit, whereby an established route is outlined on said track diagram by steady lighted lamps associated with the portions of track in that route and the presence of a train on such portions of track is indicated by a flashing of the associated lamps.

17. In a switch and signal control system of

the character described, a track layout having power-operated switches to set up different routes between signal locations in the track layout, a miniature track diagram of a railroad track layout, route establishing means for governing the position of the track switches and the clearing of the signal for said track layout, a plurality of indicating lamps on said track diagram associated respectively with the various portions of track included in the various routes, indication devices responding to the occupancy of the detector track circuits associated with the respective track switches, circuit means governed by said route establishing means and by said indication devices for lighting each indicating lamp steadily whenever the corresponding portion of track is included in a route and for flashing that lamp whenever its corresponding portion of track is occupied by a train, and means for maintaining lighted the lamps of the portions of track in a route ahead of a train and for extinguishing the lamps for the portions of track behind a train as it travels over an established route.

18. In a system of switch and signal control of the character described for governing train movement through routes between signal locations over the track switches of a railroad track layout, a miniature track diagram of the track layout, manually operable buttons associated with the signal locations represented on said diagram, normal and reverse switch control relays for each switch for governing the movement thereof to the normal or reverse position, route establishing means responsive to the operation of said buttons for energizing the normal or reverse switch control relays as required to set up the various routes, detector track sections for the various switches, directional stick relays two for each detector track section one for each direction of train movement, energizing circuits for each directional stick relay governed by said route establishing circuit and by said switch control relays to cause energization of such stick relays of the switches or ends of crossovers as are included in a given established route for one direction of train movement, stick circuits for the directional stick relays closed when the associated detector track section is occupied, stick circuits for said switch control relays governed by the directional stick relays of the associated detector track section, indicating lamps on said track diagram associated with the portions of track included in the various routes, and circuit means controlled by said directional stick relays for lighting said lamps, each of said lamps being lighted if the corresponding portion of track is included in an established route ahead of a train and being extinguished behind a train travelling through the route.

19. In a switch and signal control system of the entrance-exit type described, a miniature track diagram of a railroad track layout, symbols of signals on said track diagram adjacent the signal locations represented thereon, an indicating lamp for each signal symbol, manually operable buttons for the signal locations, an entrance relay for each signal location energized in response to actuation of the corresponding button, a signal indication device for each signal responsive to the clear or stop condition of that signal, a flash bus intermittently energized, and circuit means for each indicating lamp governed by the corresponding entrance relay and signal indication device for connecting said lamp to said flash bus upon energization of the corre-

sponding entrance relay and to a steady potential when the signal indication device responds to the clearing of the signal.

20. A switch and signal control system of the entrance-exit type as described for setting up any one of a number of routes through a railway track layout between signal locations and clearing a signal for train movement over such route comprising, a miniature track diagram of the track layout, a single self-restoring push button on said track diagram adjacent each point corresponding with a signal location constituting the entrance or exit end of one or more routes, an entrance relay for each button energizable upon operation of that button under normal conditions, route establishing circuit means for each route energized by the actuation of a button for one end of that route if the entrance relay for the other end of that route is then energized, said route establishing circuit means for any route being energizable provided no route establishing circuit means for any conflicting route is then energized, and electro-responsive means operatively associated with all of said buttons and automatically rendered effective upon the energization of any entrance relay under normal conditions for preventing the energization of any other entrance relay belonging to the track layout only until the route establishing means for some route from the signal location corresponding to such energized entrance relay has become energized by the actuation of the button belonging to the exit end of such route.

21. In an entrance-exit switch and signal control system of the character described, manually operable self-restoring push buttons on a miniature track diagram of a railway track layout and belonging to the signal locations at the ends of the routes through said railway track layout there being only one button for each signal location, route establishing circuit means associated with said routes and responsive to the joint actuation of the buttons for the opposite ends of any given route for controlling the operation of all of the track switches involved in that route to the normal or reverse position as required and for governing the clearing of a signal at one end or the other of such route dependent upon which of said buttons is first actuated, said route establishing circuit means for any given route being thus responsive provided no other route in conflict therewith is then established, said route establishing means including an entrance relay for each of said buttons energizable upon the actuation of its button under normal conditions to define the entering end of such route, and electro-responsive prevention means operatively associated with all of said buttons and rendered effective upon such energization of an entrance relay under normal conditions for preventing the energization of any other entrance relay, said prevention means remaining effective until the route establishing circuit means for some route from the entrance end defined by the entrance relay then deenergized has been rendered effective by the actuation of another button for the exit end of that route.

