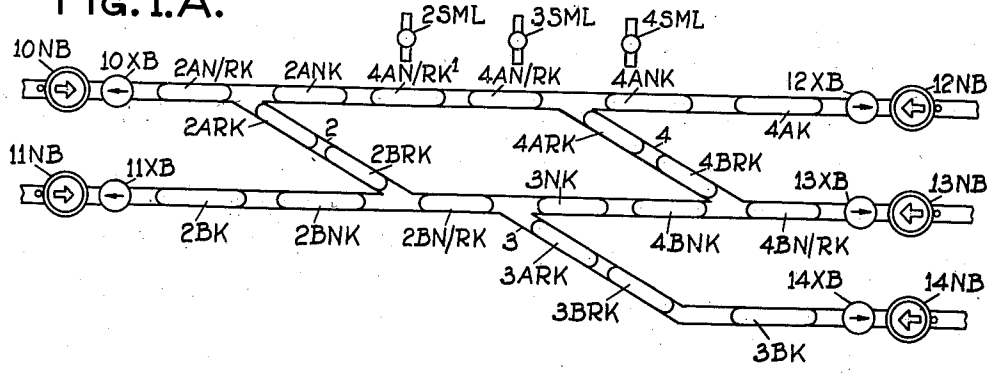
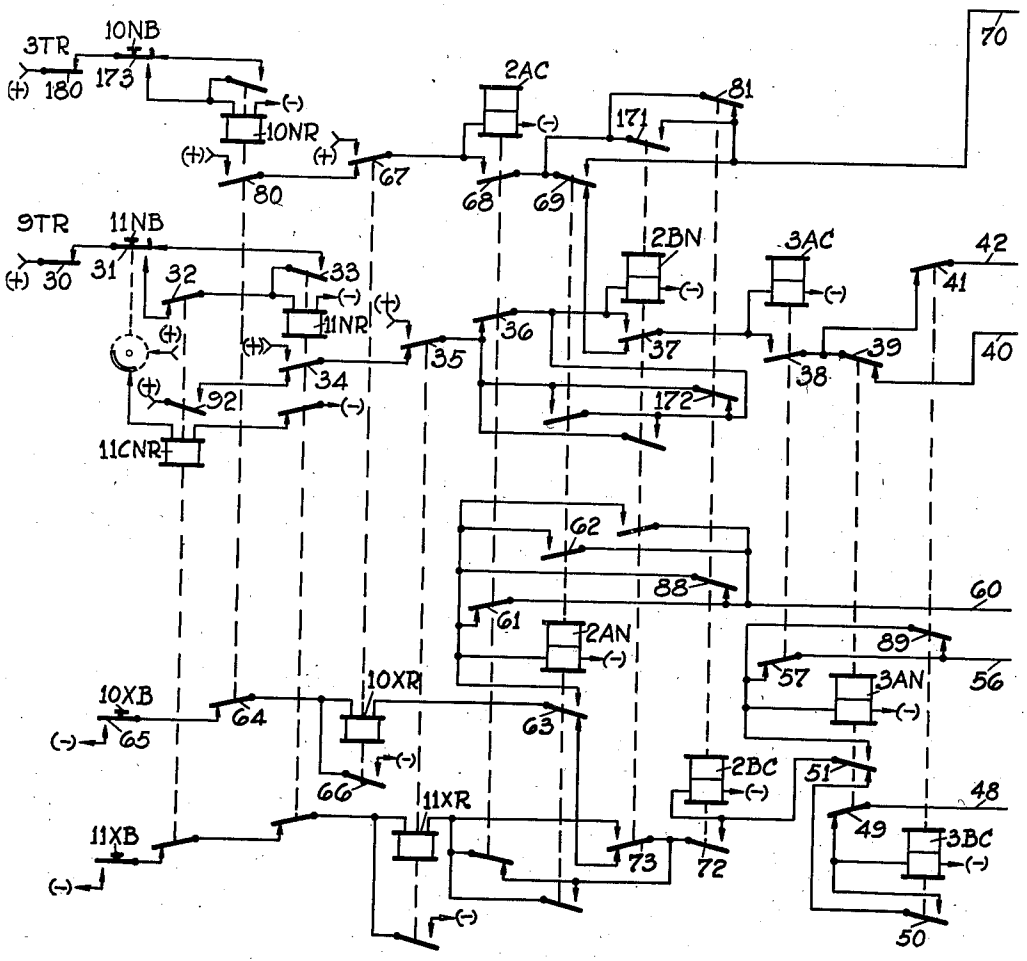
Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 1.A.





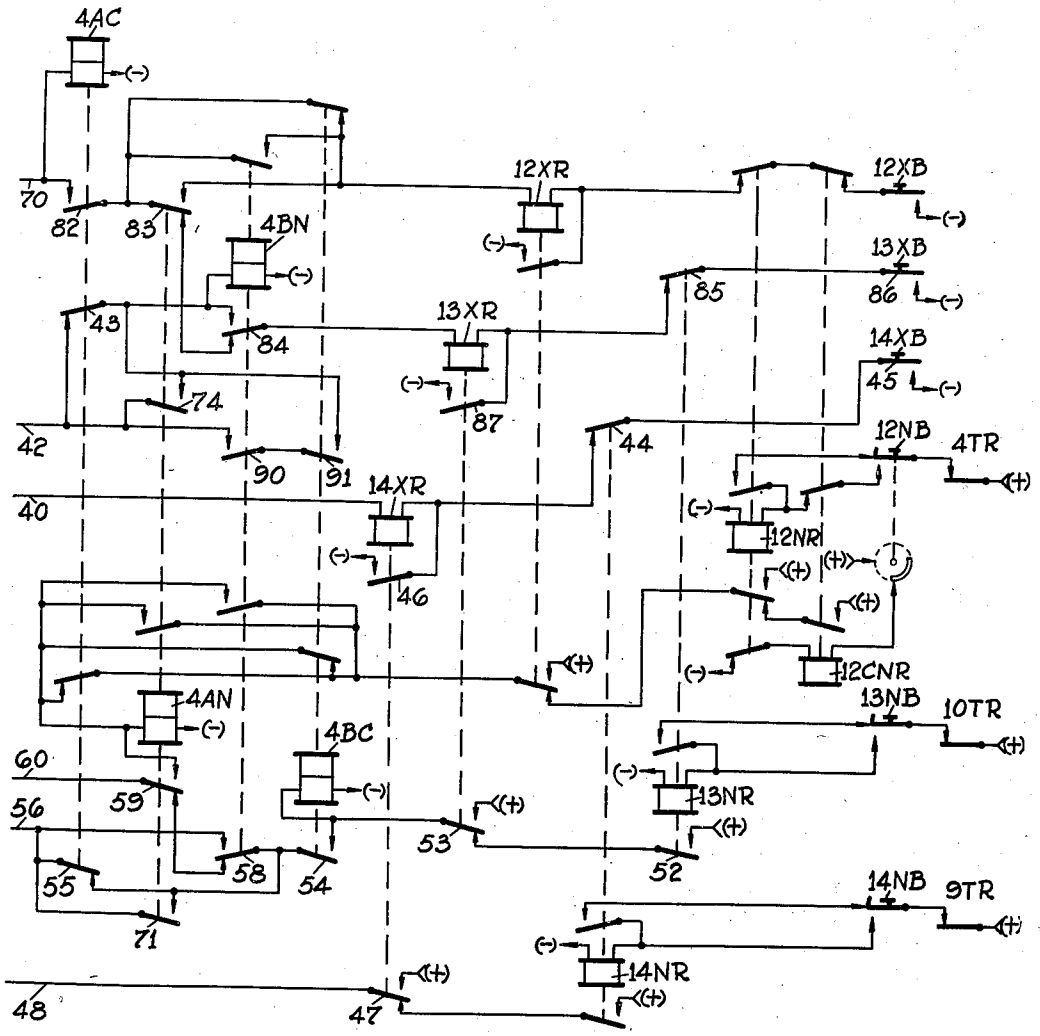
INVENTOR
BY N. B. Coley,
his Neil H. Preston,
ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed April 19, 1940 10 Sheets-Sheet 2

FIG. 1.B.



INVENTOR
N. B. Coley.
BY
Neil W. Preston.
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed April 19, 1940 10 Sheets-Sheet 3

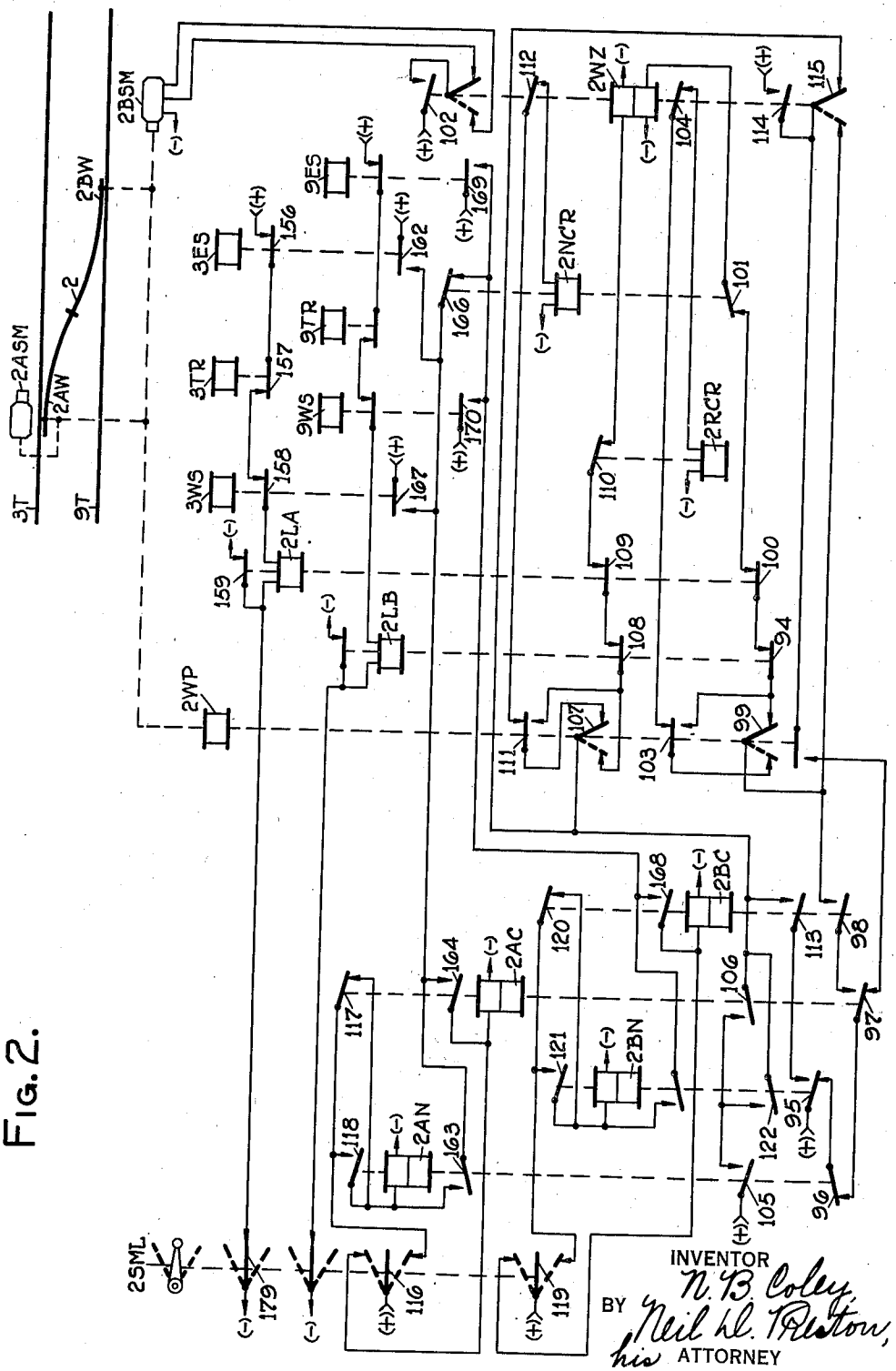


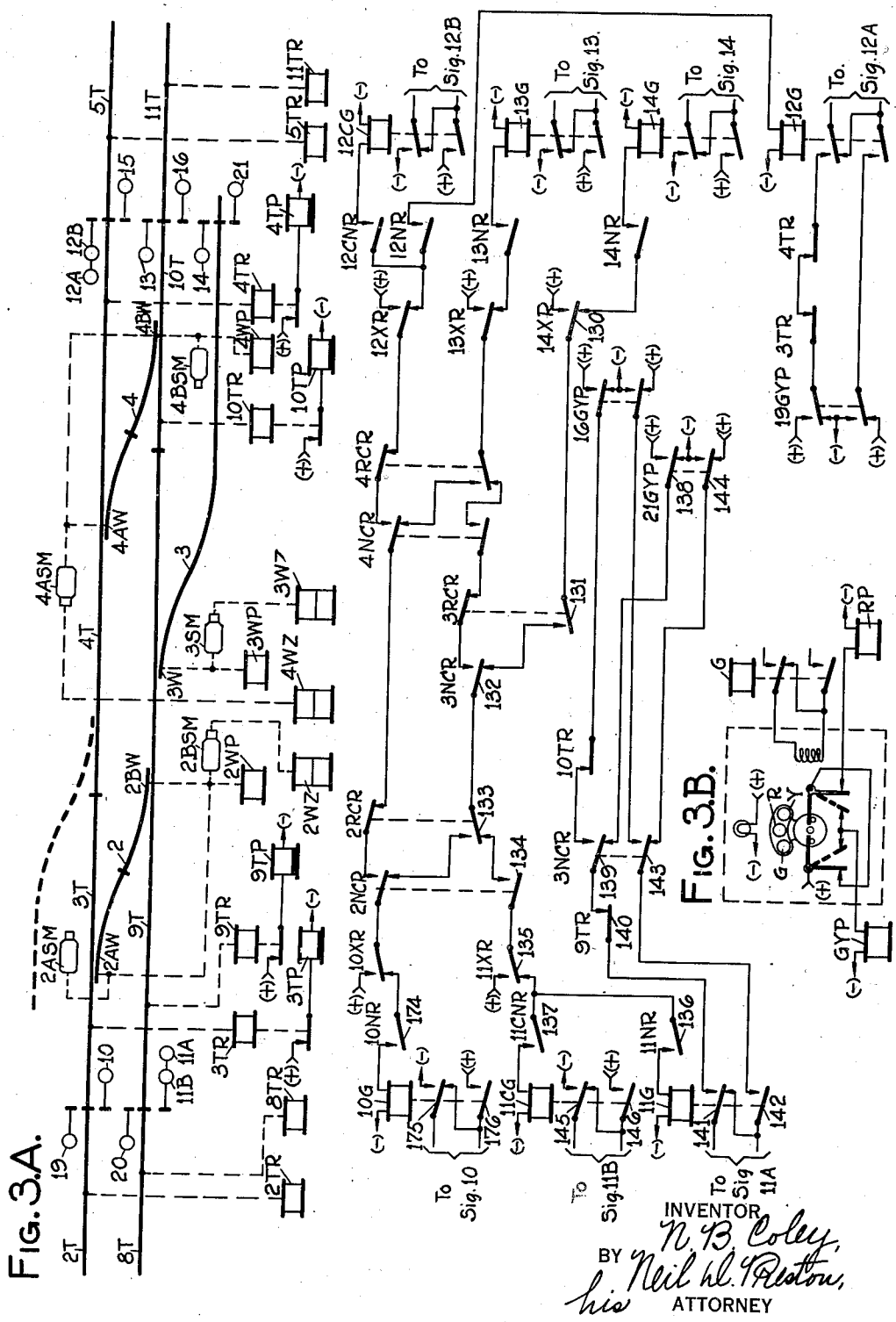
FIG. 2.

INVENTOR
N. B. Coley,
BY Neil H. Preston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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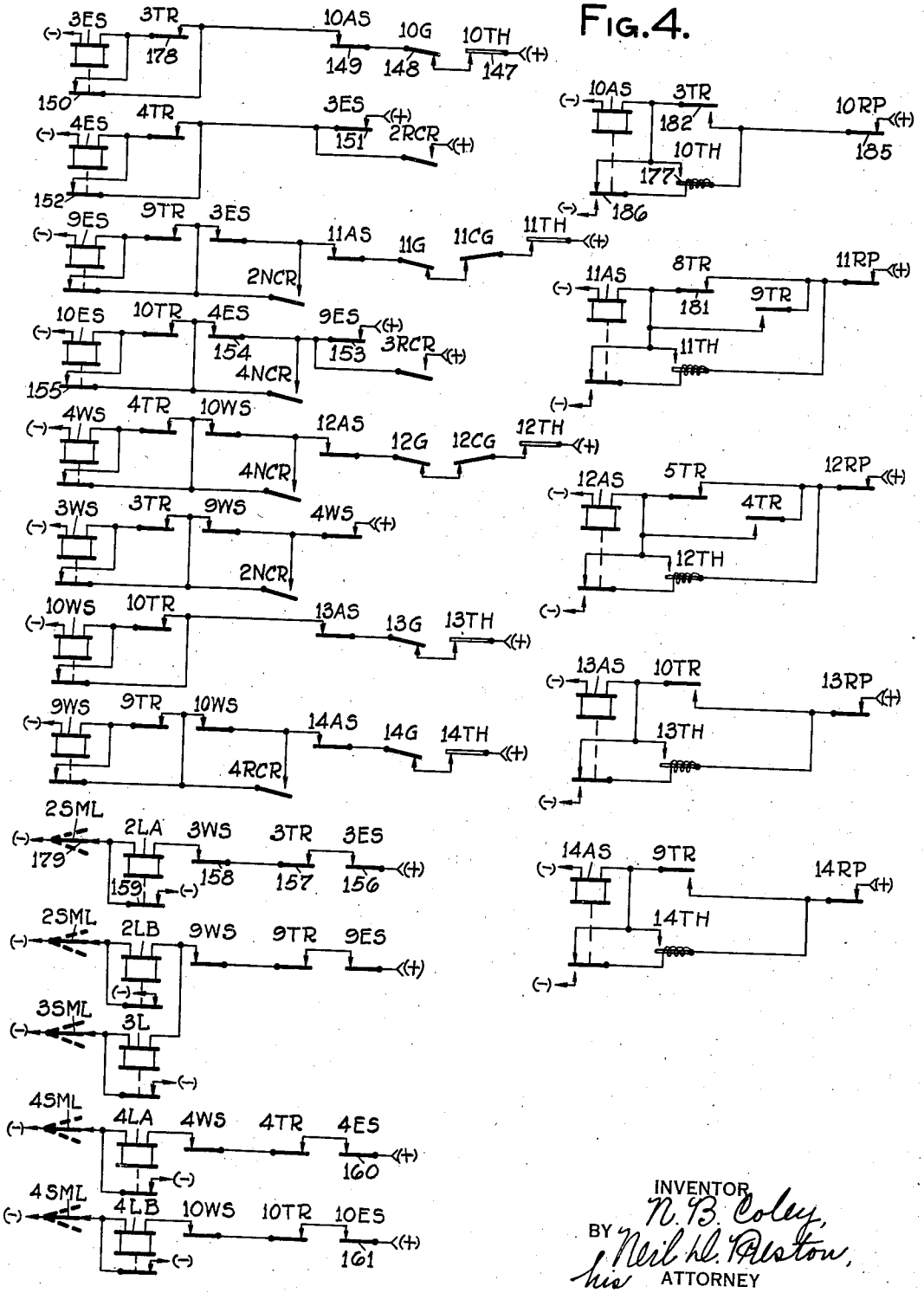
INVENTOR
N. B. Coley,
BY Neil W. Preston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 4.



