

May 1, 1951

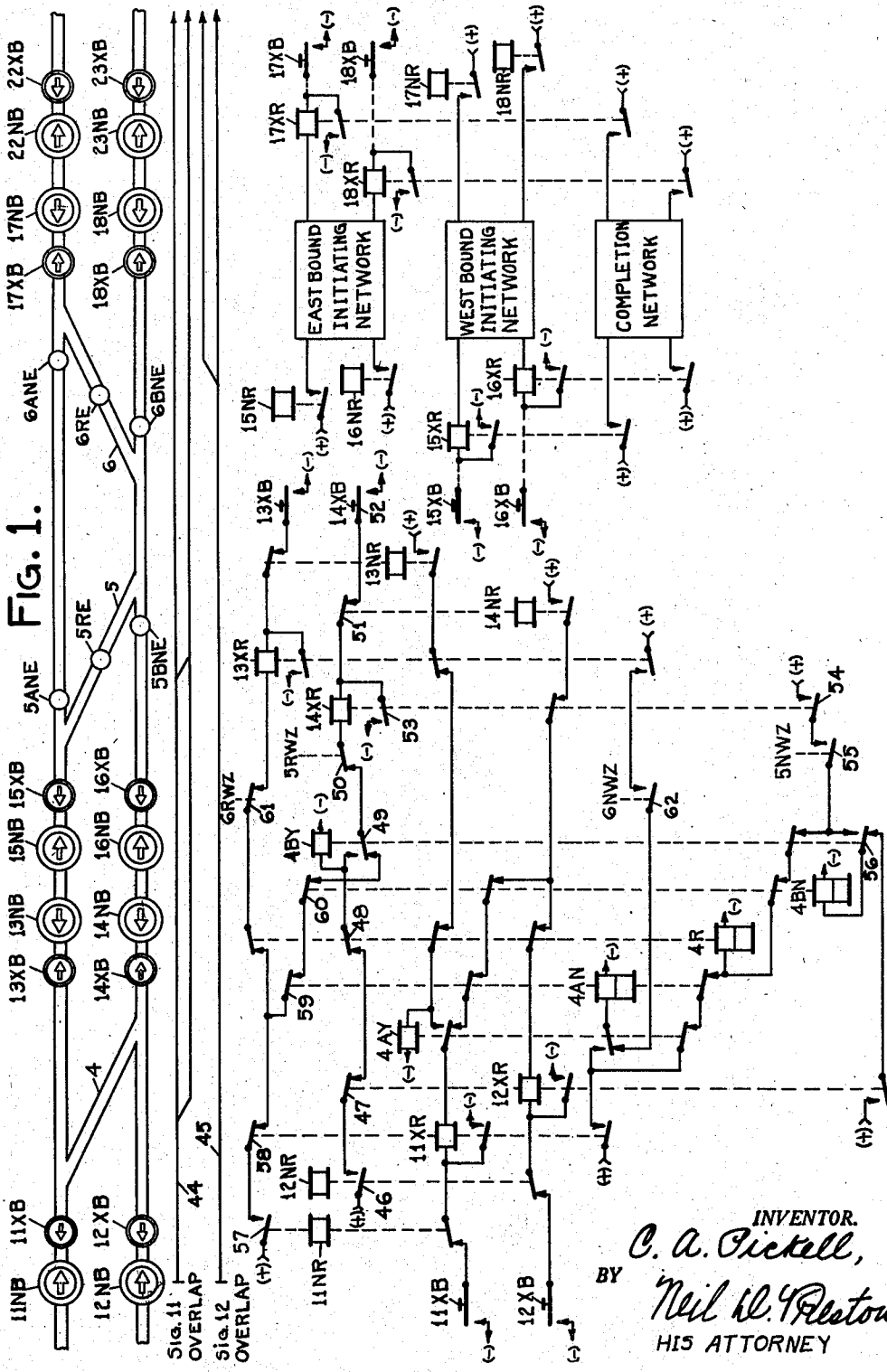
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2,550,859