22. In a traffic control system of the character described, the combination with a plurality of manually operable push buttons, each button automatically returning to the normal position after each manual actuation, and there being only one of these buttons for each of the signal locations constituting an end of one or more routes through a railway track layout, entrance relays

and exit relays belonging to the signals constituting entrance and exit ends for routes, a pick-up bus normally supplied with energy for energizing entrance relays, a pick-up circuit for each entrance relay deriving energy from said bus and including a contact closed upon manual actuation of the corresponding button, prevention means effective upon the initial energization of any entrance relay for deenergizing said pick-up bus until said means is restored, means for energizing an exit relay for the end of a route upon actuation of its corresponding button if the entrance relay for the other end of such route is then energized and provided no conflicting route is established, and means responsive to the initial energization of each exit relay for restoring said prevention means to normal.

23. In a switch and signal control system for railroads; a track layout having a plurality of power-operated track switches for setting up different routes between signal locations constituting the entrance and exit ends of such routes; track circuits for said track layout, each having a track relay; a track diagram of said track layout; a self-restoring manually operable button on said track diagram for each of the points corresponding to a signal location; an entrance relay for each of said signal locations; a normally inactive prevention means associated with all of said entrance relays; circuit means effective under normal conditions of said prevention means upon the operation of a button for any signal location for initially energizing the corresponding entrance relay; a stick circuit for each entrance relay closed when that relay is once picked up and including a front contact of that one of said track relays controlled in accordance with track occupancy at the entrance to the route or routes terminating at the corresponding signal location; circuit means effective upon the picking up of any given entrance relay for rendering said prevention means active to prevent the initial energization of any other entrance relay until said prevention means is restored to normal; route establishing means for governing the power operation of said switches and clearing said signals, said route establishing means being rendered effective in response to the operation of any given button at the exit end of any given route having an entrance relay picked up at the opposite end of that route, providing said route establishing means is not already rendered effective for a conflicting route, to operate the switches to establish that route and to clear a signal at that end of such route having the energized entrance relay; and circuit means effective upon the initial rendering effective of said route establishing means for any given route for restoring said prevention means to normal.

24. In a switch and signal control system for railroads; a track layout having a plurality of power-operated track switches operable for setting up different routes between signal locations, some of said routes being conflicting and some of said routes being non-conflicting; track circuits provided for said track layout so as to control track relays in accordance with traffic conditions in said routes; a control panel having a miniature track diagram of said track layout; a single manually operable self-restoring button on said panel for each of the signal locations; an entrance relay and an exit relay for each of said signal locations; a normally inactive lockout means associated with all of said entrance and exit relays; pick-up circuit means effective upon

the operation of any button for initially energizing the corresponding entrance relay only if said lockout means is inactive and the corresponding exit relay is deenergized, said circuit means also rendering said lockout means active at the time of operation of that button, whereby all other entrance relays are prevented from being energized upon the operation of their respective buttons until said lockout means is restored to the inactive condition; circuit means effective upon the operation of any button following the energization of an entrance relay for initially energizing the exit relay corresponding to that button only providing there is an available route between the signal location corresponding to said energized entrance relay and the signal location corresponding to such exit relay; a stick circuit for each entrance relay closed when that relay is once picked up dependent upon that one of said track relays controlled in accordance with traffic conditions at the entrance to the route or routes terminating at the corresponding signal location; a front contact on each exit relay for closing a stick circuit to render that relay dependent upon the continued energization of the particular entrance relay with which it is then associated and the continued availability of the route between their corresponding signal locations; means rendered effective upon the picking up of an exit relay to cause said lockout means to be restored to an inactive condition; route establishing means controlled by said entrance and exit relays for said track layout so as to operate the switches to set up any given route having an entrance relay and an exit relay picked up at opposite ends of such route providing there is no conflicting route already established, said means also clearing the signal at the end of the route having the entrance relay picked up.