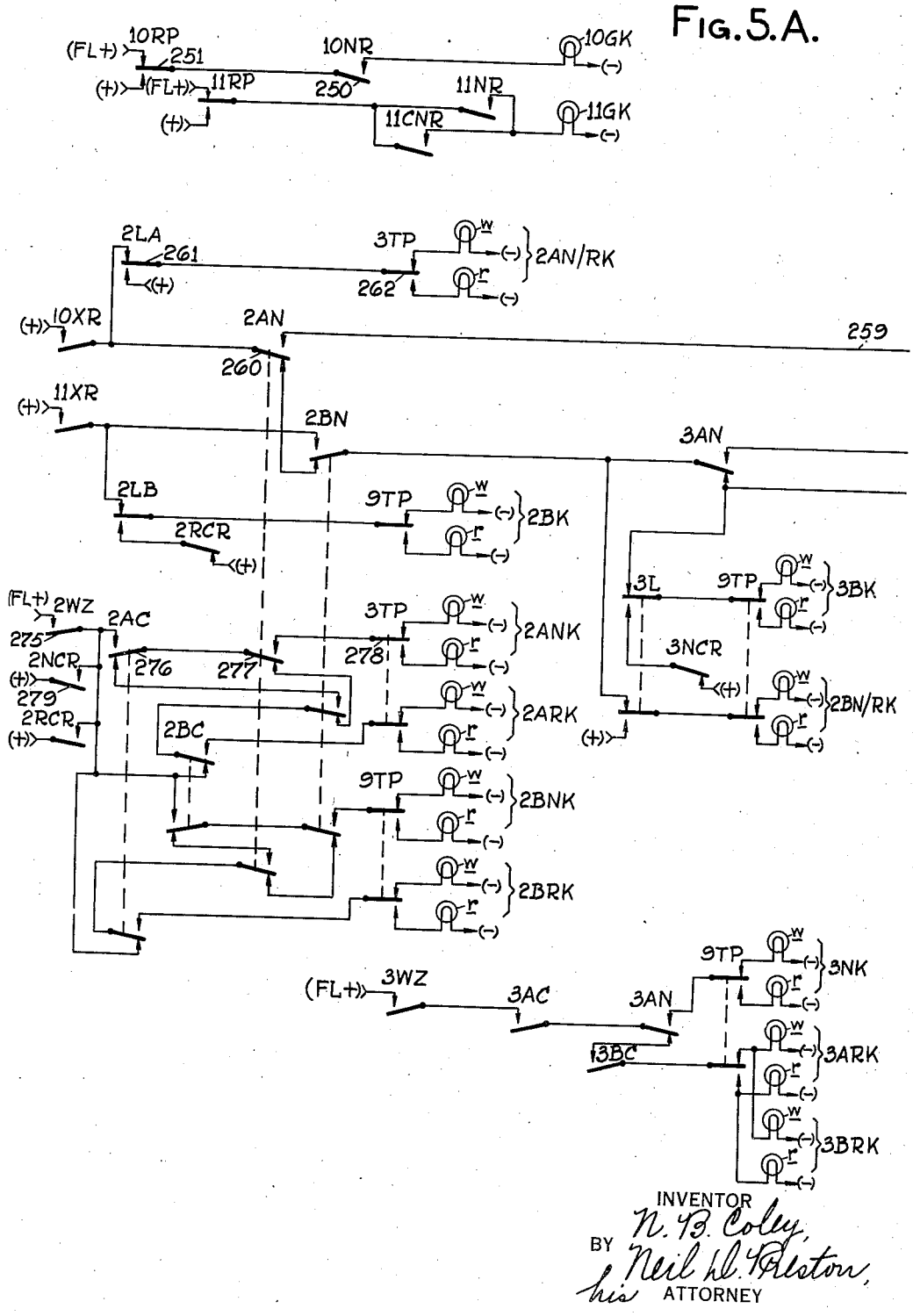
INVENTOR
N. B. Coley,
BY Neil H. Reston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 5.A.



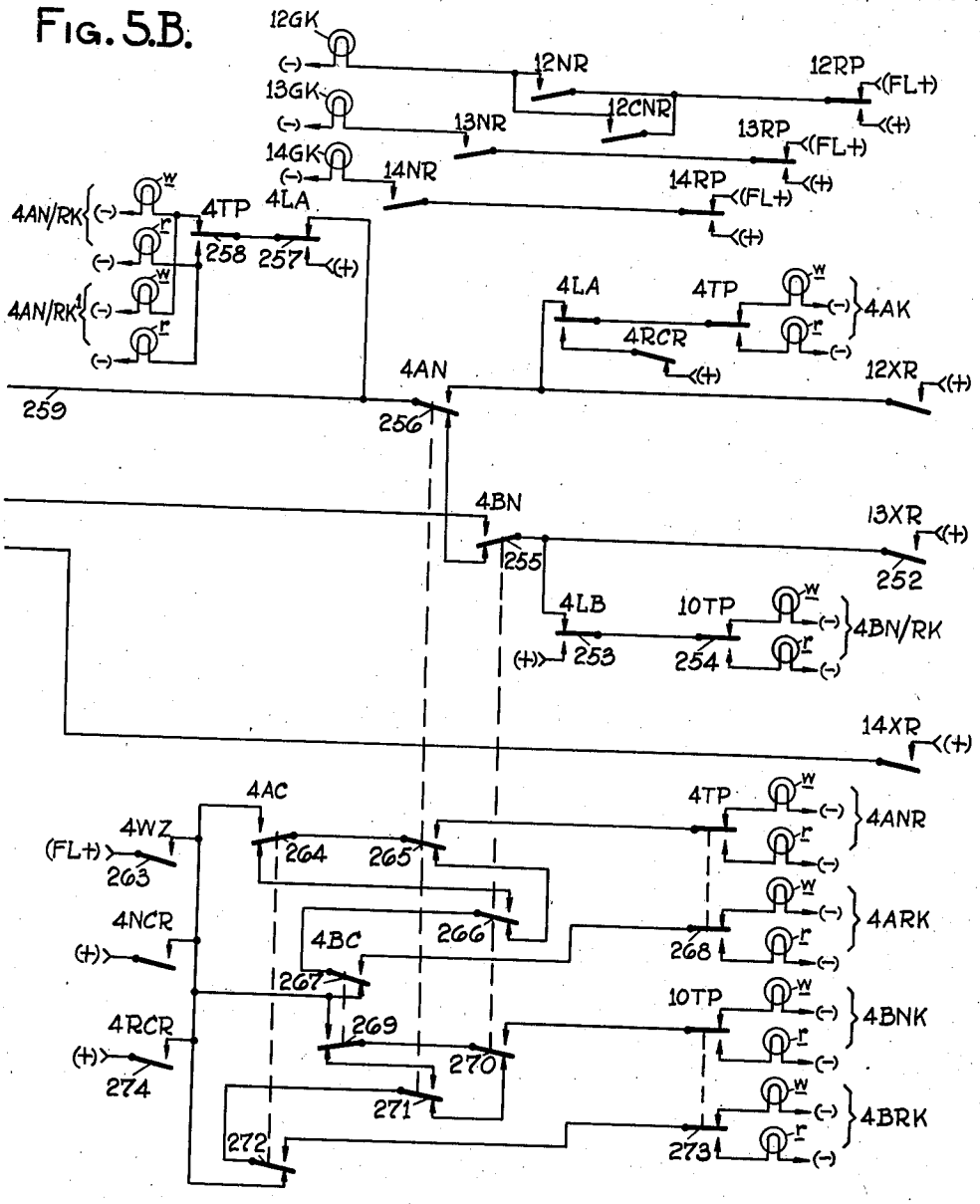
INVENTOR
N. B. Coley,
BY
Neil H. Preston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 5.B.



INVENTOR
BY N. B. Coley,
his Neil W. Preston,
ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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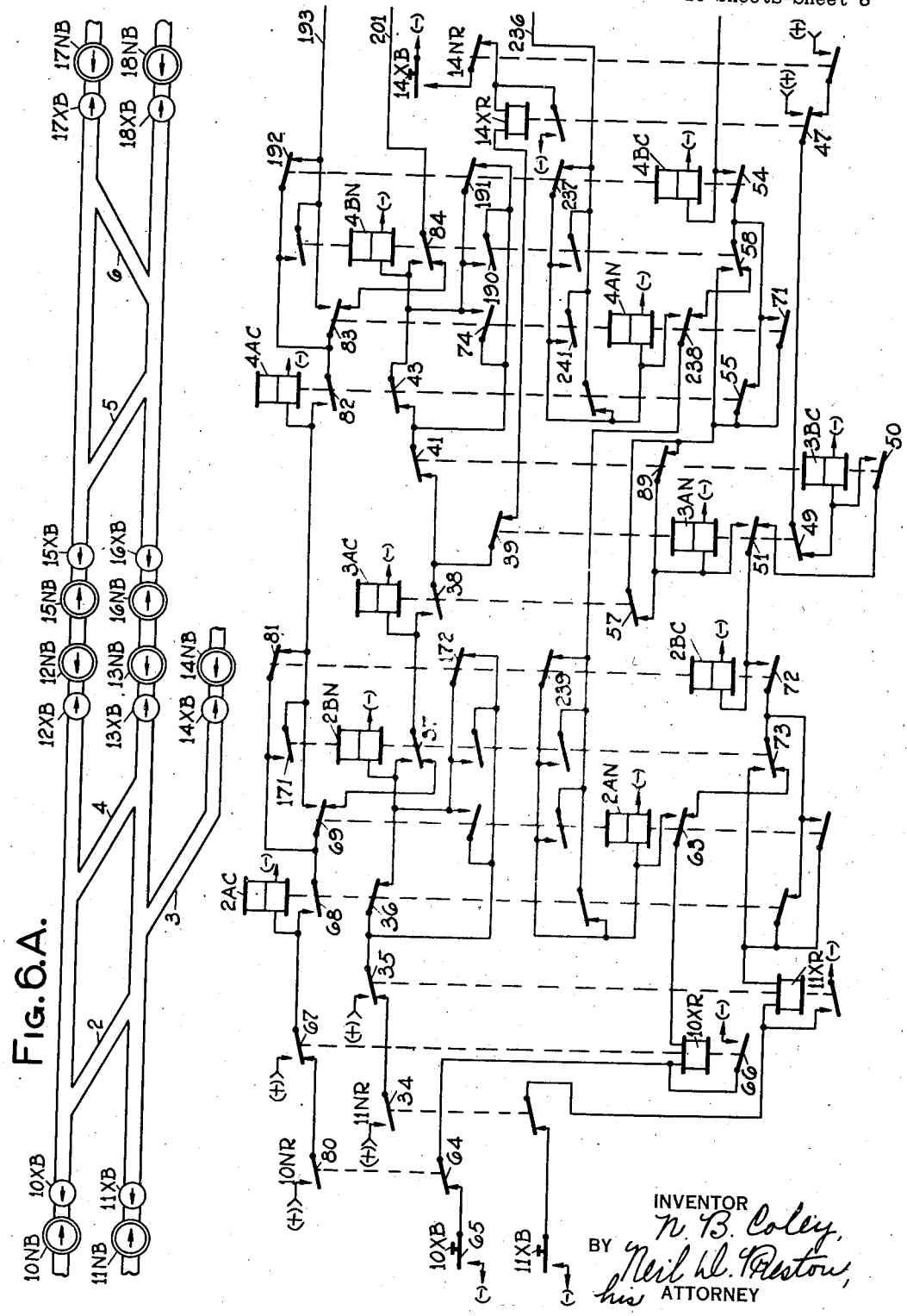


FIG. 6.A.

INVENTOR
N. B. Coley,
BY
Neil W. Preston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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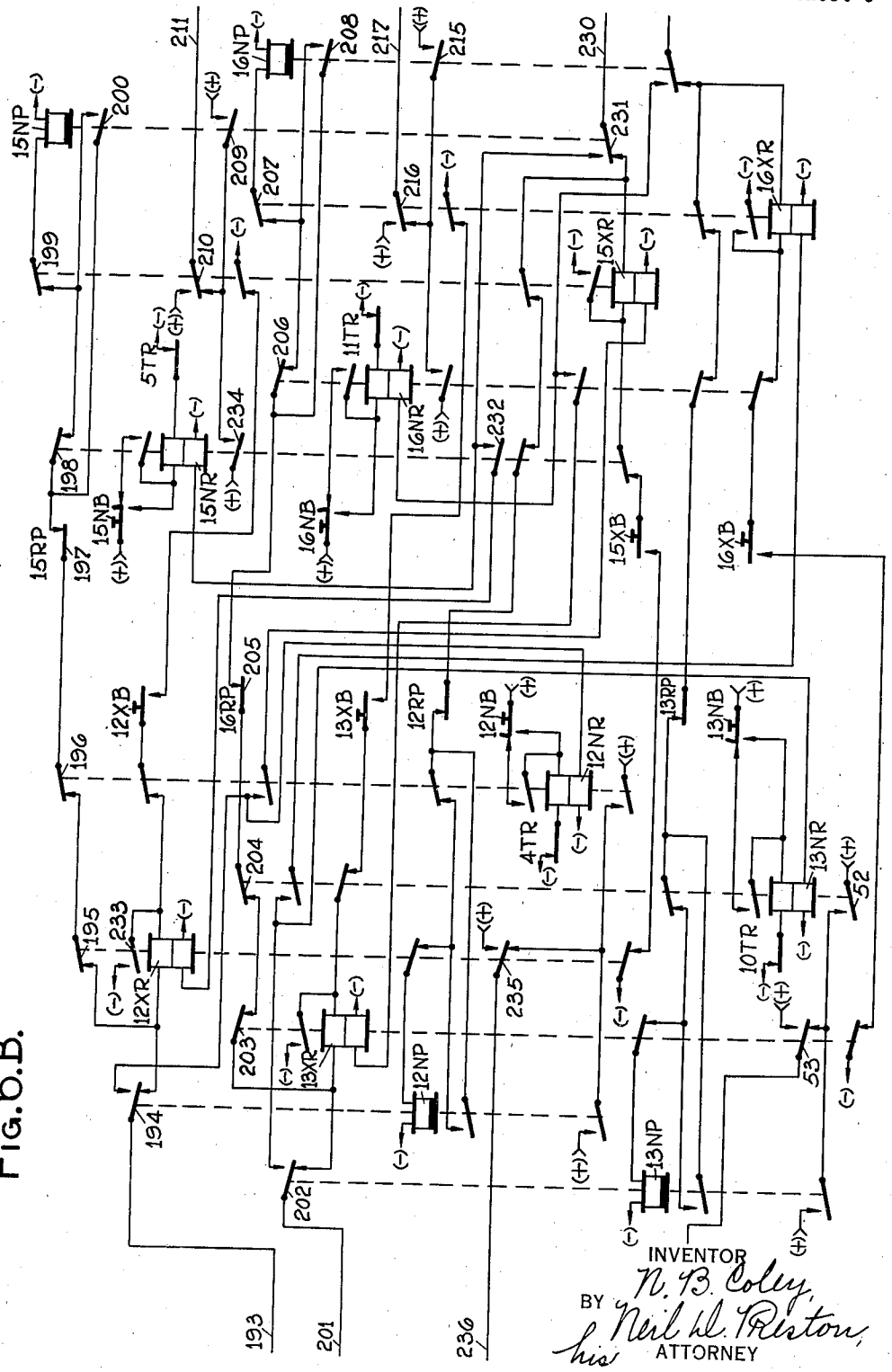


FIG. 6.B.

INVENTOR
N. B. Coley,
BY
Neil M. Preston,
his ATTORNEY

Dec. 9, 1941. N. B. COLEY 2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed April 19, 1940 10 Sheets-Sheet 10

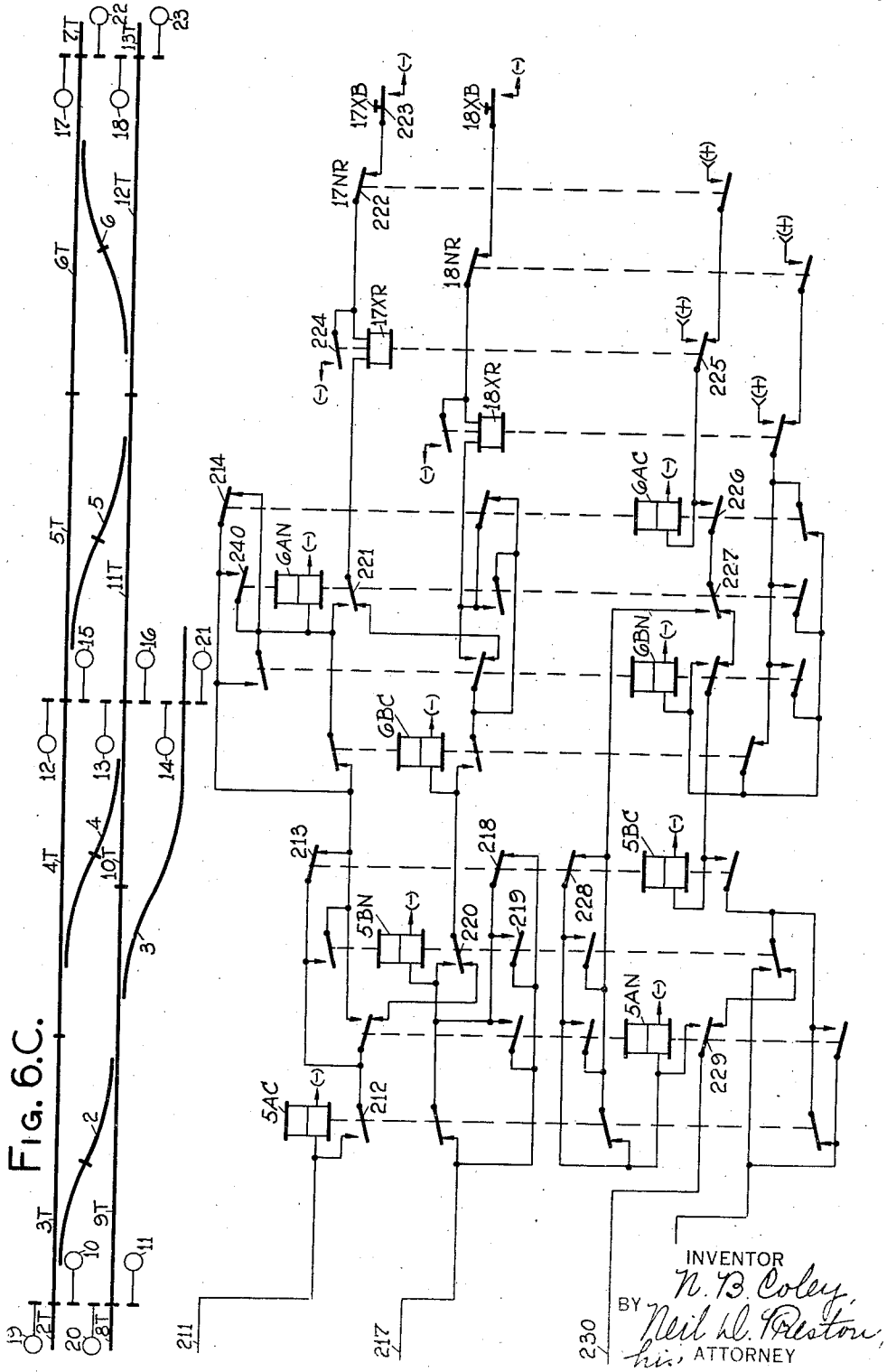


FIG. 6.C.

INVENTOR
N. B. Coley.
BY Neil H. Preston,
his ATTORNEY

Patented Dec. 9, 1941 2,265,351

UNITED STATES PATENT OFFICE

2,265,351

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Nelson B. Coley, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

Application April 19, 1940, Serial No. 330,534

18 Claims. (Cl. 246—134)

This invention relates to switch and signal control systems for railroads, and it more particularly pertains to a switch and signal control system of the entrance-exit type.

An entrance-exit switch and signal control system is characterized by having a control machine at a tower or control office which has a control panel upon which is a miniature track diagram of the track layout for which the system is provided, such diagram having control buttons disposed thereon at points corresponding to the entrance and exit ends of routes extending through the track layout as defined by the location of the various signals. The establishment of each route extending through the track layout is effected responsive to the actuation by an operator of the control buttons for the respective entrance and exit ends thereof. In order that an operator may govern the establishment of routes intelligently in accordance with traffic conditions, suitable indications are provided along the diagram relative to routes established, the condition of the track switches and signals, and the occupancy of the various track sections.

In some entrance-exit systems such as the system provided by the present invention, it is necessary to designate only the extreme entrance and exit ends of a route which includes one or more intermediate signals in order to effect the setting up of that route. A route when set up in such a manner is said to be established by "end-to-end" control, and is conveniently called a "through route." To facilitate the description of the present invention, each group of track switches by which routes not involving intermediate signals can be established, is conveniently called an interlocked group. Thus, a through route extends through a plurality of interlocked groups.

An object of the present invention is to provide an entrance-exit type of system requiring a minimum number of relays and circuit selections which can be readily and effectively applied to the governing of traffic through practically any track layout under all operating conditions required in standard railway practice.

Another object of the present invention is to provide in an entrance-exit system an improved route selecting or route establishing means whereby a definite number of switch position selecting relays is provided for selecting the normal and reverse operation of the track switches of each crossover and each single track switch in the track layout, irrespective of the number of different routes that can be established extending over each of such track switches. For the selective energization of each of such switch position selecting relays, two circuit networks are provided for each of the interlocked groups, one circuit network being energized responsive to the designation of an entrance or exit point for one end of the interlocked group, and the other circuit network being energized responsive to the designation of an entrance or exit point for the opposite end of that interlocked group.

Another object of the present invention is to allow the establishment of a route only if such route is available for use. Such object is accomplished by rendering the designation of an exit point effective for applying energy to the network for the energization of switch position selecting relays only if an exit relay for that exit point is energized. The energization of such exit relay is dependent upon its being conditioned for energization responsive to entrance designation, and the subsequent designation by a operator of that exit point. The conditioning of the exit relays is accomplished by circuit selections in the same circuit networks used for the energization of the switch position selecting relays, such selections providing closed circuit portions or branches through the networks comparable to available routes extending through the track layout. When a route becomes unavailable for use, portions of both circuit networks are opened at circuit portions comparable to the point or points of conflict which render such route unavailable.

Another object of the present invention is to provide that the route establishing means is effective to select a preferred one of alternative or optional routes extending between given entrance and exit points. If such preferred route is rendered unavailable, another of the optional routes is automatically established in accordance with entrance and exit designation of the ends of that route; thus, where several optional routes are involved, a route will always be established as long as any one of such routes is available for use. A general rule by which the system can operate relative to alternative or optional routes is that the available route diverging nearest the entrance point is set up in preference to the other routes. This rule does not apply, however, to run-around routes as in such cases the most direct available route is generally given preference.