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed May 11, 1946

4 Sheets-Sheet 1



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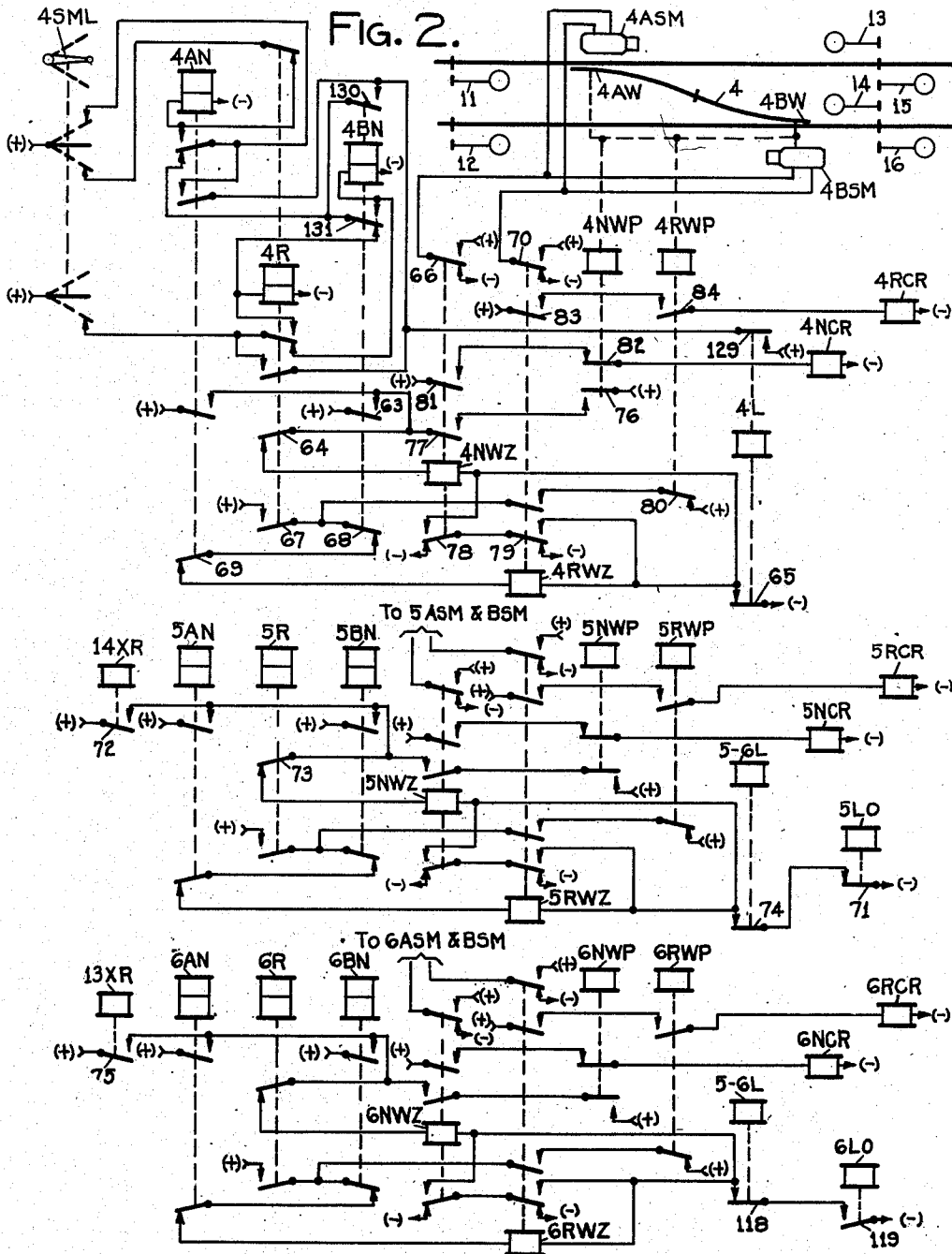
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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4 Sheets-Sheet 2



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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed May 11, 1946