25. In an interlocking system for railroads of the character described, a track layout having a plurality of track switches to form different routes between terminating points, manually operable buttons for the terminating points of the various routes through the track layout, normal and reverse switch control relays for each track switch for governing the power operation thereof to the normal or reverse position, a circuit network arranged to conform with said track layout and to include a route establishing circuit for each of the routes through said track layout, each of said route establishing circuits being energizable by the actuation of the two buttons alone for the opposite terminating points of the corresponding route for energizing in series the normal or reverse switch control relays as required for operating the track switches to set up that route, each of said route establishing circuits including back contacts of the normal or reverse switch control relays which are energized for setting up any conflicting routes, and rectifiers included in said circuit network to block the flow of current through circuit paths and normal or reverse switch control relays for impossible or undesired routes upon the actuation of buttons at the opposite ends of any given route.

26. In an interlocking system for railroads; a track layout having two stretches of main track interconnected by two power operated crossovers to provide four routes for train movement, one route for each main track, and two other routes from each main track to the other main track for opposite directions of traffic on both main tracks; manually operable devices for the ends of both stretches of main track, there being one

device for each end respectively; one reverse and two normal switch control relays for each of said crossovers for governing the power operation thereof to normal and reverse positions; a circuit network arranged to simulate said track layout, said circuit network including a route establishing circuit for each of the routes through said track layout, each of such route establishing circuits being energizable by the actuation of the two devices alone for the opposite ends of the corresponding route for energizing in series a normal or a reverse switch control relay as required for operating the cross-overs to positions to set up that route, each of said route establishing circuits including back contacts of the normal or reverse switch control relays which are energized for setting up any conflicting routes; and rectifiers included in said circuit network to block the flow of current through a circuit path corresponding to a run-around route with both of said crossovers in reverse positions, which circuit path would otherwise be energized upon the actuation of the manual operable devices for the opposite ends of a particular one of said stretches of main track.

27. In a system of the character described for governing traffic on railroads, a stretch of main track between two extreme signal locations with several intermediate signal locations, each intermediate signal having opposing signals for governing traffic in both directions, there being power-operated track switches in each portion of track between any two signals, a manually operable device for each of the signal locations, route establishing means for each portion of track between two signal locations responsive to the operation of the two manually operable devices for said two signal locations alone for operating the track switch or switches in such portion to the positions required to allow train movement over such portion and for clearing the signal at the entrance end, electro-responsive means associated with each of the manually operable devices for the intermediate signal locations for performing the same function in initiating operation of said route establishing means as the manual operation of the corresponding device, and control circuits for each of said electro-responsive means governed by said manually operable devices for the signal locations at the extreme ends of said stretch of track, whereby the manual actuation of the devices at the extreme ends of said stretch causes the operation of the electro-responsive means belonging to the intermediate signal locations to act to control the route establishing means for each portion of track between said extreme signal locations and clearing each of the intermediate signals the same as if the manually operable devices of all such signal locations had been manually operated.

28. In a switch and signal control system for governing traffic on railroads; two stretches of main track parallel to each other, each stretch having signals at its extreme ends and signals at several intermediate locations, and the portion of track between any two signal locations having power-operated track switches forming crossovers between such portion and an adjacent portion of the other stretch of track, whereby there are a plurality of interlocked groups located end-to-end for providing through routes and for providing routes through any one interlocked group from any given signal location to any other given signal location between which there are possible routes; a control panel having a miniature track

diagram of said track layout; a manually operable device on said track diagram for each of the signal locations; route establishing means for each interlocked group including normal and reverse switch control relays for governing the power operation of their respective track switches, said route establishing means for any interlocked group responding to the operation of the two manually operable devices for the signal locations alone at the opposite ends of any given route for operating the track switch or switches to set up such route and for clearing the signal at the entrance end to such route; electro-responsive means associated with each of the manually operable devices for the intermediate signal locations for performing the same function in the control of said route establishing means as the manual operation of the corresponding manually operable device; and control circuits for each of said electro-responsive means governed only by said manually operable devices for the signal locations of their respective stretches of track, said control circuits including back contacts of the reverse switch control relay of each of the switches in its stretch, whereby the manual actuation of the manually operable devices at the extreme ends of either of said stretches causes the operation of the electro-responsive means belonging to the intermediate signal locations of that stretch to control the route establishing means for each interlocked group between said extreme signal locations and the clearing of each of the intermediate signals the same as if the manually operable devices of all such signal locations had been manually operated to effect the establishment of a through route, but whereby the manual actuation of the manually operable device at one extreme end of one stretch and the actuation of the manually operable device at the opposite extreme end of the other stretch fails to cause the operation of the route establishing means for the several intervening interlocked groups, and whereby a route set up over any of the crossovers of any of the interlocked groups prevents the establishment of a through route along either of said stretches of main track by the operation of the manually operable devices at the extreme ends of such stretches.