Another object of the present invention is to adapt the entrance-exit system to conditions often encountered in practice where a particular one of a plurality of optional routes is desired to be established when available in preference to

other routes, irrespective of the direction of traffic. Such a condition can prevail, for example, where a high speed track switch is desired to be used when possible in preference to a low speed track switch included in an alternative route. Such preference is provided in accordance with special circuit selections provided in the circuit networks for the energization of the relays for selecting the required positions for the track switches, there being no extra relays required.

Another object of this invention is to cause the power operation of only the track switches that are required in each route being established, even though the normal positions of some of the track switches are definitely selected responsive to entrance designation, if such track switches can be trailed in normal positions in routes available for use emanating from that entrance point. That is, responsive to designation of an entrance point, energy is applied to the circuit network which is energized responsive to entrance or exit designation at that end of the interlocked group, which effects the energization of a relay for each facing point switch that can be included in either a normal or a reverse position in a route available for use emanating from that entrance point, and for each track switch that can be trailed in a normal position in a route available for use emanating from that entrance point. The power operation of a track switch, however, is not effected until a second relay for that track switch or crossover is picked up when energized in the other circuit network responsive to the picking up of an exit relay upon the subsequent designatiton of an exit point. The picking up of the exit relay under such conditions causes the energization of relays in the circuit network responsive to exit designation for that end of the interlock group, and the energization of those relays is effected in a manner similar to the energization of switch position selecting relays responsive to entrance designation except that circuit points of conflict have been established in the network because of the energization of relays in the network energized responsive to entrance designation in the setting up of that route. Such circuit points of conflict provide that the energization of switch control relays responsive to the picking up of an exit relay is limited to relays corresponding to a route which has been preselected by the switch position selecting relays responsive to entrance designation extending between the designated entrance and exit points. The power operation of the track switches for each of the crossovers and each of the single track switches is effected responsive to route establishment only when two switch position selecting relays for such track switch or crossover, one in each circuit network, are energized. The combination of the two relays energized determines as by a code what the position of the track switch shall be as one of those relays is energized for both the normal and reverse operation of its track switch, and thus requires the cooperation of a second relay to determine to what position the track switch shall be operated.

Another object of the present invention is to provide in the system means by which a route can be established by end-to-end control past intermediate signals. As a means for effecting such end-to-end control, a through route control relay is energized responsive to entrance designation for each intermediate signal that can be included in an available route emanating from that entrance point, the energization of that relay being ultimately effective after exit designation to cause route establishment past that intermediate signal as if the control buttons for the entrance and exit points at that intermediate signal had been actuated, if that intermediate signal is included in the through route to be established between designated entrance and exit points.

Another object of the present invention is to provide a system for clearly displaying indications along the track diagram in accordance with the response of the circuit network in the establishment of routes to keep the operator well informed as to the conditions which he must consider in intelligently manipulating the entrance and exit control buttons for the establishment of routes. Such indications are provided in the form of relatively continuous lines of light provided along the track diagram to correspond with routes established, and to distinctively indicate the presence of trains in such routes.

It is believed that other objects and purposes of the present invention will be apparent and more readily understood from reference to the accompanying drawings and as they are pointed out during the description of the present invention.

In describing the invention in detail reference will be made to the accompanying drawings, in which like reference characters designate corresponding parts throughout the several illustrations, in which letter reference characters are used to designate parts of a similar general nature or function, such parts being generally made distinctive by reason of preceding numerals representative of the location or position of the function with which such parts are associated, and in which:

Figs. 1A and 1B, when placed side by side, illustrate the miniature track diagram provided for this embodiment of the present invention together with the route establishing means provided for automatically selecting each route to be set up in accordance with the designation of the entrance and exit ends thereof;

Fig. 2 illustrates certain switch and signal control circuits for a particular crossover as typical of the circuits provided for each of the crossovers and each of the single track switches included in the track layout for which this embodiment of the present invention is provided;

Figs. 3A and 3B illustrate the track layout for which the entrance-exit system is provided, together with control circuits relative to the control of the signals of such track layout.

Fig. 4 illustrates approach and route locking means as applied to the entrance-exit system of the present invention;

Figs. 5A and 5B, when placed side by side, illustrate the means of control provided for indicator lamps for the display of indications along the track diagram illustrated in Fig. 1A; and

Figs. 6A, 6B and 6C, when placed end-to-end, illustrate the use of end-to-end control in the entrance-exit system provided by the present invention.

Reference is made in the description of the present invention from time to time, to functions common to all parts of a similar kind or class by the use of letter reference characters common to such parts without their preceding numerals. Such reference is to be understood to apply to parts designated in the drawings by reference characters that are similar except for preceding numerals.

In order to simplify the disclosure of the pres-

ent invention, various diagrammatic and conventional illustrations generally known to those familiar with the art have been employed in the drawings, rather than attempting to show the particular construction and arrangement of parts actually used in practice. The various relays and contacts are therefore shown in a conventional manner, certain circuit details well known to those familiar with the art are merely indicated by dotted lines, and symbols are used to indicate the connections to the terminals of the batteries or other sources of electric current. In order to facilitate in the arrangement of the circuits in the drawings, some of such circuits have been shown in the conventional written circuit manner, the reference character provided above each of the relay contacts being used to identify the particular relay with which such contact is associated.

The symbols (+) and (−) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current, and the circuits with which such symbols are used always have current flowing in the same direction. The symbol (FL+) is used to indicate the connection with the positive terminal of a frequently interrupted source of energy. If alternating current is used instead of direct current, the symbols are to be considered as representative of instantaneous relative polarities.

Track layout.—It is to be understood that the present invention is adapted for use with practically any type of track layout encountered in practice, and that the comparatively simple track layout illustrated in Fig. 3A for which this embodiment of the present invention is provided, illustrates merely a typical application of the system, and such track layout can also be considered as being only a particular part or unit of a complex system, other units or interlocked groups being connected, for example, as is typically illustrated in the track layout shown in Fig. 6C.

With reference to Fig. 3A, the track layout consists of two parallel tracks interconnected by crossovers **2** and **4**, and a third track connected to the lower one of such main tracks by a single track switch **3**.

With reference to Fig. 6C, a track layout corresponding to that shown in Fig. 3A is illustrated as having the main tracks extended to the right past intermediate signals to provide an adjoining interlocked group, the main tracks of that group being interconnected by crossovers **5** and **6**.

Each of the track switches in the two track layouts illustrated is power operated by a switch machine SM of a type generally employed in practice such, for example, as the switch machine shown in the patent to W. K. Howe, Patent No. 1,466,903, dated September 4, 1923. If that type of a switch machine is employed, for each of the track switches its motor should preferably be governed in a suitable means to provide overload protection and features generally required in practice with respect to the control of switch machine motors, such, for example, as is shown in the patent to W. H. Hoppe et al., Patent No. 1,877,876, dated September 20, 1932. The track switches **2**AW and **2**BW, therefore, for the A and B ends of the crossover **2**, for example, are power operated by the switch machines **2**ASM and **2**BSM respectively.

A polar neutral relay WP is employed in the usual manner for repeating the locked position of the track switches of each of the crossovers, and for the single track, in correspondence with the locked position of the switch machine or switch machines associated therewith. Such WP relay is energized with one polarity when the track switch or track switches with which it is associated are in a normal locked position, in correspondence with the normal locked position of the switch machine for such track switch or track switches; and such WP relay is energized with the opposite polarity when correspondence is established between the switch machines and track switches in their reverse locked positions. Each of the WP relays is energized only when either of such conditions is fulfilled. For effecting such control of each of the WP relays, the circuits therefore generally selected by contacts provided on a point detector contact mechanism such as is shown, for example, in the patent to C. S. Bushnell, Patent No. 1,517,236, dated November 25, 1924.

Signals are provided for governing traffic through the track layout illustrated in Fig. 3A, in both directions, signals **10**, **11**A, **11**B, **15**, **16** and **21** being provided for governing east bound traffic through the track layout to the right, and signals **12**A, **12**B, **13**, **14**, **19** and **20** being provided for governing west bound traffic to the left.

The signals illustrated are of the search light type having their indications governed in accordance with the distinctive energization, or the de-energization of an operating mechanism which can be, for example, of the type disclosed in the patent to O. S. Field, Patent No. 1,835,150, dated December 8, 1931. It is to be understood that other types of signals such as signals having individual color lamp units, position light signals, and semaphore signals can as well be employed, and it is to be further understood that the arrangement of the signals along the track layout can vary in accordance with the requirements of practice.

Of the signals illustrated in Fig. 3A, it is assumed that they are all of the low speed type displaying a yellow indication for proceed and a red indication for stop except for the signals **11**A and **12**A which in addition to those indications can display a green higher speed indication selected dependent upon the clearing of the next signal in advance. The signals **11**B and **12**B are of the low speed type generally known as call-on signals.

The track layout illustrated in Fig. 3A is shown to be divided into track sections in the usual manner, the upper track being divided into track sections **2**T, **3**T, **4**T and **5**T, and the lower one of the main tracks being divided into track sections **8**T, **9**T, **10**T and **11**T. It is to be understood that each of the track sections is provided with a track circuit (not shown) in the usual manner for the control of a track relay TR associated therewith. It is also to be understood that the track switches are properly bonded to provide the usual fouling protection.

With reference to Fig. 6C, it will be noted that the track layout illustrated therein for which the circuits shown in Figs. 6A, 6B and 6C are provided has the same general type of track circuits and signals, all of the signals, for simplicity being assumed to be of the low speed type.

Control machine.—The control machine provided in a tower or control office generally located near the track layout for which the system is provided has a control panel upon which is constructed a miniature track diagram corresponding to the track layout for which the system is

provided. Thus the track diagram illustrated in Fig. 1A is constructed on the control panel of the control machine to correspond to the track layout illustrated in Fig. 3A, such diagram having its trackway made up of a series of linear translucent inserts in the panel which can be illuminated by indicator lamps secured to the back of the panel. The position of the translucent inserts along the trackway of the diagram is determined by the type of indications desired to be displayed in a manner to be more fully described when considered in detail the indications provided. Entrance and exit buttons NB and XB respectively are provided at points on the miniature track diagram corresponding to entrance and exit points at the track layout as defined by the location of the various signals. The portions of the track diagram extending between the buttons and between the translucent inserts is preferably painted lunar white to correspond with the color of the translucent inserts, in order that the diagram may appear continuous in effect when the lamps behind the translucent inserts are extinguished.

Each of the entrance buttons NB used for designation of entrance points in the establishment of routes is of a character having several distinctive operating positions, and such button can be constructed, for example, as shown in the prior application of J. F. Merkel, Ser. No. 158,720, filed August 12, 1937. Each of such buttons is normally biased to a normal position from which it can be either depressed or pulled out. There is a contact associated therewith which is normally closed, and is maintained closed when the button is depressed, but is opened when the button is pulled out; and there is another contact which is closed only when such button is in its depressed position. Whenever a call-on signal is provided in the track layout such, for example, as the signal 11B (see Fig. 3A), the entrance button NB associated therewith has a distinctive rotated position for selecting the control of such signal, and has a contact closed in that rotated position.

Each of the exit buttons XB used for designation of its particular exit point in the establishment of routes is of the self-restoring push button type having a contact closed only when such button is depressed.

Although separate buttons have been shown in this embodiment of the present invention for use in designating the respective entrance and exit ends of each route, it is to be understood that a single button can as well be provided for both entrance and exit designation for each of the route ends, if a sufficient number of distinctive operating positions is provided to fulfill the circuit requirements, or if circuit means is provided for distinguishing between the actuation of that button for designation of respective entrance and exit points at that route end.

An auxiliary means is provided for the control of the track switches of each of the crossovers and for the control of each of the single track switches by an auxiliary switch control lever SML on the control panel provided therefore, in order to allow the individual operation of each of the single track switches and the track switches associated with each of the crossovers under desirable conditions, such for example, as for attempting to free the track switches of obstructions. Such auxiliary means can also be used to provide for the establishment of routes not ordinarily established automatically by the route establishing means, and for other purposes which will be more readily apparent from reference to the more specific description of the auxiliary control as hereinafter pointed out.

System devices.—An entrance relay NR is associated with each of the entrance points, and is energized responsive to the actuation of the entrance button NB for that entrance point. Such relay NR, when energized, is maintained energized by a stick circuit, dependent for restoration either upon passage of a train, or upon manual designation of such restoration by the pulling out of the entrance button NB for that entrance point.

In a similar manner an exit relay XR is associated with each of the exit points, such relay being picked up when the exit button XB for that exit point is depressed subsequent to the designation of an entrance point, only if there is an available route extending between those entrance and exit points. Such exit relay when picked up is maintained energized by a stick circuit, dependent upon the energized condition of the entrance relay NR for the entrance end of the route having its entrance and exit points designated.

Each of the crossovers in the track layout has associated therewith four neutral switch position selecting relays which are selectively responsive to entrance and exit designation in the establishment of routes, there being three of such relays provided for each of the single track switches. Of the four switch position selecting relays provided for each of the crossovers two of the relays are more directly associated with the A end of the crossover and the other two relays are more directly associated with the B end of the crossover. One of the relays for the A end of the crossover is responsive to designation of an entrance or exit point for a particular end of the interlocked group, while the other switch position selecting relay for that end of the crossover is energized responsive to the designation of an entrance or exit point at the opposite end of the interlocked group.

The relay AC is provided for the facing point of the track switch at the A end of the crossover and is therefore energized in the establishment of a route over that end of the crossover with the track switch in either a normal or a reverse position, while the relay AN for that end of the crossover is provided for the trailed position of the track switch and is energized only in the establishment of a route over that end of the crossover in a normal position. The relays BC and BN function in a relatively similar manner for the B end of the crossover, relay BC being common to normal and reverse positions of the track switches of the crossover. Therefore, for example, for the A end of crossover 2, the relay 2AC is energized responsive to entrance designation for east bound traffic through the track layout or responsive to exit designation for the same route end, and the relay 2AN is energized responsive to entrance designation for west bound traffic through the track layout or responsive to exit designation for that route end.

With reference to Fig. 2, a polar neutral relay WZ is provided for more directly governing the operation of each of the single track switches and the track switches of each crossover in accordance with the selective energization of the switch position selecting relays AC, AN, BN and BC. Such relay WZ is used in order to provide desirable features with respect to the control of the track switches as hereinafter pointed out,

such, for example, as a means for reversing the track switch in midstroke.

A relay NCR and a relay RCR is provided for each of the crossovers and for each of the single track switches for repeating the correspondence of the track switches of the crossover or of the single track switch with the position called for such crossover or single track switch by the energization of the switch position selecting relays.

With reference to Fig. 3A, a signal control relay G is provided for governing the clearing of each of the respective signals at the track layout after each route is established. With reference to Fig. 3B, each of the signal mechanisms is provided with contacts for selecting the control of signal repeater relays GYP and RP, the relay RP being normally energized to correspond with the red stop indication normally displayed by the signal, and the relay GYP being energized only when the signal has been cleared.

With reference to Fig. 4, various relays are provided associated with the locking, the relays ES and WS being normally energized relays associated with the route locking, the relays AS being normally energized relays associated with the approach and time locking, and the relays L, LA and LB being used as means of repeating the various types of locking provided. Each of the relays AS has a thermal relay TH associated therewith in the usual manner.

Having thus considered the general function of the various parts of the system, it is believed expedient to consider the mode of operation of the system and the principles involved in accordance with various typical operating conditions.

Operation

Normal conditions.—It is assumed that normal conditions of the system exist when the track layout is unoccupied by trains, when there are no routes established through the track layout, or partially established, and when the signals governing traffic over the routes are all at stop. In accordance with such conditions, the indicator lamps for display of the indications are all normally deenergized. The track switches will of course assume the position in which they were last required in the last route established, and, for the purpose of the present disclosure, it is assumed that the last routes established were through routes on the two main tracks, thus providing that the track switches are all in their normal positions under the assumed normal conditions. The relays associated with the route selecting or route establishing means are all normally deenergized, and the relays which are energized under normal conditions are those relays relative to the locking as shown in Fig. 4 in addition to the track relays TR, track repeater relays TP, and switch repeating relays WP which are of course normally energized in the usual manner.

Route establishing means.—The route establishing means as illustrated in Figs. 1A and 1B consists, generally speaking, of two circuit networks which are responsive for the energization of switch position selecting relays to the energization of entrance and exit relays NR and XR which in turn are energized responsive to respective entrance and exit designation in the setting up of each desired route extending through the track layout. The circuit networks fulfill two principal purposes, one of which is to provide selective energization for the exit relays XR to insure that such relays are picked up only when routes are available extending between entrance and exit points, and a second purpose of such circuit networks is to provide a circuit means for selectively energizing the switch position selecting relays for each of the crossovers and each of the single track switches, such two general purposes of the circuit networks being interrelated because of the selective energization of the switch position selecting relays governs the circuit portions through the circuit network by which the exit relays XR are conditioned to render their picking up effective upon exit designation. More specifically, one of the circuit networks has feed points comparable to the entrance and exit points at the left hand or west end of the track layout, and such feed points cause energy to flow in the circuit network when an entrance point is designated through each portion of the circuit network which corresponds to a route available for use emanating from such entrance point. If there is a route emanating from that entrance point available for use extending to an exit point, energy is fed throughout the length of the circuit network to condition the relay XR for that exit point in such a manner that it may be picked up responsive to the actuation of the exit button XB for that exit point. It is furthermore provided that as many exit relays are conditioned for energization in that manner as could be included in a route available for use emanating from the designated entrance point.

In feeding energy through the circuit network from the front contact of an entrance relay NR responsive to entrance designation, a common switch position selecting relay AC or BC is picked up for each track switch facing such entrance point, if that track switch can be included in a route available for use emanating from that entrance point. Similarly, energy feeding through the circuit network responsive to entrance designation causes the picking up of a relay AN or BN for each track switch that can be trailed in a normal position in a route available for use emanating from such designated entrance point. The response of the switch position selecting relay, to entrance designation establishes conditioning circuits for the exit relays XR in such a manner that each exit relay XR is conditioned so that it can be picked up upon exit designation for that exit point, only if there is an available route extending from the designated entrance point to that exit point.

When an exit relay XR is energized in the establishment of a route, energy is applied to the other circuit network for the energization of the switch position selecting relays to effect the selective energization of relays to complete the selection or establishment of the route. The energization of switch position selecting relay responsive to the picking up of each of the exit relays is effected in a manner comparable to the conditioning responsive to entrance designation, the same circuits being used as are used when an entrance point is designated at that route end. The selective energization of such relays responsive to exit designation, however, instead of being effected for each route emanating from such point is effective only for the route corresponding with the one preselected upon entrance designation. Thus, the response to the relays to entrance designation establishes circuit points of conflict which in effect provide that only one route is available for selection responsive to exit designation, such route corresponding with

a route preselected responsive to entrance designation.

To consider a specific example of the mode of operation of the system in the establishment of a route, assume, under normal conditions, that an operator desires to establish a route from 11 to 14. He first depresses the entrance button 11NB for designation of the entrance point for that route, and responsive to such designation the relay 11NR is picked up, and the picking up of that relay causes energy to feed through the circuit network energized in accordance with entrance and exit designation for that end of the interlocked group. Such energy feeding through the network causes the picking up of relay 2BN because the B end of the crossover 2 is trailed in a normal position in a route emanating from the entrance point at 11. The picking up of relay 2BN causes the picking up of relay 3AC because the single track switch 3 has its facing point included in a route emanating from the designated entrance point, and the picking up of that relay closes a circuit which feeds energy to the winding of relay 14XR. The picking up of relay 3AC also feeds energy along the branch of the circuit network corresponding to the main track to cause the energization of relay 4BN because the B end of crossover 4 is trailed in a normal position from the designated entrance point, and the picking up of relay 4BN closes the circuit for the conditioning of relay 13XR extending to the winding of that relay, so that such relay can be picked up if the exit button 13XR is depressed for designation of the exit point.

Assume, after relay 14XR has been conditioned for energization in the manner described that an operator depresses the exit button 14XB for designation of the exit end of the route extending from 11 to 14, and the depression of that button causes the picking up of relay 14XR inasmuch as it is assumed the route from 11 to 14 to be available. Upon the picking up of relay 14XR, energy is applied to a feed point of the circuit network which is energized responsive to the designation of route ends for the right hand end of the track layout, and energy feeding through such circuit network causes the picking up of the relay 3BC for the track switch 3. Responsive to the picking up of that relay energy is applied to the relay 2BC for the track switch at the B end of crossover 2 which faces the exit point designated, thus completing the selection of the route extending from 11 to 14. It will be noted that the picking up of relay 2BC cannot pass energy on through the branch of the network corresponding to the track portion extending over crossover 2 because such branch of the circuit network has been opened initially by the picking up of relay 2BN responsive to the picking up of relay 11NR.