4 Sheets-Sheet 3

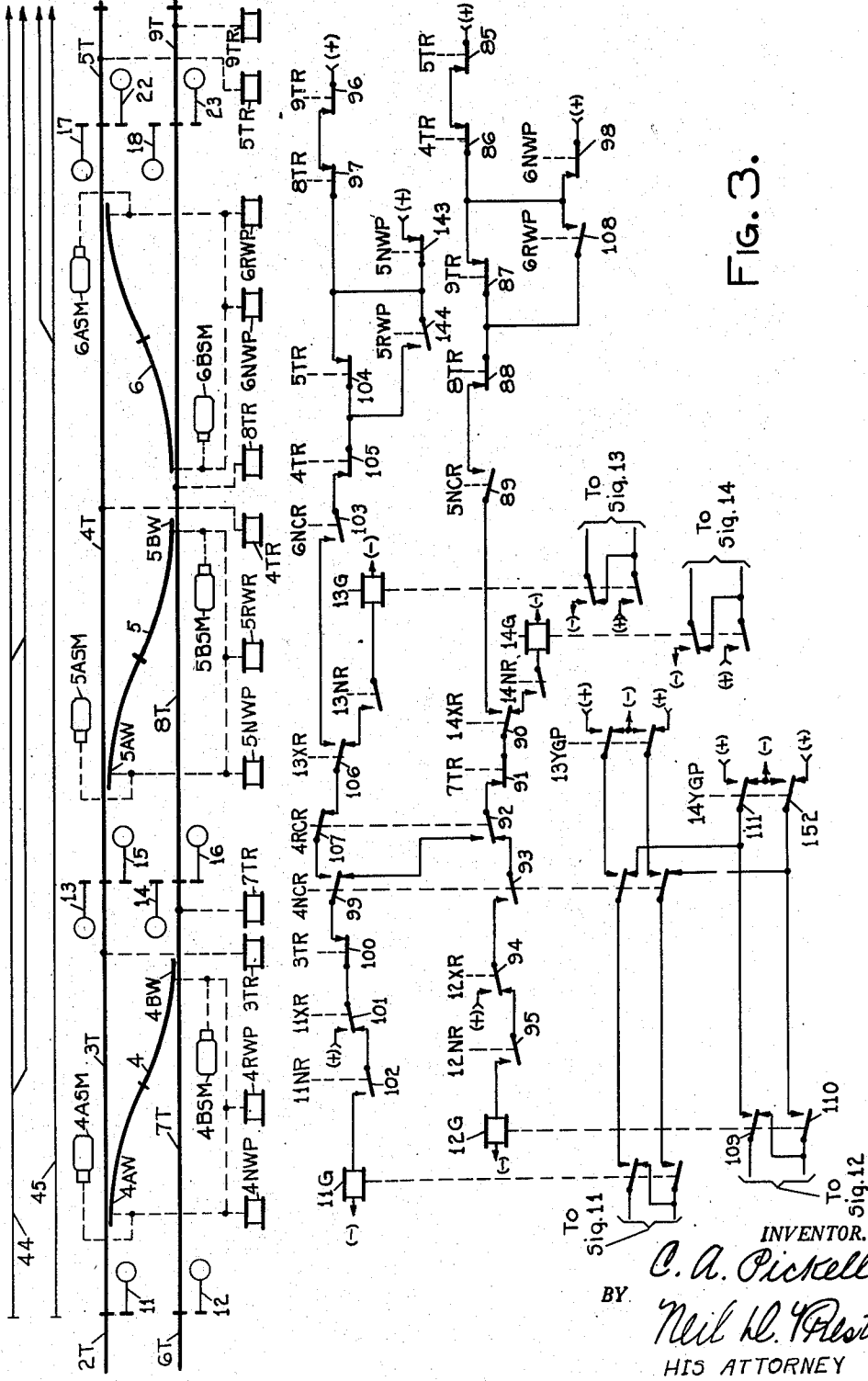


FIG. 3.

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2,550,859

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed May 11, 1946

4 Sheets-Sheet 4

FIG. 4.

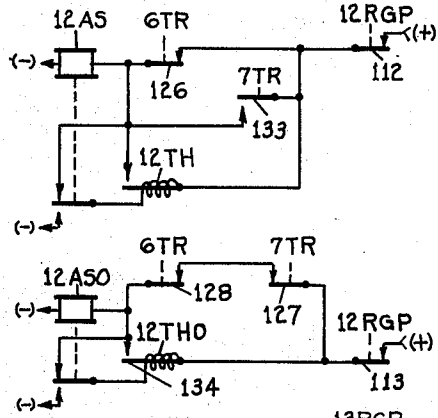
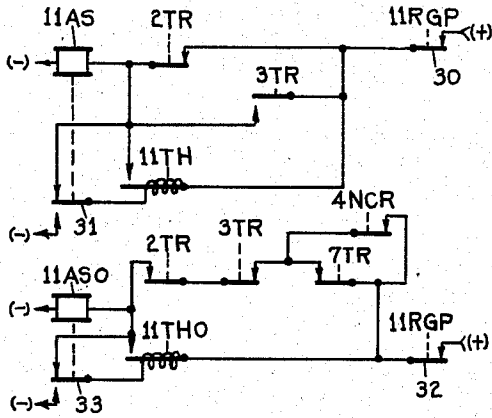


FIG. 5.