29. In an interlocking control system, a first signal at one end of a track layout for governing the movement of traffic over a first portion of a traffic route through said layout, a second signal at an intermediate point in said route for governing the movement of traffic in the same direction over a second portion of said route, a route button for each end of said route and for said intermediate point, a stick relay responsive to the operation of the button for said intermediate point, means responsive to the operation of the button for the exit end of said route when said stick relay is energized for clearing said second signal, a selector relay responsive to the operation of the button for the entrance end of said route for rendering the button for said intermediate point ineffective to control said stick relay, an exit relay responsive to the operation of the button for said intermediate point when said selector relay is energized for clearing said first signal, and means controlled by said exit relay for releasing said selector relay to render said stick relay responsive to a subsequent operation of said intermediate button.

30. In an interlocking control system, a first signal at one end of a track layout for governing the movement of traffic over a first portion of a traffic route through said layout, a second signal

at an intermediate point in said route for governing the movement of traffic in the same direction over a second portion of said route, a route button for each end of said route and for said intermediate point, a stick relay responsive to the operation of the button for said intermediate point, means responsive to the operation of the button for the exit end of said route when said stick relay is energized for clearing said second signal, a selector relay responsive to the operation of the button for the entrance end of said route for rendering the button for said intermediate point ineffective to control said stick relay, an exit relay responsive to the operation of the button for said intermediate point when said selector relay is energized for clearing said first signal, means controlled by said exit relay for releasing said selector relay to render said stick relay responsive to a subsequent operation of said intermediate button, and means responsive to the operation of the button for the exit end of said route following operation of the button for the entrance end of the route for energizing said exit relay and said stick relay for clearing said first signal and said second signal.

31. In an interlocking system, a plurality of routes through a track layout each including a track switch, a control panel comprising a representation of said track layout having a route button for each route end, a route selector controlled by the buttons at the opposite ends of the routes for operating the track switch, a normally inactive switch lever having a normal and a reverse control position for individually operating the track switch, a normal and a reverse indication lamp for indicating the position of the switch, a circuit for each lamp each including a contact closed when the switch is operated by said selector to the corresponding normal or reverse position, each said contacts being bridged by a contact closed when said lever is moved to a corresponding control position, and switch indication means for completing the circuit for the normal or reverse indication lamp when the switch occupies the corresponding position.

32. In a switch and signal control system of the entrance-exit type for governing the power operation of track switches and clearing of signals of a railway track layout to provide routes for train movement over said track layout, said track layout including a first and a second signal governing traffic in the same direction, an entrance stick relay for each of said signals, a pick-up circuit for each of said entrance relays, a track circuit controlled stick circuit for maintaining each entrance relay energized until a train passes the corresponding signal, manually operable means for independently opening the stick circuit for each entrance relay for manual restoration thereof, a single self-restoring manually operable push button associated with each of said signals, contact means operated by manual actuation of the button for said first signal for closing the pick-up circuit for the corresponding entrance relay, relay means energized upon the initial energization of said entrance relay for said first signal for opening the pick-up circuit of the entrance relay for said second signal, an exit relay associated with said second signal and energized by actuation of the corresponding button following energization of the entrance relay for said first signal, and means controlled by said exit relay and effective only after its associated button has been restored to normal after manual actuation there-

of for deenergizing said relay means to render the entrance relay for said second signal responsive to a subsequent operation of its associated button.