To consider specifically the circuits by which the relays are energized in the establishment of the route from 11 to 14, the relay 11NR is picked up responsive to the depression of button 11NB for designation of the entrance end of that route by the energization of a circuit closed from (+), including front contact 30 of relay 9TR, contact 31 of button 11NB closed in a depressed position, back contact 32 of relay 11CNR, and winding of relay 11NR, to (—). The picking up of that relay closes a stick circuit extending from (+), including front contact 30 of relay 9TR, contact 31 of button 11NB closed in both normal and depressed positions front contact 33 of relay 11NR, and winding of relay 11NR, to (—). The picking up of relay 11NR causes the picking up of relay 2BN by the energization of a circuit closed from (+), including front contact 34 of relay 11NR, back contact 35 of relay 11XR, back contact 36 of relay 2AC, and lower winding of relay 2BN, to (—). The picking up of relay 2BN causes the picking up of relay 3AC by the energization of a circuit closed from (+), including front contact 34 of relay 11NR, back contact 35 of relay 11XR, back contact 36 of relay 2AC, front contact 37 of relay 2BN, and lower winding of relay 3AC, to (—). When relay 3AC is picked up, a circuit is closed for conditioning the relay 14XR for energization extending from (+), including front contact 34 of relay 11NR, back contact 35 of relay 11XR, back contact 36 of relay 2AC, front contact 37 of relay 2BN, front contact 38 of relay 3AC, and back contact 39 of relay 3AN, wire 40, to the winding of relay 14XR. A circuit is also closed at the same time to cause the picking up of the relay 4BN extending from (+), including front contact 34 of relay 11NR, back contact 35 of relay 11XR, back contact 36 of relay 2AC, front contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 41 of relay 3BC, wire 42, back contact 43 of relay 4AC, and lower winding of relay 4BN, to (—). The picking up of relay 4BN closes a circuit in an obvious manner extending to the winding of relay 13XR to condition that relay so that it can be picked up if an exit point be designated at 13.

Assuming the operator depresses the button 14XB after the conditioning of relay 14XR has become effective, the relay 14XR is picked up by the energization of a circuit extending from (+), including front contact 34 of relay 11NR, back contact 35 of relay 11XR, back contact 36 of relay 2AC, front contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 39 of relay 3AN, wire 40, winding of relay 14XR, back contact 44 of relay 14NR, and back contact 45 of button 14XB closed in a depressed position, to (—). The picking up of that relay closes a stick circuit at front contact 46 to shunt contacts 44 and 45 out of the circuit just described.

Responsive to the picking up of relay 14XR, a circuit is closed to cause the picking up of relay 3BC extending from (+), including front contact 47 of relay 14XR, wire 48, back contact 49 of relay 3AN, and lower winding of relay 3BC, to (—). The picking up of relay 3BC causes the picking up of relay 2BC by the closing of a circuit extending from (+), including front contact 47 of relay 14XR, wire 48, back contact 49 of relay 3AN, front contact 50 of relay 3BC, back contact 51 of relay 3AN, and lower winding of relay 2BC, to (—).

The position of the track switches selected in accordance with the selective energization of the switch position selecting relays in the establishment of a route is dependent upon the combination of two relays energized for each of the single track switches or each of the crossovers, such combination determining whether such track switch or switches are to be operated to normal or reverse positions. That is, for example, the joint energization of the relays 2BN and 2BC causes the operation of the track switches of crossover 2 to normal positions, the joint energization of the relays 2AC and 2AN causes the operation of the track switches of crossover 2 to normal positions, and the joint energization of relays 2AC and 2BC with relays 2AN and 2BN deenergized causes the operation of the track switches of crossover 2 to reverse positions. The manner

in which energy is applied to the switch machines for the power operation of the track switches in accordance with the energization of the switch position selecting relays in such combinations is hereinafter considered more in detail.

With reference to the circuits which have just been described it will be noted that, before energy can be applied to the switch position selecting relay 2BN, it is checked that the track switches of crossover 2 are not called for in their reverse positions. Thus, if relays 2AC and 2BC were energized and relays 2AN and 2BN deenergized at that time, energy would be prevented from feeding through the network from front contact 34 of relay 11NR to the lower winding of relay 2BN. Such mode of operation establishes so called circuit points of conflict in the networks at points comparable to points of conflict of routes at the track layout.

Optional routes.—The route establishing means is effective automatically to select a predetermined one of alternative or optional routes extending between an entrance and an exit point as being preferred, the other route, or the other routes, being automatically established only in the event that the preferred route is not available for use, or has been rendered unavailable as far as the circuits are concerned because of the establishment of a circuit conflict by the manipulation of the auxiliary switch control levers. Such mode of operation is effected in accordance with multiple contact selections in the circuits for each of the switch position selecting relays. That is, by the multiple control selections it is provided that certain relays which preselect, responsive to entrance designation, the normal position of a track switch, overrule, so to speak, relays which preselect, responsive to entrance designation, the reverse position of that track switch; and similarly, the relays for preselecting responsive to entrance designation the reverse position of a track switch can be made to overrule relays which preselect, responsive to entrance designation, the normal position of that track switch.

If such multiple circuit selections for the switch position selecting relays are provided, as first described above, so as to give preference to the normal position of each of the track switches that can be trailed in either position in an available route extending from a designated entrance point, the optional route which is then available for use diverging nearest the designated entrance point is given the preference and is selected to be established.

However, if the circuit selections for the switch position selecting relays are provided, as second described above, so as to give the preference to the reverse positions of the track switches of a particular crossover which is not included in the first diverging route from a designated entrance point, the route including such crossover will be given preference, irrespective of the availability of other optional routes diverging nearer such entrance point.

It is believed to be apparent from the general description as it has been set forth that the two conditions described above are directional in that they are considered with reference to a designated entrance point. Such being the case, inasmuch as the circuit networks themselves are directional in their circuit selections, the type of preference for routes in one direction can be provided independent of the type of preference provided for the opposite direction of traffic.

Thus, to illustrate how either form of preference can be used, the first described form is provided (see Figs. 1A and 1B) for west bound traffic, and the second described form is provided for east bound traffic. With reference to Fig. 1A it is therefore provided that the route from 13 to 10 is preferred via crossover 4 (illustrating first described preference), and that the route from 10 to 13 is preferred via crossover 4 (illustrating second described preference). It is to be understood, however, that either type of preference can as well be provided for both directions of traffic in accordance with the requirements of practice.

The picking up of relay 13NR responsive to such entrance designation causes the picking up of relay 4BC for the lower end of crossover 4, and the picking up of that relay causes energy to feed through branches or portions of the circuit network corresponding to the track portions including the respective normal and the reverse positions of the track switches of crossover 4, the feeding of energy through the track portion corresponding to the reverse position of the track switches of that crossover being effective to cause the energization of relay 2AN for the upper end of crossover 2. When relay 2AN is picked up, the exit relay 10XR is conditioned for energization so that it can be picked up upon designation of an exit point at 10. Energy feeding through the branch of the circuit network corresponding to the lower one of the two main tracks causes the picking up of the relay 3AN for the single track switch 3. When relay 3AN is picked up, energy feeds further through the circuit network to cause the picking up of relay 2BC.

Inasmuch as the relay 10XR has been conditioned for energization by energy feeding through the circuit network upon the picking up of relay 2AN, the depression of the button 10XB for designation of the exit point at 10 in the setting up of the route causes the picking up of the exit relay 10XR, and the picking up of that relay applies energy at a feed point for the other circuit network which causes the picking up of relay 2AC for the upper end of crossover 2. The picking up of relay 2AC causes energy to feed on through the portion of the circuit network corresponding to the upper main track to cause the picking up of the relay 4AC for the upper end of crossover 4, which relay in picking up completes the selection of the route extending from 13 to 10 via crossover 4. The positioning of the track switches of crossover 2 is effected upon the picking up of relay 2AC and is dependent upon the joint energization of relays 2AC and 2AN, while the positioning of the track switches of crossover 4 is rendered effective upon the picking up of relay 4AC, dependent upon the joint energization of relays 4AC and 4BC at a time when relays 4AN and 4BN are dropped away.

The circuit selections are so provided in the selection of the route just described, that if the relay 2BC should be allowed to pick up prior to the picking up of relay 2AN, the relay 2AN would be allowed to be picked up also, and the subsequent completion of the selection of the route responsive to the picking up of the exit relay 10XR would cause the dropping away of the relay 2BC upon the picking up of relay 4AC.

To consider the circuits by which such mode of operation is provided, assume that an operator has just designated the entrance point at 13 by the depression of the button 13NB at a time when the route is available from 13 to 10 via cross-over 4. The depression of that button

effects the picking up of relay 13NR (see Fig. 1B) in a manner similar to that described with reference to the relay 11NR, and the picking up of that relay causes the energization of relay 4BC by a circuit closed from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, and lower winding of relay 4BC, to (—). The picking up of relay 4BC closes a circuit to cause the picking up of relay 3AN extending from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, front contact 54 of relay 4BC, back contact 55 of relay 4AC, wire 56, back contact 57 of relay 3AC, and lower winding of relay 3AN, to (—). Upon the picking up of relay 3AN a circuit is closed to cause the picking up of relay 2BC extending from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, front contact 54 of relay 4BC, back contact 55 of relay 4AC, wire 56, back contact 57 of relay 3AC, front contact 51 of relay 3AN, and lower winding of relay 2BC, to (—).

The picking up of relay 4BC also causes energy to flow through a portion of the circuit network corresponding to the route extending over crossover 4 to cause the picking up of relay 2AN by the energization of a circuit closed from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, front contact 54 of relay 4BC, back contact 58 of relay 4BN, back contact 59 of relay 4AN, wire 60, back contact 61 of relay 2AC, and lower winding of relay 2AN, to (—). The picking up of relay 2AN closes a stick circuit for that relay at front contact 62 to shunt back contact 61 out of the circuit just described.

Upon the designation of the exit point at 10 by the depression of the button 10XB, the relay 10XR is picked up by the energization of a circuit closed from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, front contact 54 of relay 4BC, back contact 58 of relay 4BN, back contact 59 of relay 4AN, wire 60, front contact 62 of relay 2AN, front contact 63 of relay 2AN, winding of relay 10XR, back contact 64 of relay 10NR, and contact 65 of button 10XB closed in a depressed position, to (—). The picking up of that relay closes a stick circuit at front contact 66 to shunt contacts 64 and 65 out of the circuit just described.

Responsive to the picking up of relay 10XR, the relay 2AC in the other circuit network is energized upon the closing of an obvious circuit at front contact 67. The picking up of relay 2AC causes energy to feed through the portion of the circuit network corresponding to the upper main track to effect the energization of relay 4AC, from (+), including front contact 67 of relay 10XR, front contact 68 of relay 2AC, front contact 69 of relay 2AN, wire 70, and lower winding of relay 4AC, to (—). The picking up of relay 4AC opens the circuits which have been described for relays 3AN and 2BC at back contact 55 to effect the release of such relays as those relays are no longer included in a branch of the circuit network corresponding to an available route extending from 13. The route is now completely established from 13 to 10 via crossover 4, thus rendering the route from 13 to 10 via crossover 2 or from 13 to 11 unavailable because of the reverse position selected for the track switches of crossover 4.

For the purpose of illustrating how the route can be established from 13 to 10 via crossover 2 when such route is available, and when the route between those points via crossover 4 is unavailable, it will be assumed that such route via crossover 4 is rendered unavailable because of the presence of an east bound train in the detector track section of the upper end of that track switch, the upper end of the crossover 2 having had its locking released because of the effectiveness of rear release route locking which will be hereinafter considered more in detail. The route locking for track section 4T is effective to maintain the relays 4AC and 4AN energized to correspond with the normal position in which the track switches of crossover 4 are locked.

Under the above assumed conditions, the designation of an entrance point at 13 by the depression of button 13NB causes the picking up of relay 13NR, and the picking up of that relay causes the picking up of relay 4BC by the energization of a circuit which has been described. When relay 4BC is picked up, energy can feed through the branch of the circuit network corresponding to the lower one of the main tracks in the track layout because relay 4AN is picked up at that time to close front contact 71. Thus, responsive to the picking up of relay 4BC, the relays 3AN and 2BC are successively energized, and the picking up of relay 2BC conditions the exit relay 10XR for energization so that the subsequent depression of the exit button 10XB for the designation of the exit point at 10 causes the picking up of relay 10XR by the energization of a circuit closed from (+), including front contact 52 of relay 13NR, back contact 53 of relay 13XR, front contact 54 of relay 4BC, front contact 71 of relay 4AN, wire 56, back contact 57 of relay 3AC, front contact 51 of relay 3AN, front contact 72 of relay 2BC, back contact 73 of relay 2BN, back contact 63 of relay 2AN, winding of relay 10XR, back contact 64 of relay 10NR, and contact 65 of button 10XB closed in a depressed position, to (—). The picking up of relay 10XR closes a stick circuit at front contact 66 to shunt contacts 64 and 65 out of the circuit just described.

Responsive to the picking up of relay 10XR, in the establishment of a route from 13 to 10 via crossover 2, the relay 2AC is picked up in a manner which has been described, and the picking up of that relay causes the energization of relay 3AC by closing a circuit for that relay extending from (+), including front contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, and lower winding of relay 3AC, to (—). It will be noted that the picking up of relay 2AC responsive to the energization of relay 10XR causes energy to feed through the circuit portion of the network corresponding to the crossover 2 because relay 2AN has not been energized responsive to entrance designation and therefore closes back contact 69. The picking up of relay 3AC causes the picking up of relay 4BN by the energization of a circuit closed from (+), including front contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 41 of relay 3BC, wire 42, front contact 74 of relay 4AN, and lower winding of relay 4BN, to (—).

The track switches of crossover 2 are operated to their reverse positions in accordance with the establishment of the route because of the joint energization of relays 2AC and 2BC with relays 2AN and 2BN deenergized. The single track switch 3 is operated to its normal position in

accordance with the joint energization of relays 3AC and 3AN. The track switches of crossover 4 are maintained in their normal positions in accordance with the joint energization of relays 4BN and 4BC.

It is believed to be readily apparent from the specific description as heretofore set forth how the system provided by the present invention can be applied to track layouts having a series of optional routes to provide preference for the available route diverging nearest the entrance point involved, such preference being effective for that direction of traffic irrespective of the type of optional route preference provided for the opposite direction of traffic.

It is to be understood that the same type of preference as described for west bound traffic could have been provided in Figs. 1A and 1B for east bound traffic in a similar manner to the arrangement of the circuits which have been described. Such an arrangement is illustrated, for example, in the circuits shown in Fig. 6A and 6B by which it is provided that the preferred route for each direction of traffic is the one which diverges nearest the designated entrance point.

To consider a typical example of how the circuits can be arranged to provide a preference for selecting the optional route diverging remote from the designated entrance point, with reference to Figs. 1A and 1B, assume under normal conditions that an operator desires to establish a route for east bound traffic from 10 to 13. The designation of the entrance point for such route by the depression of button 10NB causes the picking up of the entrance relay 10NR, and the picking up of that relay causes the picking up of relay 2AC in the circuit network which is energized responsive to entrance or exit designation for the route ends at the left hand end of the interlocked group. The picking up of relay 2AC causes energy to feed in the circuit network through the circuit portion corresponding to the route including the track switch at the upper end of the crossover 2 in a normal position, and also to feed through the circuit portion corresponding to the establishment of a route including the track switches of the crossover 2 in reverse positions. Energy feeding through the branch corresponding to the normal position of the track switches of crossover 2 causes the picking up of relay 4AC for the upper end of crossover 4, and energy feeding through the other branch of the circuit network causes the picking up of relay 3AC for the single track switch 3. Responsive to the picking up of relay 3AC, energy feeds on in the circuit network through a circuit portion comparable to the portion of the track layout including track switch 3 in a normal position, and also through the circuit portion corresponding to the track switch 3 in a reverse position. The feeding of energy through the circuit portion of the network corresponding to the lower main track cannot be effective, however, to cause the picking up of relay 4BN for the lower end of crossover 4 because the circuit for that relay is opened by the relay 4AC which is picked up at that time. If relay 4AC has not yet had time to be picked up, because, for example, of such relay being slightly slow in acting as compared to the other relays used in the system, the momentary energization of relay 4BN with back contact 43 of relay 4AC closed may cause the relay 4BN to be momentarily picked up, but the picking up of relay 4AC will be effective to cause the release of that relay. This particular type of a circuit interlock by which the relay 4AC causes the dropping away or prevents the energization of relay 4BN is the means provided by which the route extending from 10 to 13 via crossover 4 is selected in preference to the route via crossover 2. This is true because the picking up of relay 4BN definitely determines that the track switches of crossover 4 should be operated to normal positions if a route is completely established from 10 to 13.

To consider the circuits in detail for providing the establishment of a route from 10 to 13 via crossover 4, assume that an operator depresses the entrance button 10NB at a time when either of the routes extending between 10 and 13 is available. The picking up of relay 10NR, responsive to such entrance designation, causes the picking up of relay 2AC by the energization of a circuit closed from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, and lower winding of relay 2AC, to (—). Upon the picking up of relay 2AC a circuit is closed to cause the picking up of relay 4AC extending from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 81 of relay 2BC, wire 70, and lower winding of relay 4AC, to (—). The picking up of relay 4AC causes energy to feed through the network to condition the relays 13XR and 12XR for energization.

When relay 2AC is picked up, energy feeds through the portion of the circuit network corresponding to the crossover 2 and causes the picking up of relay 3AC for the single track switch 3 by the energization of a circuit closed from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contacts 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, and lower winding of relay 3AC, to (—). The picking up of relay 3AC causes energy to flow through the portion of the circuit network corresponding to the route including track switch 3 in a reverse position to condition the relay 14XR for energization, and energy also feeds through the branch comparable to track switch 3 in a normal position to back contact 43 which is open at that time in the circuit for relay 4BN.

Upon designation of the exit point at 13 by the depression of button 13XB, the relay 13XR is picked up by the energization of a circuit closed from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 81 of relay 2BC, wire 70, front contact 82 of relay 4AC, back contact 83 of relay 4AN, back contact 84 of relay 4BN, winding of relay 13XR, back contact 85 of relay 13NR, and contact 86 of button 13XB closed in a depressed position, to (—). The picking up of relay 13XR closes a stick circuit at front contact 87 to shunt contacts 85 and 86 out of the circuit just described.

Responsive to the picking up of relay 13XR, the relay 4BC is picked up upon the closing of an obvious circuit at front contact 53, and the picking up of that relay closes a circuit for the energization of relay 2AN extending from (+), including front contact 53 of relay 13XR, front contact 54 of relay 4BC, back contact 58 of relay 4BN, back contact 59 of relay 4AN, wire 60, back contact 88 of relay 2BC, and lower winding of relay 2AN, to (—). The track switches of crossover 4 are operated to their reverse po-

sitions in accordance with the joint energization of relays 4AC and 4BC with relays 4AN and 4BN dropped away in a manner hereinafter described, and the joint energization of the relays 2AC and 2AN cause the normal operation of the track switches of crossover 2 to complete the establishment of the route from 10 to 13 via crossover 4.

If for some reason the track switches of the crossover 4 cannot be operated to their reverse positions, because, for example, of the presence of an east bound train in the detector track section for the upper end of that crossover, when there is a route available extending from 10 to 13 via crossover 2, because of release locking having become effective for that crossover, such route can be established responsive to entrance and exit designations in a manner about to be described.

The designation of an entrance point at 10 under such conditions causes the picking up of relay 10NR, and the picking up of that relay causes the picking up of relay 2AC in a manner which has been described. Upon the picking up of relay 2AC a circuit which has been described is closed for relay 3AC, and the picking up of relay 3AC causes the picking up of relay 4BN by the energization of a circuit closed from (+), extending from front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 41 of relay 3BC, wire 42, front contact 74 of relay 4AN, (that relay being maintained energized because of the presence of a train in the detector track section), and lower winding of relay 4BN, to (—). The picking up of relay 4BN conditions the exit relay 13XR so that the depression of button 13XB causes the picking up of that relay by the energization of a circuit closed from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 41 of relay 3BC, wire 42, front contact 74 of relay 4AN, front contact 84 of relay 4BN, winding of relay 13XR, back contact 85 of relay 13NR, and contact 86 of button 13XB closed in a depressed position, (—). The picking up of relay 13XR, due to the energization of that circuit, closes a stick circuit at front contact 87 to shunt contacts 85 and 86 out of the circuit just described.

Responsive to the picking up of relay 13XR, energy is applied to an obvious circuit for relay 4BC at front contact 53, and the picking up of that relay causes the picking up of relay 3AN by the energization of a circuit extending from (+), including front contact 53 of relay 13XR, front contact 54 of relay 4BC, front contact 58 of relay 4BN, wire 56, back contact 89 of relay 3BC, and lower winding of relay 3AN, to (—). When relay 3AN is picked up, a circuit is closed to cause the picking up of relay 2BC to complete the selection of the route, extending from (+), including front contact 53 of relay 13XR, front contact 54 of relay 4BC, front contact 58 of relay 4BN, wire 56, back contact 89 of relay 3BC, front contact 51 of relay 3AN, and lower winding of relay 2BC, to (—). The track switches of crossover 2 are operated to their reverse positions in accordance with the joint energization of relays 2AC and 2BC with relays 2AN and 2BN deenergized, and the track switch 3 is operated to its normal position in accordance with the joint energization of relays 3AC and 3AN. The track switches of crossover 4 remain locked in their normal positions in accordance with the energized condition of the relays 4BC and 4BN, which are energized in accordance with the normal position of the track switches of crossover 4 to maintain the route established after the east bound train assumed to be on the upper main track has left the detector track section for the upper end of crossover 4. The picking up of relay 4BC in the establishment of the route closes a multiple path in the stick circuit for relay 13XR which includes front contact 90 of relay 4BN connected in series with front contact 91 to provide a multiple path around front contact 74 in the stick circuit for relay 13XR, thus providing that the restoration of the relay 4AN in accordance with the passing of the train on the upper track will not effect the deenergization of the relay 13XR.

Switch control.—In order that the operation of each of the track switches when setting up a route shall be effected only when its operation is required for that route, it is provided that the operation of that track switch to a normal or reverse position is effected only after it has been definitely selected that such track switch must be positioned in the route being established by the joint energization of two switch position selecting relays, one of which being energized responsive to entrance or exit designation for a route end at one end of the interlocked group, and the other being responsive to entrance or exit designation for the opposite end of the interlocked group. The combination of relays energized determines to what position the track switches shall be operated. For example, for crossover 2 it is provided that the positioning of the track switches for that crossover will be effective only under conditions where the switch position selecting relays for that crossover are energized in one of the combinations in the following table:

Switch execution table

Function	Relays			
	AC	AN	BN	BC
2 normal in route	Up	Up		
Do			Up	Up.
2 reverse in route	Up	Down.	Down.	Up.
2 normal by auxiliary control		Up	Up	
2 reverse by auxiliary control	Up	Down.	Down.	Up.
3 normal in route	Up	Up		
3 reverse in route	Up	Down.	Up	
3 normal by auxiliary control	Up	Up		
3 reverse by auxiliary control	Up	Down.	Up	

To consider as a typical example how the track switches of a crossover are operated to their reverse positions responsive to the selection of such positions in the establishment of a route, assume that a route is established extending over the crossover 2 in a manner which has been described responsive to entrance and exit designation, such as is the case in establishing a route as described extending from 10 to 13. The relay 2AC is picked up responsive to entrance designation in the establishment of that route, but the relay 2BC is not picked up until after the exit point at 13 has been designated by the depression of the button 13XB.

The picking up of relay 2BC closes a circuit for the upper winding of relay 2WZ extending from (+), including back contact 95 of relay

2BN, back contact 96 of relay 2AN, front contact 97 of relay 2AC, front contact 98 of relay 2BC, polar contact 99 of relay 2WP in a right hand position, front contact 94 of relay 2LB, front contact 100 of relay 2LA, back contact 101 of relay 2NCR, and lower winding of relay 2WZ, to (—). The picking up of relay 2WZ due to such energization causes the shifting of the polar contacts of that relay to a left hand position and the application of energy at front contact 102 to the reverse control circuit for the switch machines 2ASM and 2BSM for the crossover 2.

After the track switches have completed their operation to their reverse positions, the relay 2WP is again energized and its polar contacts are operated to a left hand position to open the control circuit for relay 2WZ at polar contact 99, thus causing the relay 2WZ to be dropped away, and the opening of the switch machine control circuit at front contact 102. The dropping away of relay 2WZ under such conditions causes the picking up of the reverse correspondence relay 2RCR by the energization of a circuit closed from (+), including back contact 95 of relay 2BN, back contact 96 of relay 2AN, front contact 97 of relay 2AC, front contact 98 of relay 2BC, polar contact 99 of relay 2WP in a left hand position, front contact 103 of relay 2WP, back contact 104 of relay 2WZ, and winding of relay 2RCR, to (—). When relay 2RCR is picked up a branch of the signal control circuits is closed to indicate that such portion of the route has been established in a manner to be hereinafter described when considering more specifically the control of the signals.

Following a similar mode of operation, the track switches of crossover 2 can be power operated from their reverse to their normal positions in accordance with the joint energization of relays 2AC and 2AN responsive to the establishment of a route, or the joint energization of relays 2BN and 2BC. To consider an example of how the track switches are operated to their normal positions, assume that such track switches are in their reverse positions at a time when a route is established including the upper end of crossover 2 in a normal position, and assume the relays 2AN and 2AC to be energized in the establishment of such route. The joint energization of relays 2AN and 2AC applies energy, under such conditions, to the upper winding of relay 2WZ by a circuit closed from (+), including front contact 105 of relay 2AN, front contact 106 of relay 2AC, polar contact 107 of relay 2WP in a left hand position, front contact 108 of relay 2LB, front contact 109 of relay 2LA, back contact 110 of relay 2RCR, and upper winding of relay 2WZ, to (—). The picking up of relay 2WZ, due to such energization, the polar contacts of that relay are operated to a right hand position, and the closing of front contact 102 energizes the normal control wire for the switch machines 2ASM and 2BSM to cause the operation of the track switches of crossover 2 to normal positions. After the switch machines have completed their operation, the relay 2WP is picked up with its polar contacts operated to a right hand position, thus causing the release of relay 2WZ by the shifting of contact 107. Upon the dropping away of relay 2WZ a circuit is closed to cause the picking up of relay 2NCR extending from (+), including front contact 105 of relay 2AN, front contact 106 of relay 2AC, polar contact 107 of relay 2WP in a right hand position, front contact 111 of relay 2WP, back contact 112 of relay 2WZ, and winding of relay 2NCR, to (—). The picking up of relay 2NCR closes a branch of the circuit network for the signal control relays in a manner to be hereinafter described.

It is believed to be readily apparent from the above described circuits that the selection of the normal positions for the track switches of the crossover 2 by the energization of the relays 2BN and 2BC in the establishment of a route including the lower end of the crossover 2 causes the normal operation of the track switches by the energization of circuits similar to those which have been described, except that energy is applied to the circuits for relays 2WZ and 2NCR by front contacts 95 and 113 of relays 2BN and 2BC respectively rather than by contacts 105 and 106 of relays 2AN and 2AC respectively. If the normal positions of the track switches of crossover 2 are called for at a time when those track switches are already in such positions, it is believed obvious that the relay 2NCR is picked up immediately in accordance with the position of the polar contact 107 of relay 2WP, and the relay 2WZ remains deenergized. In a similar manner, responsive to the picking up of relays 2AC and 2BC with relays 2AN and 2BN deenergized in the establishment of a route including the reverse positions of the track switches of crossover 2 at a time when such track switches are already in those positions, the relay 2RCR is energized immediately in accordance with the position of the polar contact 99 of relay 2WP, and the relay 2WZ remains deenergized.

It is provided that the polar neutral switch control relay 2WZ is maintained energized by a stick circuit, once the operation of the track switches of crossover 2 has been initiated, to insure the complete operation of those track switches. For example, when the relay 2WZ has been picked up for operating the track switches of crossover 2 to reverse positions, a stick circuit is established for the lower winding of that relay extending from (+), including front contact 114 of relay 2WZ, polar contact 115 of relay 2WZ in a left hand position, polar contact 99 of relay 2WZ in a right hand position, front contact 94 of relay 2LB, front contact 100 of relay 2LA, back contact 101 of relay 2NCR, and lower winding of relay 2WZ, to (—). In a similar manner a stick circuit is closed including polar contact 115 of relay 2WZ in a right hand position during operation of the track switches of crossover 2 from their reverse to their normal positions.

It is also provided that the track switches of the crossover 2 can be power operated in accordance with the positioning by an operator of the auxiliary switch control lever 2SML provided for that crossover. The operation of the track switches responsive to the positioning of that lever can be effected only when those track switches are not included in a route established, and it is further provided that the establishment of a route, subsequent to the positioning of the track switches of the crossover in accordance with the operation of the auxiliary switch control lever 2SML, cannot be effective to change the position of the track switches as selected by that SML lever as long as such lever is maintained in its normal or reverse operating positions.

The actuation of the auxiliary switch control lever 2SML for crossover 2 to a normal operating position causes the picking up of the switch

position selecting relays 2AN and 2BN, and the picking up of such relays effects the energization of the relay 2WZ for causing the power operation of the switch machines 2ASM and 2BSM in a manner similar to that described in accordance with the energization of other relay combinations characteristic of the selection of the normal positions of the track switches of crossover 2.

The actuation of the lever 2SML, for example, to the normal operating position causes the picking up of the relay 2AN by the energization of a circuit closed from (+), including contact 116 of lever 2SML in a downward position, back contact 117 of relay 2AC, and upper winding of relay 2AN, to (—). The picking up of that relay closes a stick circuit at front contact 118 to shunt back contact 117 of relay 2AC out of the circuit just described. At the same time a circuit is closed to cause the picking up of relay 2BN extending from (+), including contact 119 of lever 2SML in a downward position, back contact 120 of relay 2BC, and upper winding of relay 2BN, to (—). The picking up of that relay closes a stick circuit at front contact 121 to shunt contact 120 out of the circuit just described. Responsive to the joint energization of the relays 2AN and 2BN, the relay 2WZ is picked up when energy is applied to a circuit which has been described for the upper winding of that relay such energy being applied in accordance with the closing of contacts 105 and 122 of relays 2AN and 2BN.

If the lever 2SML, for example, is operated to its upper reverse operating position at a time when the track switches of the crossover 2 can be operated to their reverse positions, such as under the conditions assumed to be normal, the relays 2AC and 2BC are picked up to cause the operation of the track switches of crossover 2 to reverse positions. The relay 2AC is picked up under such conditions by the energization of an obvious circuit closed at contact 116 of lever 2SML in an upper position, and relay 2BC is picked up by the energization of an obvious circuit closed at contact 119 of lever 2SML in an upper position. The joint energization of the relays 2AC and 2BC with relays 2AN and 2BN deenergized causes the reverse operation of the track switches of crossover 2 in a manner corresponding to that which has been described.

If it is desired to cause the reversal of the track switches of crossover 2, for example, in midstroke for some particular reason such as because of the failure of the track switch to complete its operation on account of an obstruction, such mode of operation can be accomplished by restoring the switch position selecting relays to normal, and causing the energization of the relays for the desired position of the track switches either by the establishment of a route, or by the actuation of the auxiliary switch control lever 2SML. To consider an example of how such mode of operation can be effected, assume that the reverse position of the track switches of crossover 2 has been called for, and the relay 2WZ has been energized in accordance with the reverse positions selected for the track switches. Also assume that an obstruction prevents the complete operation of the track switches and the operator restores the relays for selecting the reverse positions and causes the energization of the relays for causing the operation of the track switches of crossover 2 to normal positions. The relay 2WZ is maintained energized during such restoration by the stick circuit for that relay which has been described, but the application of energy to the upper winding of relay 2WZ is effected upon the joint energization of the switch position selecting relays for selecting the normal operation of the track switches, and such energization causes the neutralization of the flux in the relay 2WZ, and the momentary release of that relay, such release being effective to open the stick circuit for the lower winding of that relay at front contact 114, and causes the polar contacts of relay 2WZ to shift in their positions in accordance with the normal switch control called for. Such shifting of the polar contacts causes the operation of the track switches of the crossover 2 back to their normal positions.

Signal controls.—With reference to Fig. 3A, the clearing of each of the signals is dependent upon the energization of a signal control relay G, each of such G relays being energized by a circuit network selected by the correspondence relays NCR and RCR for each of the track switches. The selections in that circuit network provide that the energization of a G relay for clearing a signal governing entrance to a route being set up can be effected only after each of the track switches included in the route has been properly positioned to correspond with the route selected responsive to the designation of the entrance and exit ends of that route. Upon the picking up of a relay G for causing the clearing of a signal, energy is applied directly to that signal, or dependent upon track circuit selections, and upon the condition of the signal in advance, dependent upon the type of signal being cleared (a high or a low speed signal), and dependent upon the requirements of the particular condition encountered in practice.

To consider a typical example of how a signal is cleared responsive to the establishment of a route by the route establishing means, after all the track switches in that route have been properly positioned, assume that a route is established in accordance with entrance and exit designation extending from 11 to 14 in a manner which has been described. The picking up of relay 3BC in the establishment of that route (see Fig. 1A) jointly with the energized condition of relay 3AC which is energized responsive to designation of the entrance end of that route, causes the picking up of the relay 3WZ (not shown) for that single track switch (if that track switch is not already in its reverse position), and upon the complete operation of the track switch to its reverse position, the relay 3WZ is dropped away, and the relay 3RCR is picked up in a manner similar to the mode of operation described with respect to the operation of the track switches of crossover 2 as described with reference to Fig. 2. The picking up of the relay 3RCR closes a portion of the circuit network illustrated in Fig. 3A for the control of the G relays, and in a similar manner the relay 2NCR for crossover 2 is picked up after the track switches of crossover 2 have been operated to their normal positions, and after the relay 2WZ for such track switch is dropped away to deenergize the control circuits for the switch machines of that crossover.

The energization of relay 2NCR, therefore in the setting up of the route from 11 to 21 closes a circuit to cause the energization of relay 11G (if the operator has designated the entrance end of that route by the depression of the entrance button) extending from (+), including front

contact 130 of relay 14XR, front contact 131 of relay 3RCR, back contact 132 of relay 3NCR, back contact 133 of relay 2RCR, front contact 134 of relay 2NCR, back contact 135 of relay 11XR, front contact 136 of relay 11NR, and winding of relay 11G, to (—). If in designating the entrance end of that route the operator had rotated the entrance button 11NB for that entrance point to select the low speed or call-on signal to be cleared for governing that route, the relay 11CG would have been picked up in preference to the relay 11G because of the closing of front contact 137 of relay 11CNR. The relay 11CNR can be picked up upon designation of an entrance point at 11 by the rotation of the button 11NB (see Fig. 1A) in an obvious manner, and the picking up of such relay applies energy at front contact 92 to the circuit network to become effective in the establishment of a route in a manner comparable to the effectiveness of relay 11NR in the establishment of a route.

Upon the picking up of relay 11G for clearing the high speed signal 11A in the route extending from 11 to 14, energy is applied to that signal for the display of a green clear indication, if the next signal 21 in advance is clear, by the energization of a circuit closed from (+), including front contact 138 of relay 21GYP, back contact 139 of relay 3NCR, front contact 140 of relay 9TR, front contact 141 of relay 11G, mechanism of signal 11A, front contact 142 of relay 11G, back contact 143 of relay 3NCR, and front contact 144 of relay 21GYP, to (—). The relay 21GYP is energized to repeat the clear condition of the signal 21 in an obvious manner corresponding to that shown as typical in Fig. 3B for the energization of relay GYP, the relay GYP being energized only when the mechanism of the signal with which it is associated is energized with one polarity or the other for the display of a green or a yellow indication. Thus, if the signal 21 is at stop at a time when the route is established from 11 to 14, and the relay 11G is energized, the dropped away position of relay 21GYP causes energy to be applied to the circuit just described for the mechanism of signal 11A of an opposite polarity to cause such mechanism to operate to a position for the display of a yellow proceed indication. It will be obvious, however, that the energization of a signal mechanism of signal 11A can be effected for the display of a yellow indication only if the track sections included in the route extending to the next signal in advance are unoccupied by a train.

If the route extending from 11 to 14, for example, is occupied by an east bound train, and the operator desired to cause a following train to close into the same route, the signal 11A governing entrance to that route cannot be cleared, but, if the operator rotates the entrance button 11NB in the designation of that route, the signal control relay 11CG is picked up, and the energization of that relay causes the display of a yellow indication by the call-on signal 11B, the mechanism of signal 11B being energized upon the closing of front contacts 145 and 146 of relay 11CG, irrespective of the occupied condition of the route such signal governs.

It is believed to be readily apparent to those familiar with the art, from the typical conditions which have been described how each of the signals can be cleared responsive to the establishment of a route governed thereby, the circuit network provided for the energization of the relays G being equally effective for energizing the relays G provided for signals governing west bound traffic as the relays G for signals governing east bound traffic.

Electric locking.—Although various types of electric locking and various combinations of such types can be employed with the entrance-exit system provided by the present invention, the system according to the present embodiment is particularly adapted for the use of the conventional rear release type of route locking in combination with approach or time locking, approach locking being provided generally for the high speed signals, and time locking being provided generally for the low speed signals. Thus, with reference to the track layout illustrated in Fig. 3A, time locking is provided for signals 10, 13 and 14, and approach locking is provided for signals 11 and 12.

In the type of rear release route locking employed in this embodiment of the present invention, directional route locking relays ES and WS are provided for the respective east and west directions of traffic through the track layout, there being an ES and a WS relay provided for each of the track circuits included in the interlocked group illustrated in Fig. 3A. Although an east and a west stick relay are provided for each of the track circuits, it is to be understood that a rearrangement of the circuits can be provided in practice to eliminate some of the east and west stick relays, dependent upon the track layout for which the system is provided, an east and a west stick relay being shown in this embodiment of the present invention for each of the track sections to more clearly indicate how the system can be readily expanded and applied to more complex track layouts.

The relays ES and WS for each of the track sections are normally energized relays being effective for locking the track switch or track switches in that track section when one or the other of such relays is dropped away. The dropping away of each of such ES and WS relays is effected upon the establishment of a route for that direction of traffic including that track section. Thus, for example, with reference to the circuits shown in Fig. 4, and the track layout illustrated in Fig. 3A, the establishment of a route responsive to entrance and exit designation extending from 10 to 13 via crossover 4 causes the dropping away of the relay 3ES which is normally energized by a circuit extending from (+), including normally closed contact 147 of the thermal relay 10TH, back contact 148 of relay 10G, front contact 149 of relay 10AS, front contact 150 of relay 3ES, and winding of relay 3ES, to (—). Responsive to the establishment of the route extending from 10 to 13, the signal control relay 10G is energized in a manner described with reference to the signal control circuits, and the picking up of relay 10G causes the release of relay 3ES by opening the normally energized circuit for that relay at back contact 148. The dropping away of relay 3ES responsive to the picking up of relay 10G upon the establishment of a route from 10 to 13 via crossover 4, causes the release of the route locking relay 4ES which is normally energized by a circuit closed from (+), including front contact 151 of relay 3ES, front contact 152 of relay 4ES, and winding of relay 4ES, to (—). The dropping away of relay 3ES opens the circuit for relay 4ES at front contact 151.

Upon the dropping away of relay 4ES, the normally energized circuit for relay 10ES is opened, because the route is established including crossover 4, such normally energized circuit extending from (+), including front contact 153 of relay 9ES, front contact 154 of relay 4ES, front contact 155 of relay 10ES, and winding of relay 10ES, to (—). The release of relay 10ES is dependent upon the opening of front contact 154 of relay 4ES. It will therefore be seen that a relay ES is dropped away for each of the track sections in the route assumed to be established extendng from 10 to 13 via crossover 4.

Each of the route locking relays ES in dropping away causes the release of the normally energized lock relay L provided for each of the track switches included in that track section. That is, the dropping away of relay 3ES causes the dropping away of the lock relay 2LA which is provided for the upper end of crossover 2, and which is normally energized by a circuit closed from (+), including front contact 156 of relay 3ES, front contact 157 of relay 3TR, front contact 158 of relay 3WS, winding of relay 2LA, and front conact 159 of relay 2LA, to (—). The dropping away of relay 3ES opens the circuit just described for relay 2LA at front contact 156. In a similar manner the dropping away of relay 4ES causes the release of relay 4LA, which is provided for the upper end of crossover 4 and is energized in a manner comparable to the energization of relay 2LA, relay 4LA being dropped away because of the opening of front contact 160 of relay 4ES. In a similar manner, the dropping away of relay 10ES opens the normally energized circuit of relay 4LB which is provided for the lower end of crossover 4, at front contact 161.

The dropping away of a lock relay LA, LB or L for a track switch opens the control circuit for the relay WZ for governing the operation of that track switch to insure that such track switch remains during passage of a train in the position to which it has last been operated. For example, with reference to Fig. 2, the dropping away of relay 2LA upon the setting up of the route from 10 to 13 via crossover 4 opens the circuit for the upper winding of relay 2WZ at front contact 109, and opens the circuit for the lower winding for that relay at front contact 100.

The route locking in becoming effective also establishes a stick circuit for the switch position selecting relays corresponding to the route established to maintain such relays energized as long as the route locking is effective, and by their energization to establish circuit points of conflict in the circuit network provided for the initial energization of such relays in a manner and for purposes to be hereinafter considered.

To consider the manner in which switch position selecting relays AC, AN, BN and BC have their stick circuits energized dependent upon the route locking, assume that a route has been set up, and the route locking has become effective, for a route extending from 10 to 13 via crossover 4. Under such conditions, responsive to the establishment of that route, the dropping away of relay 3ES causes a stick circuit to be established for the relay 2AN, which is picked up in the selection of that route, extending from (+), including back contact 162 of relay 3ES, front contact 163 of relay 2AN, and upper winding of relay 2AN, to (—). At the same time the stick circuit for relay 2AC is also closed, because such relay is also picked up in the selection of that route, extending from (+), including back contact 162 of relay 3ES, front contact 164 of relay 2AC, and upper winding of relay 2AC, to (—).