33. A switch and signal control system of the entrance-exit type for governing power operation of track switches and clearing of signals of a railway track layout including two signals for governing traffic in opposite directions over a route comprising, a miniature track diagram of said track layout, a single self-restoring manually operable push button associated with each of said signals, an entrance stick relay associated with each entrance signal for controlling the clearing circuit for said signal, a pick-up circuit for each entrance relay normally effective upon actuation of the corresponding button to energize that entrance relay, a track circuit controlled stick circuit for maintaining each entrance relay energized until a train passes the corresponding signal, relay means energized in response to the energization of the entrance relay for one of said signals by actuation of its corresponding button for opening the pick-up circuit of the entrance relay for the opposing signal, an exit relay for each signal energized by actuation of the corresponding button when the opposing entrance relay is energized, and route establishing means including said entrance and exit relays and responsive to the sequence of actuation of said buttons for operating the track switches to set up said route and clear a signal for the end of said route having its entrance relay energized.

34. In a switch and signal control system of the entrance-exit type for a track layout affording a through route over two adjoining portions of track between certain entrance and exit signal locations past an intermediate signal comprising, a single self-restoring manual operable button associated with each of said signal locations, entrance relays one associated with said entrance signal and another with said intermediate signal, a track circuit controlled stick circuit for maintaining each entrance relay energized until a train passes the corresponding signal, a pick-up circuit for each entrance relay closed by actuation of the corresponding button, relay means responsive to the initial energization of the entrance relay for said entrance signal for opening the pick-up circuit for the entrance relay for said intermediate signal, exit relays one associated with said intermediate signal and another with said exit signal and controlled by actuation of the corresponding buttons, means responsive to the energization of the exit relay for said intermediate signal for deenergizing said relay means to permit energization of the entrance relay for said intermediate signal by a subsequent actuation of its button, route establishing means for each of said track portions including the entrance and exit relays thereof for operating track switches and controlling the clearing of an entrance signal for a route over said track portion, and means responsive to the energization of the exit relay for the exit end of said through route following energization of the entrance relay for the entrance end of said through route for energizing the same entrance relay and exit relay associated with said intermediate signal controlled by actuation of the corresponding button, and thereby establish said through route over said adjoining portions of track and clear said intermediate signal.

35. In an interlocking control system, a track layout including a plurality of track switches which may be arranged to form different traffic routes said layout including two alternative routes between the same route ends, a normal and reverse control relay for each switch, a route network including a route circuit for each route each such circuit including in series the normal or reverse control relay for each switch of the route and contacts which open when route circuits for conflicting routes are energized, manually operable means for each route end in said layout, means responsive to the operation of the manually operable means for the two ends of a route to energize the corresponding route circuit to pick up the normal and reverse control relays as required to establish such route, and selecting means comprising contacts included in the route circuits for said two alternative routes and effective to prevent the energization of one but not of the other of said two alternative routes in response to the operation of the manually operable means for the opposite ends of such routes unless a route circuit conflicting with said other alternative route but not with said one route is energized.

36. In an interlocking control system, a track layout including a plurality of track switches which may be arranged to form different traffic routes said layout including two alternative routes between the same route ends, a normal and reverse control relay for each switch, a route network including a route circuit for each route each such circuit including in series the normal or reverse control relay for each switch of the route, manually operable means for each route end in said layout, means responsive to the operation of the manually operable means for the two ends of a route to energize the corresponding route circuit to pick up the normal and reverse control relays as required to establish such route, contact means included in the route circuits for said two alternative routes and normally effective to prevent the energization of one but not of the other, and means for operating said contact means automatically to permit the energization of the route circuit for said one alternative route when a train occupies a route conflicting with said other alternative route but not with said one alternative route.

37. In an interlocking control system, a track layout including parallel tracks connected by track switches which are manually controllable to form different traffic routes, a locking relay for each switch controlled by traffic conditions, a route network corresponding to said track layout and comprising a plurality of interconnected circuits including a route circuit for each traffic route through said layout, manually operable contact means for the ends of the routes, means responsive to the operation of the contact means for the two ends of a route to energize the corresponding route circuit, provided that the locking relay for each switch of the route is not deenergized to lock such switch in a position conflicting with such route, means comprising asymmetric units included in portions of said route circuits to prevent the diversion of current from an energized route circuit to interconnected portions of other route circuits, and means controlled by each route circuit when energized to operate the track switches as required to establish the corresponding route.

38. In combination, a track layout including track switches operable to form different traffic

routes with a signal for each track at each end of the layout, certain of said routes being located end to end to form a first and a second portion of a through route having an intermediate signal, a single route button and an entrance relay for each signal location, means normally effective when any route button is momentarily operated to energize the associated entrance relay, route establishing means for each route effective when energized to operate the track switches as required for such route, means responsive to the operation of the route button for the exit end of a route having the entrance relay for its entrance end energized for energizing the route establishing means for such route, means for clearing the signal associated with the energized entrance relay when such route becomes established, means responsive to the energization of the entrance relay for the first portion of said through route for energizing said entrance relay for said second portion and for energizing the route establishing means for both portions in response to the momentary operation of the button for the exit end of the second portion, means effective if said intermediate button is operated to energize the route establishing means for the first portion only of said through route, and means responsive to the release of said intermediate button after such operation for conditioning the same entrance relay for said second portion to be energized in response to a second operation of said button.

39. In a switch and signal control system of the entrance-exit type for governing the power operation of track switches and the clearing of signals of a railway track layout including a plurality of interlocked groups and affording one or more through routes over said interlocked groups past one or more intermediate signals, a manually operable device for each signal location constituting the entrance or exit end of a route or through route, route establishing means for each interlocked group including entrance and exit stick relays responsive respectively to the actuation of manually operable control devices for entrance and exit signal locations of that interlocked group for operating the track switches as required to provide routes between the entrance and exit signal locations thus designated, through route electro-responsive means associated with each signal location which may become an intermediate signal location in a through route and acting when energized to cause energization of said entrance and exit relays for that signal location and thereby initiate operation of the associated route establishing means in the same way as if that intermediate signal location had been designated by actuation of manually operable devices as the entrance and exit ends of routes originating and terminating at that intermediate signal location, and means responsive to the actuation of manually operable devices to designate entrance and exit signal locations at the ends of a through route for energizing said electro-responsive means for each intermediate signal location only if all parts of that through route are not in conflict with routes then established or occupied by a train.

40. In a switch and signal control system of the entrance-exit type for governing the power operation of track switches and clearing of signals for a railway track layout to provide routes for train movement between entrance and exit signal locations, said track layout including a double intermediate signal location having signals

governing train movements in opposite directions, a single self-restoring push button associated with each signal location including said double intermediate signal location, an entrance relay for each signal location constituting the entrance end of a route, an exit relay for each signal location constituting the exit end of a route, means responsive to the manual actuation of the buttons for the signal locations at the opposite ends of a route for energizing an entrance relay for one of these signal locations and an exit relay for the other signal location in accordance with the sequence in which said buttons are actuated, route establishing means responsive to the energization of the entrance relay and the exit relay for the opposite ends of a given route for operating the appropriate track switches to the positions required for that route and for governing the clearing of the signal for the signal location having its entrance relay energized, and means governing the energization of the two entrance relays for said double intermediate signal location dependent upon the establishment of a route or presence of a train at one side or the other of said signal location and thereby provide for the energization of only one of said entrance relays as required to establish a route on the opposite side of that signal location.

41. In an entrance-exit system of the character described for a railway track layout including a double intermediate signal location having signals governing train movements in opposite directions, a miniature track diagram of said track layout, a single self-restoring push button located on said track diagram at points corresponding with each signal location constituting the entrance end of a route, there being a single button for said double intermediate signal location, normal and reverse switch control relays for each switch for governing the operation thereof to corresponding normal and reverse positions, an entrance relay for each signal location constituting the entrance end of a route, there being two entrance relays for said double intermediate signal location, route establishing means governed by the energization of an entrance relay for one end of a desired route and the subsequent manual actuation of a button to designate the opposite exit end of that route for energizing the normal or reverse switch control relays of the appropriate switches as required to establish that route, track circuit controlled means for maintaining each switch control relay for a switch in an established route energized dependent upon the presence of a train in that route, an energizing circuit for each entrance relay including a contact closed by actuation of the button for the corresponding signal location, and means including normally open contacts governed by said switch control relays for rendering effective the energizing circuit for only one of the entrance relays associated with said double intermediate signal when a route terminating at that signal location is established or occupied by a train.