It will be noted that the stick circuit energy provided for relays 2AC and 2AN when a route is established including the upper end of crossover 2 in a normal position, is independent of stick circuit energy which can be provided for the relays 2BN and 2BC for a route including the normal position of the track switch at the lower end of crossover 2, thus providing that the release of the relays 2AC and 2AN can be effected upon the restoration of the route locking, irrespective of the condition of the route locking relays for the opposite end of the crossover, and a similar condition exists with reference to the dropping away of the relays 2BN and 2BC for the lower end of crossover 2. Although the stick circuits for the groups of relays 2AC and 2AN, and 2BN and 2BC are interconnected, the above described circuit isolation is accomplished when a route is established including either end of the crossover in a normal position upon the opening of back contact 166 of relay 2NCR which is energized under such conditions.

If a route is set up, however, extending over the crossover 2, the relay 2NRC is dropped away, and the closing of its back contact 166 provides that, in addition to the stick circuit which has been described for relay 2AC being fed from back contact 162 of relay 3ES, or from back contact 167 of relay 3WS, (dependent upon the direction of traffic established) a stick circuit is closed for the relay 2BC, which is picked up when a route is established over the crossover 2, extending from (+), including back contact 167 of relay 3WS or back contact 162 of relay 3ES (dependent upon the direction for which the route is established) back contact 166 of relay 2NRC, front contact 168 of relay 2BC, and upper winding of relay 2BC, to (—). The establishment of those stick circuits, when a route is established including the crossover 2 with its track switches in their reverse positions, provides that the relays 2AC and 2BC are maintained picked up as long as the route locking is effective for the track sections of either end of the crossover 2, energy being fed to the stick circuits described also by back contacts 169 and 170 of relays 9ES and 9WS (dependent upon the direction of traffic) in a manner comparable to that described with reference to the energization in accordance with the effectiveness of the route locking for the upper end of the crossover.

It is believed to be apparent to those familiar with the art, and it will be more readily understood upon considering the restoration to normal of the system in detail, that the switch position selecting relays AN, AC, BN and BC are maintained energized for the track switches included in established routes in the advance of a train, and are maintained energized until the passage of such train has allowed the picking up of the track relay or track relays for the detector track section or track sections associated with the respective track switches. The maintenance of the switch position selecting relays energized by their stick circuits dependent upon the route locking in such a manner, provides that the circuit networks for the initial energization of such relays are opened to provide so called circuit points of conflict to prevent the preconditioning of routes. In other words, the circuit points of conflict define in the circuit networks as to the availability

of routes. As a specific example, with reference to Fig. 1A, the presence of a train in the detector track section for the upper end of crossover 2 in a route extending from 10 to 13 via crossover 4 causes the relays 2AC and 2AN to be maintained energized, and the energization of the relay 2AN opens the branch of the circuit network energized responsive to entrance or exit designation for the route ends at the left hand end of the track layout at back contact 69, and similarly in the other circuit network, the back contact 63 of relay 2AN opens the circuit portion corresponding to the route including the track switches of crossover 2 in their reverse positions which, of course, conflicts with the route established extending from 10 to 13 via crossover 4. By the opening of the circuit networks in this manner, it is believed to be readily apparent that it is maintained, during the passage of a train through a route, that each of the exit relays XR can be conditioned for energization only if there is an available route extending between a designated entrance point and that exit point.

The sticking of the switch position selecting relays dependent upon the route locking when the reverse position of a track switch is called for is effective in a much similar manner to provide circuit points of conflict and prevent preconditioning of routes. For example, as is illustrated when the relays 2AC and 2BC are maintained energized in accordance with the effectiveness of the route locking for a route extending over crossover 2 with its track switches in their reverse positions, the energization of relay 2BC opens the portion of the circuit network energized in accordance with entrance designation for the establishment of routes for east bound trains at back contact 81, front contact 171 of relay 2BN being open at that time because such relay is dropped away when a route is established including the track switches of crossover 2 in their reverse positions.

In a similar manner, for the opposite end of the crossover 2, the opening of back contact 172 of relay 2BC opens the portion of the circuit network which is energized responsive to entrance designation in the establishment of routes for east bound trains to provide a circuit point of conflict in the network comparable to the actual point of conflict of routes at the track layout.

It is believed obvious from the specific description of the circuit points of conflict established for one of the circuit networks, that circuit points of conflict are established in a similar manner for the other circuit network provided for the energization of the switch position selecting relays.

Restoration to normal.—The restoration to normal of the parts of the system provided by the present invention for each of the routes extending through the track layout can be effected either upon manual designation by an operator, or upon automatic restoration dependent upon the passage of a train through such route.

To consider first the restoration of the parts of the system associated with the setting up of a route to normal in accordance with the manual designation of such restoration by an operator, assume that a route has been established as has been described extending from 10 to 13 via crossover 4 and that the signal 10 has been cleared governing entrance to such route and the route locking has become effective, all in a manner which has been described.

Under such conditions, assume that an operator designates the restoration to normal of the parts of the system associated with that route by the pulling out of the entrance button 10NB (see Fig. 1A) for the entrance end of that route. The pulling out of that button causes the release of relay 10NR by opening the stick circuit for that relay at contact 173 of button 10NB. Upon the dropping away of relay 10NR (see Fig. 3A), the dropping away of the signal control relay 10G is effected by the opening of front contact 174 of relay 10NR, and the dropping away of relay 10G causes the deenergization of the mechanism of signal 10 upon the opening of the circuit for such signal mechanism at front contacts 175 and 176. The deenergization of the mechanism of signal 10 causes the display of a red indication by that signal, and with reference to Fig. 3B, causes the dropping away of the signal repeater relay GYP for that signal, and the energization of the signal at stop repeater RP for that signal.

In accordance with the energization of the relay 10RP responsive to the restoration of signal 10 to stop (see Fig. 4) a circuit is closed for the winding of the thermal relay 10TH associated with the time locking relay 10AS, extending from (+), including front contact 185 of relay 10RP, winding of thermal relay 10TH, and back contact 186 of relay 10AS, to (—). After sufficient time has been taken in the heating of the thermal relay 10TH, a pick-up circuit is closed for relay 10AS extending from (+), including front contact 185 of relay 10RP, contact 177 of thermal relay 10TH closed when such thermal relay is in its operated position, and winding of relay 10AS, to (—). The picking up of relay 10AS closes a stick circuit at front contact 186 to shunt contact 177 of thermal relay 10TH out of the circuit just described. The resistance of the relay winding is sufficient to allow the cooling of the thermal relay 10TH.

After the thermal relay 10TH is cooled, the pick-up circuit for relay 3ES is closed extending from (+), including contact 147 of thermal relay 10TH, back contact 148 of relay 10G, front contact 149 of relay 10AS, front contact 178 of relay 3TR, and winding of relay 3ES, to (—). Upon the picking up of relay 3ES, the relay 4ES is energized because of the closing of front contact 151 of relay 3ES, and the closing of front contact 154 of relay 4ES causes the picking up of relay 10ES in an obvious manner to complete the restoration to normal of the route locking and time locking relays associated with the route under consideration.

With reference to Figs. 1A and 1B, the dropping away of relay 10NR causes the deenergization of relay 13XR, and the deenergization of the pick-up circuits for relays 2AC and 4AC. Upon the dropping away of relay 13XR, the pick-up circuits for relays 4BC and 2AN are opened upon the opening of front contact 53.

The restoration of the relays 2AC, 4AC, 4BC and 2AN is, however, dependent upon the opening of the stick circuits for those relays upon the restoration to normal of the route locking. Thus, for example, with reference to Fig. 2, the relays 2AC and 2AN are dropped away upon the opening of their stick circuits when the route locking relay 3ES is picked up at back contact 162.

Responsive to the restoration of the switch position selecting relays for each of the crossovers and single track switches included in the route, the correspondence relay NCR or RCR for that track switch or crossover is dropped away, as, for example, the restoration of the relays 2AC and 2AN opens the circuit which has been de-

scribed for relay 8NCR at front contacts 106 and 105 respectively.

When the route locking relay is restored for each of the various track sections in the route, the lock relay L, LA or LB for that track section becomes energized. Thus, for example, with reference to Fig. 2, the energization of relay 3ES closes a circuit to cause the picking up of relay 2LA extending from (+), including front contact 156 of relay 3ES, front contact 157 of relay 3TR, front contact 158 of relay 3WS, winding of relay 2LA, and normally closed contact 179 of the auxiliary switch control lever 2SML, to (—). The picking up of that relay closes its normally energized stick circuit at front contact 159.

The inclusion of normally closed contact 179 of the auxiliary lever 2SML in the pick-up circuit of relay 2LA provides that the operation of the track switches of crossover 2 in accordance with the positioning of the auxiliary control lever 2SML can be effected only if the electric locking allows such positioning at the time the lever is actuated from its normal position. Such mode of operation is said to prevent the "preconditioning" of a track switch by the positioning of the auxiliary control lever SML for such track switch at a time when such track switch is electrically locked.

The restoration to normal of the parts of the system associated with the setting up of a route when automatically initiated upon passage of a train, is effective in a manner very similar to that which has been described, the entrance of a train into the track section immediately in advance of the entering signal being effective to initiate such restoration by causing the dropping away of the entrance relay for that entrance point.

As a typical example of how restoration is effective upon passage of a train, assume, with reference to Figs. 1A and 1B, that an east bound train accepts signal 10 when such signal has been cleared upon the setting up of a route extending from 10 to 13 via crossover 4. The entrance of the train into the track section 3T causes the dropping away of the track relay 3TR, and the dropping away of that relay opens the stick circuit for the entrance relay 10NR at front contact 180. The dropping away of relay 10NR causes the restoration to stop of the signal 10 in a manner which has been described, but the restoration of that signal to stop cannot cause the restoration of the route locking relays because (see Fig. 4) the front contact 178 of relay 3TR in the pick-up circuit of relay 3ES is open at that time. The deenergization of relay 3TR, however, closes a circuit at back contact 182 to cause the picking up of relay 10AS.

Inasmuch as the relay 3ES cannot yet be restored, the stick circuits for relays 2AN and 2AC are maintained energized (see Fig. 2) and thus provide that, although the dropping away of the entrance relay 10NR (see Fig. 1A) opens the pick-up circuit for relay 2AC and causes the dropping away of the relay 13XR in a manner which has been described, the dropping away of relay 13XR opening the pick-up circuit for the relay 2AN, the relays 2AC and 2AN are maintained energized because of the presence of the train in the track section 3T.

When the train enters track section 4T, and leaves track section 3T, the picking up of the track relay 3TR (see Fig. 4) closes the pick-up circuit which has been described for relay 3ES, and the picking up of relay 3ES opens the stick circuits for relays 2AC and 2AN (see Fig. 2) to cause the dropping away of those relays. The picking up of relay 3ES cannot immediately effect the picking up of the relay 4ES because of the presence of the train in the track section 4T, however the relay 4ES is picked up when the train leaves that track section.

Inasmuch as the track switches of crossover 4 are included in the route established in their reverse positions, the presence of a train in either or both of track sections 4T and 10T maintains the position selecting relays 4AC and 4BC energized by their stick circuits because of the locked condition of the track switches of crossover 4. When the train leaves the track section 10T, however, the picking up of the relay 10ES is effected, and the picking up of that relay causes the release of the stick circuits (not shown) for the relays 4AC and 4BC, thus completing the restoration to normal of the route establishing means. Each of the lock relays L, LA, and LB for the track switches included in the route is restored upon the restoration to normal of the route locking relays for the track sections with which such lock relays are associated in a manner which has been described.

It is believed from the typical examples of the restoration to normal of the system which have been described, that it will be readily apparent how restoration is effective for any route in the track layout. The restoration to normal for the parts of the system associated with the setting up of a route which has been designated to be governed by a call-on signal being effective only upon the restoration by rotation of the entrance button NB for the entrance end of that route. That is, for example, to restore to normal the parts of the system associated with the setting up of a route emanating from the entrance point at 11 (see Fig. 1A) when such route has been designated to be governed by a call-on signal by the rotation of the button 11NB, the operator must rotate the button 11NB back to its normal position, and in doing so cause the release of the call-on entrance relay 11CNR in an obvious manner, the dropping away of that relay being effective to cause the restoration to normal of the parts of the system in a manner corresponding to that which has been described. It is believed obvious from the circuit for the call-on entrance relay 11CNR, that the passage of a train does not cause the automatic restoration of the parts of the system associated with the route established, and that such restoration can be effected only by the proper actuation of the entrance button NB for the entrance end of the route by an operator.

With reference to Fig. 4, if approach locking is provided instead of the time locking as has been described, the relay AS for the signal involved can have its control circuit provided as is shown, for example, for the relay 11AS which provides approach locking for signal 11. It is believed obvious upon considering the circuit provided for the relay 11AS, that such relay is governed similar to the relay 10AS to which specific reference has been made, except that the restoration of a route having an entrance point at 11 to stop, when the track section in the rear of the signal governing entrance to such route is unoccupied, can be effected immediately in accordance with front contact 181 of relay 8TR in the circuit for relay 11AS being closed at that time.

End-to-end control.—It is believed from the

foregoing description that it will be readily apparent that a number of interlocked groups can be governed in accordance with the principles as they have been set forth, such groups being adjacent as is illustrated, for example, in Fig. 6C. In accordance with such principles each group would function as a separate unit, and entrance and exit designation would be necessary within each group in order to cause the establishment of a route extending through that group. With reference to Fig. 6C, it will be apparent that, in setting up a through route extending from 10 to 17, it should be unnecessary that an operator designate the respective entrance and exit points for the intermediate signal location. Thus, in accordance with the present invention, it is provided that the establishment of each of the through routes in the track layout can be effected responsive to designation by an operator of the extreme entrance and exit ends only of that route, a through route relay NP being effective to cause the setting up of the route past each of the intermediate signals as if the respective entrance and exit control buttons for such intermediate signal were actuated by an operator.

With reference to Figs. 6A, 6B and 6C, it will be noted that, of the two interlocked groups, the left hand interlocked group is similar to the track layout illustrated in Fig. 3A with which the description has heretofore been associated. In view of such similarity many of the circuits illustrated in Fig. 6A correspond to circuits which have been described with reference to Figs. 1A and 1B, such circuits being readily identified by reference characters corresponding to reference characters used for the circuits illustrated in Figs. 1A and 1B. In order to simplify to some extent the disclosure of the system of end-to-end control, there have been no call-on signals provided for the track layout illustrated in Fig. 6C, it being assumed that such call-on signals can be provided in accordance with the requirements of practice in a manner which has been heretofore described.

It is provided that the circuits for the switch position selecting relays AC, AN, BN and BC differ from circuits that have been described mainly in that the means for preferred route selection is changed from that shown in Figs. 1A and 1B to provide that, irrespective of the direction of traffic, the optional or alternative route diverging nearest the designated entrance point is always established when available in preference to other routes. In other words, preference is given to that optional route diverging nearest the designated entrance point for either direction of traffic. To provide such preference, the circuits in Fig. 6A are provided to correspond with the circuits provided in Figs. 1A and 1B except that the portion of the circuit network energized responsive to entrance or exit designation for a route end at the left end of the interlocked group includes front contact 190 of relay 4BN in multiple with back contact 191 of relay 4BC (see Fig. 6A) in a portion of the circuit network replacing the contacts 90 and 91 of relays 4BN and 4BC illustrated in Fig. 1B. Such circuit arrangement provides the desired preference in accordance with the principles of the system as they have been set forth when considering in detail the route establishing means provided.

In the establishment of a route by end-to-end control, the through route relay NP for each of the intermediate signals that can be included in a through route emanating from the designated entrance point is conditioned over the circuit network in a manner comparable to the conditioning of each of the exit relays XR responsive to entrance designation. In fact, the conditioning of each of the through route relays NP is accomplished over the same circuit portions of the network that are used in the conditioning of the exit relay XR for that particular route end. It is further provided that each of the through route relays NP can be energized when there is an available route extending to that intermediate signal from a designated entrance point, only if there is no route established immediately in advance of such intermediate signal.

To consider the sequence of events which take place responsive to entrance and exit designation of the extreme ends of a through route, assume that an operator, at a time when the system is under normal conditions, desires to establish a route from 10 to 17 on the upper track. The picking up of the entrance relay 10NR responsive to entrance designation for such route causes the successive energization of the relays 2AC and 4AC, and the relay 15NP is picked up upon the picking up of relay 4AC. In a similar manner, inasmuch as the route from 10 to 13 is also available emanating from the designated entrance point, the relay 3AC is picked up, and the picking up of that relay causes the picking up of the relay 4BN. Upon the picking up of relay 4BN, the through route relay 16NP is energized.

Responsive to the picking up of each of the relays NP, energy is applied to the circuit network energized responsive to entrance designation for east bound traffic for the right hand interlocked group, in a manner comparable to the energization of such network responsive to entrance designation for such signal location. The picking up of relay 15NP therefore causes the picking up of relay 5AC, and the picking up of that relay causes the picking up of relay 6AN, and when such relay is picked up, the relay 17XR is conditioned for energization so that it can be picked up responsive to the depression of the exit button 17XB. In a similar manner the picking up of relay 16NP causes energy to be applied to the portion of the circuit network comparable to the lower track in the track layout to cause the successive energization of relays 5BN and 6BC. The picking up of relay 6BC conditions the exit relay 18XR for energization so that it can be picked up responsive to the designation of an exit point at 18 by the depression of the exit button 18XB.

Assuming the operator to depress the button 17XB for the designation of the exit end of the route being established, the picking up of relay 17XR causes the successive energization of the relays 6AC and 5AN, thus completing the selection of the positions of the track switches required for the right hand interlocked group, and causing the execution of the switch controls to cause the track switches of crossovers 5 and 6 to be operated to their normal positions in accordance with the route selected.

Upon the picking up of relay 5AN, which signifies that the route is completely selected from the exit end designated through the right hand interlocked group, energy is applied to the lower winding of the relay 15NR for the intermediate signal location to cause such relay to be picked up, the energization of such relay be-

ing selected in accordance with the picked up condition of the through route relay 15NP. Upon the picking up of relay 15NR, the relay 12XR is picked up for the exit point at the intermediate signal associated with the left hand interlocked group, and the picking up of such relay causes the release of the through route relay 15NP. When relay 12XR is picked up, the relays 4AN and 2AN are successively energized to complete the selection of the route extending through the left hand track layout. The picking up of relay 2AN for the crossover 2 definitely determines that the track switches of crossover 2 are to be operated to their normal positions, and in doing so establishes a circuit point of conflict which causes the release of the relays energized in the circuit portion of the network corresponding to the lower track, including the through route relay 16NP for the intermediate signal on the lower track.

To consider specifically the circuits which provide such mode of operation, assume an operator to depress the button 10NB for designation of an entrance point at 10, and the entrance relay 10NR (see Fig. 6A) to be picked up in a manner corresponding to that which has been described. The picking up of that relay causes the successive energization of the relays 2AC and 4AC in a manner which has been described, and the picking up of relay 4AC closes a circuit to cause the picking up of relay 15NP extending from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 81 of relay 2BC, front contact 82 of relay 4AC, back contact 192 of relay 4BC, wire 193, back contact 194 of relay 12NP, back contact 195 of relay 12XR, back contact 196 of relay 12NR, front contact 197 of relay 15RP, back contact 198 of relay 15NR, back contact 199 of relay 15XR, and winding of relay 15NP, to (—). The picking up of relay 15NP closes a stick circuit at front contact 200 to shunt contact 198 out of the circuit just described.

At the same time, responsive to the picking up of relay 10NR, the relays 3AC and 4BN are successively energized by circuits which have been described, and upon the picking up of relay 4BN a circuit is closed to cause the picking up of relay 16NP extending from (+), including front contact 80 of relay 10NR, back contact 67 of relay 10XR, front contact 68 of relay 2AC, back contact 69 of relay 2AN, back contact 37 of relay 2BN, front contact 38 of relay 3AC, back contact 41 of relay 3BC, back contact 191 of relay 4BC, front contact 84 of relay 4BN, wire 201, back contact 202 of relay 13NP, back contact 203 of relay 13XR, back contact 204 of relay 13NR, front contact 205 of relay 16RP, back contact 206 of relay 16NR, back contact 207 of relay 16XR, and winding of relay 16NP, to (—). The picking up of relay 16NP closes a stick circuit at front contact 208 to shunt contact 206 out of the circuit just described.

Upon the picking up of relay 15NP, energy is applied to the circuit network for the right hand interlocked group which is energized responsive to entrance or exit designation at the left hand end of such route, to cause the picking up of relay 5AC by the energization of a circuit closed from (+), including front contact 209 of relay 15NP, back contact 210 of relay 15XR, wire 211, and lower winding of relay 5AC, to (—). The picking up of that relay closes a circuit to cause the picking up of relay 6AN, extending from (+), including front contact 209 of relay 15NP, back contact 210 of relay 15XR, wire 211, front contact 212 of relay 5AC, back contact 213 of relay 5BC, back contact 214 of relay 6AC, and lower winding of relay 6AN, to (—). When the relay 6AN is picked up a stick circuit is closed at front contact 240 and the relay 17XR is conditioned for energization in an obvious manner.

When the through route relay 16NP for the intermediate signal 16 is picked up, energy is applied to the circuit network to cause the picking up of relay 5BN over a circuit extending from (+), including front contact 215 of relay 16NP, back contact 216 of relay 16XR, wire 217, back contact 218 of relay 5BC, and lower winding of relay 5BN, to (—). Upon the picking up of relay 5BN, the relay 6BC is picked up by the energization of a circuit closed from (+), including front contact 215 of relay 16NP, back contact 216 of relay 16XR, wire 217, front contact 219 of relay 5BN, front contact 220 of relay 5BN, and lower winding of relay 6BC, to (—). Upon the picking up of relay 6BC, the exit relay 18XR is conditioned for energization in an obvious manner.