42. In a switch and signal control system of the entrance-exit type for railway track layouts including insulated track circuit sections interconnected by track switches to form different traffic routes, a miniature track diagram of said track layout having visual indicating means comprising translucent strips and electric lamps for illuminating each represented track section substantially throughout its length, manually op-

erable self-restoring push buttons on said track diagram for designating the entrance and exit ends of desired routes, route establishing means responsive to the operation of a button to designate the entrance end of a route followed by the operation of a button to designate the exit end of that route for operating the track switches as required to establish that route, circuit means governed by said route establishing means for steadily lighting the lamps for the indicating means of each track section included in such established route, and track circuit controlled means for changing the steady lighting of said lamps associated with each track section to an intermittent lighting while that track section is occupied by a train, whereby each track section represented on the miniature track diagram is steadily illuminated when included in an established route and is given an illuminated flashing indication when occupied by a train.

43. In an entrance-exit type system of the character described for railroad track layouts comprising insulated track sections each having a track relay and interconnected by power operated track switches operable to provide different routes for train movement between signal locations, a miniature track diagram of said track layout comprising indicating means associated with each track section for illuminating substantially linear portions thereof adjacent the switches, normal and reverse switch control relays for each switch for governing the power operation thereof to a corresponding normal or reverse position, manually operable buttons located on said track diagram for designating the entrance and exit signal locations for desired routes, route establishing means responsive to the manual operation of buttons to designate the entrance and exit signal locations of a route for energizing the normal or the reverse switch control relay of the appropriate switches as required to establish that route, means for automatically restoring said route establishing means to normal upon the entrance of a train into the route established thereby, means including directional stick relays controlled by the track relays of said track sections for maintaining energized the switch control relay of each switch in a track section included in an established route independently of the restoration of said route establishing means to normal upon the entrance of a train into that route and until that train has entered and passed out of that track section, two control circuits for said indicating means of each track section, both of said control circuits being closed by normally open contacts of the switch control relays of the switch or switches in that track section and rendered effective alternately in accordance with the energized or deenergized condition of the track relay of that track section, whereby the indicating means for each track section included in an established but unoccupied route or in an occupied route ahead of a train may be lighted in one way by one of its control circuits and in a different way by its other control circuit when that track section is actually occupied by a train.

44. A switch and signal control system for track layouts including insulated track circuit sections each having a track relay and interconnected by track switches to form traffic routes, a miniature

track diagram of said track layout comprising a plurality of indicating means for illuminating substantially linear portions of the represented track, there being an indicating means associated with the normal and the reverse position of each switch and with each intervening stretch of track between said switch position indicating means, manually operable self-restoring push buttons located on said track diagram to identify entrance and exit signal locations of desired routes, route establishing means responsive to the operation of buttons to designate the entrance and exit signal locations of any given route for operating the appropriate track switches to the positions required to establish that route, circuit means governed by said route establishing means and by the track relays of said track sections for steadily lighting each of the indicating means associated with the intervening stretches of track between the switches in the established route independently of the operated position of such switches and also each of the indicating means associated with the normal or reverse position of each of said switches only when that switch has operated to the position required for the route, said circuit means maintaining said indicating means for each track section steadily lighted ahead of a train traversing the route and until the train has passed over that track section, and means governed by the track relay of each track section for changing the steady illumination of the corresponding indicating means provided by said circuit means to an intermittently flashing illumination while that track section is actually occupied by a train.

45. In a system of the character described for governing train movement over track switches for a railway track layout, said track layout having optional routes over track switches in different positions between two signal locations at the common ends of said routes, manually operable buttons for said two signal locations at the common ends of said routes, a normal and a reverse switch control relay for each of the switches in said optional routes, a circuit network including a route establishing circuit for each of the optional routes, each of said route establishing circuits including a normal or a reverse relay of each of the switches in that route as the case may be and also back contacts of the normal or reverse switch control relays included in the other route, a selecting relay acting when energized to open that one of said route circuits corresponding to a preferred one of said optional routes and to close that one of said route circuits corresponding to an inferior one of said optional routes, manually operable means effective only if said preferred optional route is not established or occupied by a train for initially energizing said selecting relay, stick circuit means for maintaining said selecting relay energized independently of said manually operable means while said inferior optional route is established or occupied by a train, and manually operable auxiliary switch control means associated with each switch for selectively controlling the normal and reverse operation of the corresponding switch to cause individual operation thereof independently of said route circuits.

NEIL D. PRESTON.