Assuming the operator to designate the exit point at 17 by the depression of the exit button 17XB, the relay 17XR is picked up upon the energization of a circuit closed from (+), including front contact 209 of relay 15NP, back contact 210 of relay 15XR, wire 211, front contact 212 of relay 5AC, back contact 213 of relay 5BC, front contact 240 of relay 6AN, front contact 221 of relay 6AN, winding of relay 17XR, back contact 222 of relay 17NR, and contact 223 of button 17XB closed in a depressed position, to (—). The picking up of relay 17XR closes a stick circuit at front contact 224 to shunt contacts 222 and 223 out of the circuit just described.

Responsive to the picking up of relay 17XR, the closing of front contact 225 causes the picking up of relay 6AC by the energization of an obvious circuit, and the picking up of that relay causes the picking up of relay 5AN (selected in accordance with the energized condition of relay 6AC) by the energization of a circuit closed from (+), including front contact 225 of relay 17XR, front contact 226 of relay 6AC, front contact 227 of relay 6AN, back contact 228 of relay 5BC, and lower winding of relay 5AN, to (—).

When relay 5AN is picked up, a circuit is closed to cause the picking up of relay 15NR (selected in accordance with the energized condition of relay 15NP), extending from (+), including front contact 225 of relay 17XR, front contact 226 of relay 6AC, front contact 227 of relay 6AN, back contact 228 of relay 5BC, front contact 229 of relay 5AN, wire 230, front contact 231 of relay 15NP, and lower winding of relay 15NR, to (—). The picking up of such relay closes a stick circuit therefor provided in a manner comparable to that which has been heretofore described. The picking up of relay 15NR, under such conditions, causes the picking up of relay 12XR by the energization of a circuit closed from (+), including front contact 225 of relay 17XR (see Fig. 6C), front contact 226 of relay 6AC, front contact 227 of relay 6AN, back contact 228 of relay 5BC, front contact 229 of relay 5AN, wire 230, front contact 231 of relay 15NP, front contact 32 of relay 15NR, and lower winding of relay 12XR, to (—). The picking up of relay 12XR due to such energization causes the establishment of a stick circuit closed at front contact 233 to maintain such relay energized, dependent for deenergization upon the restoration of the

entrance relay 10NR governing entrance to the route. The relay 15NP is dropped away upon the picking up of relay 12XR by the opening of back contact 195, such relay being sufficiently slow acting to insure the establishment of the stick circuit for relay 12XR closed at front contact 233 before the dropping away of relay 15NP opens the pick-up circuit for relay 12XR at front contact 231.

Prior to the dropping away of relay 15NP, energy in applied to the circuits described for relays 5AC, 6AN and 17XR at front contact 234 of relay 15NR, thus providing that the circuits for those relays are maintained energized dependent upon the energized condition of relay 15NR after the dropping away of relay 15NP.

After the relay 12XR is picked up, the relay 4AN is picked up by the energization of a circuit closed from (+), including front contact 235 of relay 12XR, wire 236, back contact 237 of relay 4BC, and lower winding of relay 4AN, to (—). The picking up of relay 4AN causes the energization of relay 2AN by the closing of a circuit extending from (+), including front contact 235 of relay 12XR, wire 236, front contact 241 of relay 4AN, front contact 238 of relay 4AN, back contact 239 of relay 2BC, and lower winding of relay 2AN, to (—). The track switches of crossovers 2 and 4 are of course operated to their normal positions in accordance with the joint energization respectively of relays 2AC and 2AN, and the join energization of the relays 4AC and 4AN.

Responsive to the complete operation of the track switches to establish the route selected, the signal 10 governing entrance to such route is cleared in accordance with the energization of signal control circuits which have been described with reference to Fig. 3A, such signal circuits being typical of the circuits (not shown) provided for the clearing of the intermediate signal 15 responsive to the proper positioning of the track switches of the crossovers 5 and 6 of the right hand interlocked groups.

From the circuits just described it will be noted that the relay 15NP can be picked up only when there is an available route extending to the intermediate signal 15 from the entrance point designated, and that such relay can be picked up only when relays 15NR and 15XR are both dropped away, thus insuring that the establishment of a through route can become effective only after the manual designation of an exit point when no portion extending through one of the interlocked groups in the through route has been previously established. It will also be noted that the picking up of the exit relay 12XR is effected dependent upon the joint energization of the relays 15NP, 15NR and 17XR, thus insuring that an exit point for the through route must be designated before such exit relay can be picked up by through route control.

The signal-at-stop repeater relay 15RP which is normally energized has a front contact included in the circuit for relay 15NP so that, if a route is set up having an entrance point at 15 at a time when an entrance point is designated at 10, the through route connection for the networks is held open until the signal 15 has been restored to stop, thus providing that the exit relay 17XR will have sufficient time to drop away before through route conditioning energy is applied to its winding in accordance with the energization of relay 15NP.

It is believed to be readily apparent from the description as it has been set forth with respect to optional route selection, that the principles of operation as described also apply where through route control is involved. In accordance with the principles of optional route selection by which the circuits are provided in Figs. 6A, 6B and 6C, of the three optional routes extending between 10 and 23, the available route diverging nearest the designated entrance point is always automatically selected. Such is true because the through route control merely provides circuit means for connecting the networks for the various interlocked groups without altering the mode of operation of the route selecting means. In fact, as far as route selection is concerned, each route is selected where through routes are involved in a manner comparable to the manner in which the routes would be selected for the same track layout if there were no intermediate signals.

Where run-around routes are involved, such as in the track layout illustrated in Fig. 6C if all of such routes are available, the most direct route is selected. This is clearly illustrated in the establishment of the through route extending from 10 to 17 as described, the most direct route including intermediate signal 15 being established in preference to the run-around route because the energization of relay 6AN responsive to entrance designation determines that the energization of the other circuit network responsive to exit designation will follow a circuit portion of the circuit network corresponding to the upper track as selected by front contact 227. If for some reason, the most direct route is not available, because, for example, of the track switches of crossover 2 having their reverse positions called for by the auxiliary lever 2SML, a corresponding circuit point of conflict is established in the circuit networks to prevent the energization of relays corresponding to a route along the upper track including relay 6AN for the upper end of crossover 6. Inasmuch as the relay 6AN cannot be energized under such conditions, the designation of an exit point for the route at 17 causes the establishment of the route from 10 to 17 via crossovers 2 and 6 because the dropped away condition of relay 6AN closes back contact 227 to provide that, responsive to exit designation, energy will follow the portion of the circuit network corresponding to the run-around route.

Indications.—It is important in order that an operator can most intelligently cause the establishment of routes through the track layout that he be clearly informed by indications as to conditions relative to routes established, track occupancy, and the condition of the signals. Such indications can be provided by the use of magnetically operated miniature switch points on the diagram in combination with indicator lamps disposed along the diagram for indication of the routes established and the condition of occupancy of the track sections; but it is believed that indications can more clearly be provided in accordance with the present invention in the form of relatively continuous lines of light along the track diagram to correspond to the routes established, and the condition of occupancy of such routes. Such indications are provided in the system according to this embodiment of the present invention, by the selective energization of miniature indicator lamps mounted behind linear translucent inserts in the control panel, such inserts forming the trackway of the track diagram.

With reference to Figs. 1A and 1B it will be

noted that the translucent inserts have been shown, and that a distinctive reference character is provided for each of the inserts to readily identify it as being illuminated by the energization of miniature indicator lamps designated by similar reference characters in Figs. 5A and 5B.

The system provides that the indicator lamps are normally dark, and the designation of an entrance point causes the flashing of an indicator lamp included in the entrance button for that point. Such lamp will continue to flash until the complete establishment of the proposed route is effected and the signal governing entrance to such route has been cleared. Upon the designation of the exit end of a route subsequent to the designation of the entrance end thereof, white indicator lamps are illuminated for the track portions corresponding to the route selected by the route establishing means. The light sections of the diagram along the route used for indicating switch positions are flashed until their respective track switch or track switches have been properly positioned to correspond with the positions called for by the route establishing means. Upon passage of a train through the route, the entrance of a train into each track section causes the extinguishing of the white lamps corresponding to that section, and the illumination of red lamps to indicate track occupancy. The red lamps are extinguished for the track sections in the route in the rear of the train, and the white lamps are again illuminated for the route in the rear of the train if such sections of the route have their track switches maintained locked.

It is further provided that the energization of the indicator lamps for the translucent inserts between the inserts used for switch position indication, and the translucent inserts adjacent the route ends, is effective only responsive to route designation by entrance and exit manipulation. Thus, the positioning of a track switch by actuation of the auxiliary switch control lever for that track switch causes only the illumination of the translucent inserts used for indicating the position of that track switch. Such selective energization of the indicator lamps is accomplished by the energization of the lamps not used for switch indication from a circuit network energized only responsive to route designation by entrance and exit manipulation. Such indicator lamps are maintained energized after the route locking has become effective, dependent upon locking relays L, LA and LB which are deenergized only upon the establishment of the route by entrance and exit control.

To consider a typical example of the display of indications in accordance with the establishment of a route and the passage of a train, assume that an operator desires to cause the establishment of a route in a manner which has been described extending from 10 to 13 via crossover 4. Before designating the ends of such route, he first determines by inspection of the translucent inserts along the track diagram that such route is available because of the translucent inserts for all portions of such route being dark. When the operator depresses the entrance button 10NB for designation of the entrance point, the relay 10NR is picked up, and the picking up of that relay closes an obvious circuit (see Fig. 5A) at front contact 250 to cause the energization of the signal indicator lamp 10GK which is included within the button 10NB. Such indicator lamp is flashed under such conditions in accordance with the application of energy intermittently interrupted to the circuit for that lamp at front contact 251 of relay 10RP. Upon the clearing of the signal 10 governing entrance to the route, the signal repeater relay 10RP is dropped away, and the closing of back contact 251 causes the steady illumination of the signal indicator lamp 10GK to indicate that signal 10 has been cleared.

Responsive to the designation of the exit point at 13 by the depression of button 13XB, the relay 13XR is picked up, and the picking up of that relay causes the energization of the white lamp *w* (see Fig. 5B) of the light section 4BN/RK adjacent the exit button 13XB. Such lamp is energized by a circuit closed from (+), including front contact 252 of relay 13XR, front contact 253 of relay 4LB, front contact 254 of relay 10TP, and lamp *w* of light section 4BN/RK, to (—).

Inasmuch as the relays 4AN and 4BN are both maintained deenergized in the establishment of that route, a circuit is closed at the same time to cause the energization of the white lamp *w* of light section 4AN/RK extending from (+), including front contact 252 of relay 13XR, back contact 255 of relay 4BN, back contact 256 of relay 4AN, front contact 257 of relay 4LA, front contact 258 of relay 4TP, and lamp *w* of light section 4AN/RK, to (—). The lamp *w* of the adjoining light section 4AN/RK[1] is also illuminated due to the energization of that circuit.

The relay 2AN is picked up in the establishment of the route responsive to the picking up of relay 13XR in a manner which has been described, and the picking up of that relay causes the illumination of the white lamp *w* of light section 2AN/RK by the energization of a circuit closed from (+), including front contact 252 of relay 13XR, back contact 255 of relay 4BN, back contact 256 of relay 4AN, wire 259, front contact 260 of relay 2AN, front contact 261 of relay 2LA, front contact 262 of relay 3TP, and lamp *w* of light section 2AN/RK, to (—). The illumination of that light section completes the illumination of the translucent inserts for the light sections along the route except for those inserts which are used for indicating the positions of the track switches. When the relay 4BC is picked up responsive to the picking up of the relay 13XR in the establishment of that route, the relay 4WZ is energized for the operation of the track switches of the crossover 4 to their reverse positions (if such track switches are not already in such positions) and the picking up of relay 4WZ causes the energization of the white lamp *w* of light section 4ARK by a circuit closed from (FL+) including front contact 263 of relay 4WZ, front contact 264 of relay 4AC, back contact 265 of relay 4AN, back contact 266 of relay 4BN, front contact 267 of relay 4BC, front contact 268 of relay 4TP, and the white lamp *w* of light section 4ARK, to (—). A circuit is also closed under such conditions for the white lamp *w* of light section 4BRK extending from (FL+), including front contact 263 of relay 4WZ, front contact 269 of relay 4BC, back contact 270 of relay 4BN, back contact 271 of relay 4AN, front contact 272 of relay 4AC, front contact 273 of relay 10TP, and the white lamp *w* of light section 4BRK, to (—).

If the track switches of crossover 4 are in their reverse positions when such positions are called for in the establishment of the route, or after such track switches have completed their opera-

tion to their reverse positions, the circuits described will be steadily energized in accordance with the closing of front contact 274 of relay 4RCR, such relay being picked up when the track switches of crossover 4 are locked in their reverse positions in accordance with the joint energization of relays 4AC and 4BC when relays 4AN and 4BN are deenergized. The relay WZ, as has been pointed out when considering in detail the switch control circuits, is energized only when the track switches are out of correspondence with the positions called for.

The picking up of relay 2AN in the establishment of the route from 10 to 13 via crossover 4 causes the picking up of relay 2WZ (if the track switches of crossover 2 are not already in their normal positions) and the picking up of such WZ relay causes the flashing of the white lamp *w* of light section 2ANK (see Fig. 5A) by the intermittent energization of a circuit closed from (FL+) including front contact 275 of relay 2WZ, front contact 276 of relay 2AC, front contact 277 of relay 2AN, front contact 278 of relay 3TP, and the white lamp *w* of light section 2ANK, to (—). The picking up of the normal correspondence relay 2NCR as soon as the track switches of crossover 4 become in correspondence with the normal positions called for in the establishment of the route, closes front contact 279 and causes the steady energization of the circuit just described for the white lamp *w* of light section 2ANK, thus completing the illumination of the portion of the miniature track diagram corresponding to the route which has been selected extending from 10 to 13 via crossover 4, the energization of the indicator lamps associated with such route being effective as soon as the route is selected, prior to the positioning of the track switches in accordance with the route, and prior to the clearing of the signal governing entrance thereto. The line of light formed by the illumination of the translucent inserts along the miniature track diagram provides a means whereby an operator can readily identify the routes established, and the other routes which are not in conflict with the established route.

As soon as the route locking becomes effective after the route is established, the lock relays 2LA, 4LA and 4LB are dropped away, and the dropping away of those relays applies energy to the circuits which have been described for lamps initially energized from the circuit network dependent upon the exit relay 17XR. Thus, the dropping away of relay 2LA applies energy at back contact 261 to the circuit for the white lamp *w* of light section 2AN/RK; the dropping away of relay 4LA applies energy at back contact 257 to the circuits for the white lamps *w* of light sections 4AN/RK and 4AN/RK[1]; and the dropping away of relay 4LB applies energy at back contact 253 to the circuit for the white lamp *w* of light section 4BN/RK.

When a train accepts the signal 10 governing the established route from 10 to 13 via crossover 4, the dropping away of the track relay 3TR upon passage of such signal causes the release of the relay 10NR and the restoration of the signal 10 to stop in a manner which has been described. With reference to Fig. 5A, the dropping away of relay 10NR opens front contact 250 of the circuit for the signal indicator lamp 10GK to cause that lamp to be extinguished. When the relay 3TR is dropped away, the relay 3TP also becomes deenergized, and the dropping away of that relay opens the circuit which has been described for the white lamp *w* of light section 2ANK, and closes a circuit in an obvious manner at back contact 278 for the red lamp *r* of light section 2ANK. In a similar manner, the dropping away of relay 3TP causes the white lamp *w* of light section 2AN/RK to be extinguished and the red lamp *r* for that light section illuminated upon the closing of back contact 262.

Upon entrance of the train into track section 4T, the relay 4TP is deenergized, and the dropping away of that relay causes the extinguishing of the white lamps *w* of light sections 4AN/RK and 4AN/RK[1] respectively and the illumination of the red lamps *r* upon the closing of back contact 258 for such light sections. In a similar manner, the dropping away of relay 4TP causes the extinguishing of the white lamp *w* of light section 4ARK and the illumination of the red lamp *r* for that light section upon the closing of back contact 268. When the train in proceeding over the crossover 4 enters track section 10T, the dropping away of relay 10TP causes the extinguishing of the white lamp *w* of light section 4BRK and the illumination of the red lamp *r* of that light section upon the closing of back contact 273. The white lamp *w* of light section 4BN/RK is also extinguished, and the red lamp *r* is illuminated for that light section in accordance with the closing of back contact 254.

It will be noted that the switch position selecting relays AC, AN, BN and BC for each of the single track switches and crossovers included in each of the established routes are maintained energized upon passage of a train as long as the route locking is maintained effective for their track switches in accordance with the circuits as typically shown in Fig. 2 and as described when considering the route locking in detail. When the track relay 3TR becomes energized after passage of the train through the route, the picking up of that relay causes the restoration of the route locking relay 3ES for that track section, and the picking up of such route locking relay causes the relays 2AC and 2AN to be dropped away (see Fig. 2) and the dropping away of such relays opens the circuits which have been described for the energization of the lamps of light section 2ANK. The restoration of the route locking also causes the picking up of the lock relay 2LA, and the picking up of that relay opens the circuit for the lamps of light section 2AN/RK at back contact 261, the circuit by which the white lamp *w* of that light section had been originally energized being opened because of the restoration of the exit relay 13XR upon passage of the train through the route.

In a similar manner restoration becomes effective for each of the light sections for the other track sections in the rear of the train. By use of track repeater relays TP for selecting between the white lamps *w* and the red lamps *r* which can be made slightly slow acting if necessary, it is provided that sufficient time will have elapsed upon passage of a train from a track section to allow the deenergization of the indicator lamps for such track section before the relay TP for that track section can have time to be picked up and thus provide a momentary flash of the white lamps.

Having described the present invention as applied to a particular relatively simple track layout as one specific embodiment, it is desired to be understood that this form is used for the purpose of facilitating the disclosure, rather than limiting the forms the present invention may as-

sume, and that various adaptations, alterations and modifications can be made to the specific form shown in accordance with the requirements of practice, all within the spirit or scope of the present invention except as limited by the following claims.

What I claim is:

1. In a switch and signal control system of the character described for the establishment of each desired route extending through a track layout which provides by crossovers a plurality of conflicting routes extending between entrance and exit points; manually operable contact means for designation of each of the entrance and exit points; a common switch position selecting relay for each of the track switches at the opposite ends of a crossover; a normal switch position selecting relay for each of the track switches; means for operating each crossover to the reverse position when said common switch position selecting relays for the ends of that crossover are both energized, and to the normal position when one of said common switch position selecting relays and its corresponding normal switch position selecting relay are both energized; circuit means responsive to entrance designation for energizing said common switch position selecting relay for each track switch facing such entrance point in an available route, irrespective of whether such available route extends over that track switch in a normal or a reverse position, and for energizing said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from such entrance point; and circuit means responsive to exit designation for an available route, subseqent to the designation of the entrance end thereof, for energizing said common switch position selecting relay for each track switch facing such exit point in that route, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position upon passage of a train over such route from that exit point; whereby the combination of switch position selecting relays contemporaneously energized for each crossover selects the normal and reverse positions of the track switches for each route having its entrance and exit ends designated.

2. In a switch and signal control system of the character described for the establishment of each desired route extending through a track layout having a plurality of conflicting routes provided by crossovers extending between signal locations constituting entrance and exit points for both directions of traffic; a miniature track diagram of the track layout having disposed thereon control buttons for designation of the respective entrance and exit points; a common and a normal switch position selecting relay for each of the track switches at the end of a crossover; means for operating each crossover to the reverse position when said common switch position selecting relays for the ends of that crossover are both energized, and to the normal position when one of said common switch position selecting relays and its corresponding normal switch position selecting relay are both energized; two circuit networks for the energization of said switch position selecting relays, one of such networks being energized responsive to entrance or exit designation for signal locations at one end of the track layout and the other of the circuit networks being responsive to entrance or exit designation for signal locations at the other end of the track layout, each of such networks when energized responsive to entrance designation being effective to energize said common switch position selecting relay for each track switch that can be included in a route available for use emanating from that entrance point, irrespective of whether such route extends over that track switch in a normal or a reverse position, and being effective to energize said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from each entrance point, and that circuit network when energized responsive to exit designation, subsequent to the energization of the other network by the designation of the entrance end of an available route extending to that point, being effective to energize said common switch position selecting relay for each track switch facing such exit point in that route, and being effective to energize said normal switch position selecting relay for each track switch that could be trailed in a normal position in that route upon passage of a train from that exit point; whereby the positions of the track switches are selected for each of the crossovers by distinctive combinations of relays energized for such crossover to establish each route available for use extending between designated entrance and exit points.

3. In a switch and signal control system of the character described for a track layout having a plurality of crossover with a track switch at each end and operable to provide conflicting routes between signal locations constituting entrance and exit points for both directions of traffic; a miniature diagram of the track layout having buttons for designation of the respective entrance and exit points; a normal control relay and a common control relay for each of the track switches; means for operating each crossover to the reverse position when said common switch position selecting relays for the ends of that crossover are both energized, and to the normal position when one of said common switch position selecting relays and its corresponding normal switch position selecting relay are both energized; two circuit networks, one network having feed points corresponding to the signal locations at one end of the track layout, and the other network having feed points corresponding to the signal locations at the opposite end of the track layout, and each network acting, when supplied with energy at a feed point corresponding to a designated entrance signal location, to energize the common control relay for each switch which is in each available route originating at such entrance signal location and which has facing point relationship to said entrance signal location, and to energize the normal control relay for each switch which is in each such route and which can be trailed in a normal position by a train moving from said entrance signal location, but acting when supplied with energy at a feed point corresponding to a signal location designated as the exit end of a particular available route, following the energization of the other network at a feed point corresponding to the entrance end of such route, to energize the normal switch control relay for each of the switches in such particular route trailed in the normal position with respect to the exit end of said route and to also energize the common control relay for each of the switches in such particular route in a facing point relation to the exit end of said route.

4. In a switch and signal control system of the entrance-exit type for a track layout including

crossovers each having a power track switch at each end and operable to provide a plurality of conflicting routes extending between entrance and exit points; manually operable contact means for designation of each of the entrance and exit points; a common switch position selecting relay for each of the track switches; a normal switch position selecting relay for each of the track switches; circuit means responsive to entrance designation for energizing said common switch position selecting relay for each track switch facing such entrance point in an available route, and for energizing said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from such entrance point; circuit means responsive to exit designation for an available route, subsequent to the designation of the entrance end thereof, for energizing said common switch position selecting relay for each track switch facing such exit point in that route, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position upon passage of a train over such route from that exit point; and switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of said common and said normal switch position selecting relays for the track switch at either end of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of said common switch position selecting relays for the track switches at both ends of that crossover when said normal switch position selecting relays for those track switches are deenergized.

5. In a switch and signal control system of the character described for a track layout providing by at least one single power track switch a plurality of conflicting routes extending between entrance and exit points; manually operable contact means for designation of each of the respective entrance and exit points; switch position selecting relays for each of the single track switches; circuit means responsive to the designation of each of the entrance points for energizing a first of said switch position selecting relays for a facing single track switch regardless of whether such switch is required to be in a normal or a reverse position for an available route emanating from that entrance point, or for energizing a second or a third of said switch position selecting relays for a trailing single track switch, dependent upon whether such track switch is trailed in a respective normal or reverse position, in an available route emanating from that entrance point; circuit means responsive to the designation of each of the exit points, subsequent to the designation of an entrance point for an available route extending to that exit point, for energizing said first of said switch position selecting relays for a single track switch facing that exit point in that route, or for energizing said second or said third of said switch position selecting relays for the normal or reverse position of a single track switch that could be trailed upon passage of a train over such route from that exit point, dependent upon the respective normal or reverse position in which that track switch could be trailed; and switch operating means responsive to the contemporaneous energization of said first and said second switch position selecting relays for each of the single track switches for causing the power operation of that track switch to a normal position, such means also being responsive to the contemporaneous energization of said first and said third switch position selecting relays for each of the single track switches for causing the power operation of that track to a reverse position.

6. In a switch and signal control system of the entrance-exit type for a track layout having a plurality of conflicting routes provided by crossovers between signal locations constituting entrance and exit points for both directions of traffic; manually operable control buttons disposed on a miniature track diagram of the track layout for designation of the respective entrance and exit points; a common and a normal switch position selecting relay for the track switch at each end of the crossovers; two circuit networks for the energization of said switch position selecting relays, one of such networks being energized responsive to entrance or exit designation for signal locations at one end of the track layout and the other of the circuit networks being energized responsive to entrance or exit designation for signal locations at the other end of the track layout, each of such circuit networks when energized responsive to entrance designation being effective to energize said common switch position selecting relay for each track switch in a facing point relation to said designated entrance point and included in any route available for use emanating from that entrance point, and being effective to energize said normal switch position selecting relay for each track switch that can be trailed in a normal position in any route available for use emanating from that entrance point, and that circuit network when energized responsive to exit designation, subsequent to the designation of the entrance signal location of an available route extending to that point, being effective to energize said common switch position selecting relay for each track switch facing such exit point in that route, and being effective to energize said normal switch position selecting relay for each track switch that could be trailed in a normal position in that route upon passage of a train from that exit point; and switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of the associated common and normal switch position selecting relays for the track switch at either end of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of said common switch position selecting relays for both of the track switches of that crossover when said normal switch position selecting relays for both of those track switches are deenergized.

7. In a switch and signal control system of the character described for a track layout having a plurality of conflicting routes provided by crossovers between signal locations constituting entrance and exit route ends for traffic in both directions; a miniature track diagram of the track layout having control buttons disposed thereon for designation of the respective entrance and exit route ends; a common and a normal switch position selecting relay for the track switch at each end of a crossover; two circuit networks for the energization of said switch position selecting relays, one of such networks being energized responsive to entrance or exit designation for route ends at one end of the track layout and the other of the circuit networks being energized respon-

sive to entrance or exit designation for route ends at the other end of the track layout, each of such networks when energized responsive to entrance designation being effective to energize said common switch position selecting relay for each track switch in a facing point relation to the designated entrance point that can be included in an available route emanating from that entrance point, and being effective to energize said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from that entrance point, and that circuit network when energized responsive to exit designation, subsequent to the designation of the entrance end of an available route extending to that point, being effective to energize said common switch position selecting relay for each track switch facing such exit point in that route, and being effective to energize said normal switch position selecting relay for each track switch that could be trailed in a normal position in that route upon passage of a train from that exit point; switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of said common and said normal switch position selecting relays for the track switch at either end of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of said common switch position selecting relays for both of the track switches of that crossover when said normal switch position selecting relays for those track switches are deenergized; and signal clearing means effective only after the track switches have been properly operated to correspond to the route selected by said switch position selecting relays for clearing the signal at each designated entrance point.

8. In a switch and signal control system of the character described for a track layout having a plurality of conflicting routes extending between entrance and exit points provided by crossovers having power track switches; manually operable contact means for designation of each of the entrance and exit points; two switch position selecting relays for each end of each of the crossovers; circuit means responsive to entrance designation for each of the entrance points for then energizing one of said switch position selecting relays for each track switch that is in either a facing point relation or is in a trailing point relation in the normal position with respect to such entrance point in an available route emanating from that point; circuit means responsive to exit designations for each of the exit points for energizing the other of said switch position selecting relays for each track switch that is facing or trailing in a normal position with respect to such exit point in an available route extending to that exit point from a designated entrance point; switch operating means responsive to distinctive combinations of said switch position selecting relays energized for each of the crossovers for causing the power operation of each of the track switches required for the setting up of each route extending between designated entrance and exit points; and stick circuit means for maintaining said switch position selecting relays energized for each route after a train has entered that route so as to be dependent for deenergization upon the passage of the train past that track switch or crossover.

9. In a switch and signal control system of the entrance-exit type for a track layout providing by crossovers a plurality of conflicting routes extending between entrance and exit signal locations which constitute entrance and exit points for both directions of traffic; manually operable contact buttons on a miniature track diagram of the track layout for designation of the respective entrance and exit points; two switch position selecting relays for each end of each of the crossovers; two circuit networks for the energization of said switch position selecting relays, one of such networks being energized responsive to entrance or exit designation for signal locations at one end of the track layout and the other of the circuit networks being energized responsive to entrance or exit designation for signal locations at the other end of the track layout, each of such networks when energized in response to entrance designation being then effective to cause the energization of one of said switch position selecting relays for each track switch that is either facing or trailing in a normal position with respect to such entrance point in all routes available for use emanating from that point, and each circuit network when energized in response to exit designation, subsequent to the energization of the other network by the designation of the entrance end of an available route extending to that exit point, being effective to energize one of said switch position selecting relays for each track switch in that route that is either facing or trailing in a normal position with respect to such exit point in that route; switch operating means responsive to distinctive combinations of said switch position selecting relays energized for each of the crossovers for causing the power operation of the track switches of each of the crossovers required for the setting up of each route extending between designated entrance and exit points; and stick circuit means effective upon the setting up of each route for maintaining said switch position selecting relays energized for the track switches of each crossover in an established route extending in advance of a train so as to be dependent for deenergization upon passage of a train past that crossover.

10. In a switch and signal control system of the character described for a track layout having a plurality of conflicting routes provided by crossovers having power switches, such routes extending between entrance and exit points defined by the location of wayside signals; manually operable contact means for designation of the respective entrance and exit points; a normal and a common switch position selecting relay for each of the track switches; a polar neutral switch control relay for each of the crossovers; normally deenergized normal and reverse correspondence relays for the respective normal and reverse conditions of each of the crossovers; circuit means responsive to the designation of each of the entrance points for energizing said common switch position selecting relay for each of the track switches facing such entrance point in an available route emanating from that point, and for energizing said normal switch position selecting relay for each of the track switches that can be trailed in a normal position in an available route extending from such entrance point; circuit means responsive to the designation of each of the exit points, subsequent to the designation of an entrance point for an available route extending to such exit point, for energizing said common switch position selecting relay for each of the track switches facing such exit point in

that route, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position upon passage of a train over such route from that exit point; circuit means responsive to the contemporaneous energization of distinctive combinations of said switch position selecting relays for respective normal and reverse positions for the track switches of each of the crossovers for causing the distinctive energization of said polar neutral relay for that crossover for operating the track switches to corresponding positions, such circuit means being effective to energize each polar relay only during the time when the track switches of that crossover are out of correspondence with the positions called for by the distinctive combination of said switch position selecting relays energized for that crossover; circuit means for selectively energizing said normal or said reverse correspondence relay for each crossover included in each established route when the track switches of such crossover are in their positions called for by said switch position selecting relays, such circuit means being effective only when said polar neutral relay for that crossover is deenergized; and signal clearing means effective to clear the signal governing entrance to each of said routes only when one of said correspondence relays is energized for each of the crossovers having one or both of its track switches included in that route.

11. In a switch and signal control system of the entrance-exit type for a track layout providing by crossovers having power track switches a plurality of conflicting routes extending between entrance and exit points; manually operable contact means for designation of each of the entrance and exit points; an auxiliary switch control lever for each of the crossovers having normal and reverse operating positions in addition to a neutral position; a common switch position selecting relay for each of the track switches; a normal switch position selecting relay for each of the track switches; circuit means responsive to entrance designation for energizing said common switch position selecting relay for each track switch facing such entrance point in an available route, and for energizing said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from such entrance point; circuit means responsive to exit designation for an available route, subsequent to the designation of the entrance end thereof, for energizing said common switch position selecting relay for each track switch facing such exit point in that route, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position upon passage of a train over such route from that exit point; circuit means responsive to the actuation of said auxiliary switch control lever for each of the crossovers to a normal operating position for energizing said normal switch position selecting relay for each of the track switches of that crossover; circuit means responsive to the actuation of said auxiliary switch control lever for each of the crossovers to a reverse operating position for energizing said common switch position selecting relay for each of the track switches of that crossover; and switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of said common and said normal switch position selecting relays for the track switch at either end of that crossover or upon the contemporaneous energization only of the normal switch position selecting relays for the track switches of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of said common switch position selecting relays for the track switches of that crossover when said normal switch position selecting relays for such track switches are deenergized.

12. In a switch and signal control system of the character described for a track layout having a plurality of alternative routes provided by crossovers extending between an entrance and an exit point; a miniature track diagram of the track layout having control buttons disposed thereon for designation of the respective entrance and exit points; a common and a normal switch position selecting relay for the track switch at each end of each of the crossovers; circuit means responsive to designation of said entrance point for energizing said common switch position selecting relay for each track switch facing such entrance point in an alternative route, and for energizing said normal switch position selecting relay for each track switch that can be trailed in a normal position in an alternative route extending from such entrance point to thereby preselect a predetermined one of said alternative routes; circuit means responsive to the designation of said exit point for energizing said common switch position selecting relay for each track switch facing that exit point in an alternative route, except when that route extends over the reverse position of an adjacent crossover nearer the exit end having said normal switch position selecting relay energized for that one of its track switches nearer said exit end, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position in an alternative route upon passage of a train from that exit point, except when that route extends over the reverse position of an adjacent crossover nearer said exit end and having said normal switch position selecting relay energized for that one of its track switches near said exit end; and switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of said common and said normal switch position selecting relays for the track switch at either end of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of said common switch position selecting relays for both ends of that crossover when said normal switch position selecting relays for the track switches of that crossover are deenergized; whereby, of a plurality of alternative routes extending between an entrance and exit point, the available route diverging nearest the entrance point is established responsive to the designation of the ends of that route in preference to other routes which may be available.

13. In a switch and signal control system of the character described for a track layout having alternative routes provided by crossovers extending between an entrance and an exit point; a miniature track diagram of the track layout having disposed thereon manually operable contact means for designation of the respective entrance and exit points; a common and a normal switch position selecting relay for the track switch at each end of each of the crossovers; circuit means responsive to the designation of said entrance

point for energizing said common or said normal switch position selecting relay for each track switch that is respectively facing or trailing in a normal position for a train movement in an available route emanating from said entrance point, such circuit means being rendered ineffective for energizing the normal switch position selecting relay for the track switch of the end of a certain crossover remote from the entrance point if a common switch position selecting relay for the track switch for the opposite end of that crossover is energized responsive to such entrance designation; circuit means responsive to the designation of said exit point for energizing said common or said normal switch position selecting relay for those track switches that would be facing or trailing in a normal position respectively if a train were to pass thereover from said exit point and are included in the alternative route preselected by the energization of said common switch position selecting relay of said certain crossover, such circuit means being rendered ineffective for track switches included in other alternative routes requiring the track switches of said certain crossover to be in normal positions; and switch operating means for the track switches of each of the crossovers for operating such track switches to normal positions upon the contemporaneous energization of said common and said normal switch position selecting relays for the track switch at either end of that crossover, and for operating such track switches to reverse positions upon the contemporaneous energization of the common switch position selecting relays for both ends of that crossover when said normal switch position selecting relays for such track switches are deenergized; whereby the alternative route including said certain crossover in the reverse position is established in preference to the other alternative routes.

14. In a switch and signal control system of the character described for a track layout which provides by crossovers a plurality of conflicting routes extending between entrance and exit points for a given direction of traffic, such track layout being divided into a plurality of track sections; a miniature track diagram of said track layout at a control office made up of a plurality of translucent inserts in a control panel, one or more of such inserts being provided for each of the various track sections and for the respective normal and reverse positions of the track switches of the crossovers; indicator lamps for the illumination of the translucent inserts; manually operable control buttons disposed on said diagram for designation of the respective entrance and exit points; a common switch position selecting relay for the track switch at each end of the crossovers; a normal switch position selecting relay for the track switch at each end of the crossovers; a reverse operating circuit for each crossover closed by the energization of both of the corresponding common switch position selecting relays; a normal operating circuit for each crossover closed by the energization of either of the corresponding common switch position selecting relays and the associated normal switch position selecting relay; circuit means responsive to the designation of each of the entrance points for energizing said common switch position selecting relay for each track switch facing that entrance point in an available route, irrespective of whether such available route extends over that track switch in a normal or a reverse position, and for energizing said normal switch position selecting relay for each track switch that can be trailed in a normal position in an available route extending from that entrance point; circuit means responsive to the designation of each of the exit points subsequent to the designation of the entrance point for an available route extending to that exit point, for energizing said common switch position selecting relay for each track switch facing such exit point in that route, irrespective of the position required for that track switch, and for energizing said normal switch position selecting relay for each track switch that could be trailed in a normal position upon passage of a train over such route from that exit point; and circuit means for selectively illuminating said translucent inserts by the energization of said indicator lamps in accordance with the energized condition of said common and said normal switch position selecting relays for each of the crossovers when the entrance and exit ends of a route to be established have both been designated to provide in effect a relatively continuous line-of-light for the illumination of the portion of the track diagram corresponding to the route having its entrance and exit ends designated.

15. In a switch and signal control system of the entrance-exit type for a track layout providing a plurality of interlocked groups adjoining at intermediate signal locations, each of such groups having crossovers which provide a plurality of conflicting routes extending between entrance and exit points, certain of said routes over said interlocked groups constituting parts of through routes past intermediate signal locations; manually operable contact means for each of the entrance and exit points; two switch position selecting relays for each end of each of the crossovers; a through route relay for each of the intermediate signal locations; circuit means responsive to entrance designation for each of the entrance points for energizing a certain one of said switch position selectong relays for each track switch that is facing or trailing in a normal position with respect to such entrance point in all available routes and through routes emanating from that point, such means also being effective to cause the energization of said through route relay for each of the intermediate signal locations that can be included in an available through route emanating from that entrance point; circuit means responsive to exit designation for each of the exit points for energizing the other of said switch position selecting relays for each track switch that is facing or trailing in a normal position with respect to that exit point in an available route or through route extending from that exit point toward the entrance point designated, said circuit means being effective for a through route only provided said through route relay is energized for each of the intermediate signals in that through route, the response of such switch position selecting relays being effective to cause the restoration of said through route relay for each of the intermediate signals in that route, and thereby open the established through route connection, and switch operating means responsive to distinctive combinations of said switch position selecting relays energized for each of the crossovers for causing the power operation of each of the track switches required for the setting up of each route extending between designated entrance and exit points, whereby a through route can be set up by designation of the extreme ends only of that route, or

the part of such through route extending through each of the interlocked groups can be established independent of through route control.

16. In a switch and signal control system of the character described for a track layout providing a plurality of interlocked groups adjoining at intermediate signal locations, each of such groups having crossovers which provide a plurality of conflicting routes extending between entrance and exit points; certain of said routes over said interlocking groups constituting through routes past intermediate signal locations; manually operable contact means for designation of the respective entrance and exit points; a through route relay for each of the intermediate signal locations; two switch position selecting relays for the track switch at each end of each of the crossovers; circuit means responsive to entrance designation for each of the entrance points for energizing a certain one of said switch position selecting relays for each of the track switches within that interlocked group which faces such entrance point in an available route, irrespective of whether such available route extends over that track switch in a normal or a reverse position, and for energizing a certain one of said switch position selecting relays for each track switch within that interlocked group that can be trailed in a normal position in an available route extending from such entrance point; circuit means responsive to exit designation for each of the exit points, subsequent to the designation of the entrance end of an availabe route in that interlocked group extending to such exit point, for energizing the other of said switch position selecting relays for each track switch facing that exit point in such route, irrespective of the position required for that track switch in such route, and for energizing the other of said switch position selecting relays for each track switch that could be trailed in a normal position upon passage of a train over that route from that exit point; switch operating means responsive to distinctive combinations of said switch position selecting relays energized for each of the crossovers for causing the power operation of each of the track switches required for the setting up of each route extending between designated entrance and exit points; and through route control means including said through route relay for each of the intermediate signal locations effective upon designation of the respective entrance and exit ends of each of the through routes to render said circuit means effective as if the respective entrance and exit points for such intermediate signal location in that through route were designated by an operator.

17. In a control system of the character described for governing the power operation of track switches constituting the ends of crossovers in a track layout for setting up various routes between locations constituting entrance and exit points, control buttons for said locations operable to designate any given location as an entrance or an exit point, control relays for the track switches of said track layout, there being one control relay associated with the facing point position of each track switch and another control relay associated with the normal trailing position of each track switch, switch operating circuits effective upon the energization of the facing point control relay and the normal trailing point control relay of the switch for either end of a crossover to operate the switches at both ends of said crossover to a normal position, said switch operating circuits being effective upon the energization of the two facing point control relays for the switches at the opposite ends of any given crossover to cause the reverse operation of both such switches, circuit means effective upon the actuation of a control button to designate an entrance point to energize a facing point control relay for each track switch having a facing point relation to said entrance point and included in any available route originating at that location and also effective to energize the normal trailing point control relay for each track switch that would be trailed normal in any available route originating at such location, circuit means effective upon the actuation of a control button to designate the exit point of any particular route originating at a location having already been designated as an entrance point for energizing the facing point control relay for each switch in that route having a facing point relation to said exit location and for energizing the normal trailing point control relay for each switch that faces said entrance point but is required to be in a normal position for said particular route, contacts operated by the energization of said control relays of each switch when included in a route for rendering said circuit means ineffective to energize other control relays for all conflicting routes, and circuit means effective while a train is in an established route for maintaining energized the control relays independently of the restored condition of said control buttons so as to prevent the actuation of control buttons for some conflicting route from effecting operation of control relays for such conflicting route.

18. In a switch and signal control system of the character described for the establishment of each route extending over track switches at the ends of crossovers through a track layout providing a plurality of conflicting routes extending between entrance and exit points, manually operable contact means for designation of the respective entrance and exit points, circuit means comprising two circuit networks responsive to entrance designation for energizing the same common switch position selecting relay for each track switch facing that entrance point in all available routes, irrespective of whether an available route extends over that track switch in a normal or a reverse position, and a normal switch position selecting relay for each track switch trailed in a normal position from that entrance point in any available route, and for energizing responsive to exit designation the same common switch position selecting relay for each track switch facing that exit point in a route extending to a designated entrance point and a normal switch position selecting relay for each switch trailed in the normal position in that route.

NELSON B. COLEY.