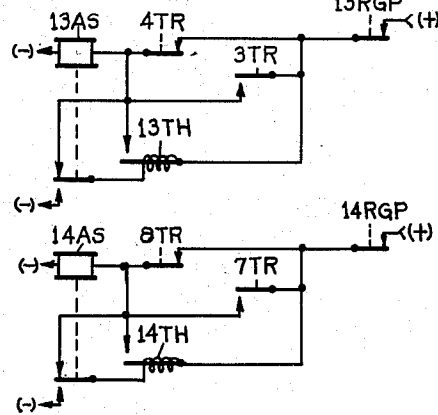
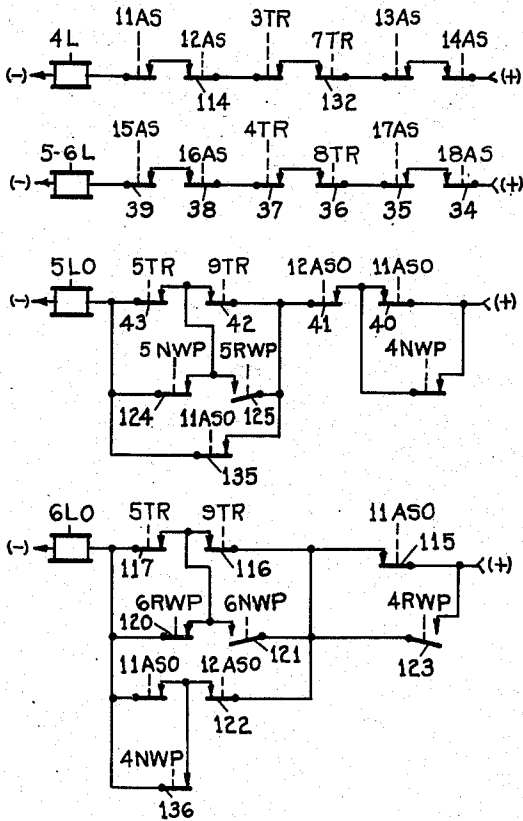
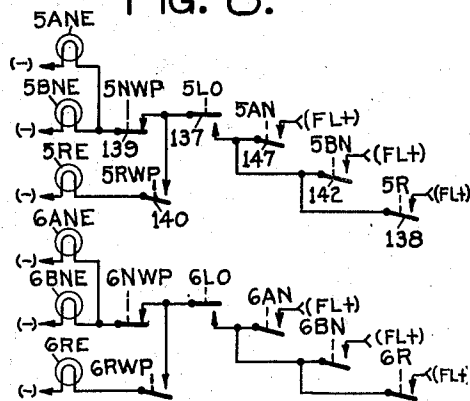


FIG. 6.



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# UNITED STATES PATENT OFFICE

2,550,859

## SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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9 Claims. (Cl. 246—134)

1

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

In an entrance-exit type switch and signal control system, a control panel having a miniature diagram of the track layout for which the system is provided has disposed thereon entrance and exit control buttons for the respective entrance and exit ends of the various routes, a route being considered as extending from one signal to the next signal in advance for governing the same direction of traffic. A route as thus defined is said to be within an interlocked group. A route is said to be established when the required positions for each of the track switches for such route are selected in response to the joint designation of the respective entrance and exit ends of that route by actuation of the corresponding entrance and exit buttons. A route becomes set up after the track switches have been power operated to their required positions.

In track layouts for congested areas such as subways, for example, where signals are placed close together to facilitate handling of a large volume of traffic, the spacing of the signals is generally shorter than braking distance of a train, and therefore the caution indication of certain of the signals must be dependent upon conditions of occupancy of several track sections in advance of that signal, rather than upon just the track sections included between that signal and the next signal in advance. Track sections required to be unoccupied for the caution control of a signal beyond the next signal in advance, are called overlap track sections, and a signal that is governed by conditions of occupancy in overlap track sections is said to have overlap control. Such signal can indicate clear or caution only if its overlap track sections are unoccupied.

An object of the present invention is to provide locking for each facing point track switch in an overlap section extending beyond an established route. Such overlap locking is conditional in that it allows operation of a facing point track switch in an overlapping track section, only if the track sections included in the overlap control extending over the track switch in its newly operated position are unoccupied.

Another object of the present invention is to operate each trailing track switch in an overlap track section to its normal position when a route is established having its entrance point governed by a signal having overlap control through that

2

track switch in its normal trailing position. This is desirable in order to prevent damage to the trailed track switches in case a train overruns the stop signal at the exit end of the established route.

Another object of the present invention is to allow preconditioning of a route, only when that route may call for the power operation of a track switch that is locked by reason of overlap locking. Thus such route can be selected by route establishing means in response to the designation of the respective entrance and exit ends of that route, but such route can become completely set up only after the overlap locking for any track switch included in that route is released.

Another object of the present invention is to distinctively indicate on the miniature diagram of the track layout each track switch that is locked by overlap locking when a route extending through that track switch is designated for establishment by the actuation of entrance and exit control buttons.

Another object of the present invention is to distinctively indicate the position in which a track switch is locked by overlap locking when a route extending through that track switch is designated for establishment by the actuation of entrance and exit control buttons.

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

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 those parts having similar features and functions are designated by like letter reference characters which are generally made distinctive by reason of preceding numerals indicative of their association with various switches or signals, and in which:

Fig. 1 illustrates the route establishing means provided for the track layout of this embodiment of the present invention, together with a miniature track diagram of such track layout having disposed thereon control buttons for designation of the respective entrance and exit ends of the routes;

Fig. 2 illustrates circuit means provided for causing the power operation of the track switches in accordance with the selection of their position by the route establishing means disclosed in Fig. 1;

Fig. 3 illustrates the track layout for which

this embodiment of the present invention is provided together with circuits involved in the control of typical signals for governing traffic through the track layout;

Fig. 4 illustrates the manner of control of approach locking relays for this embodiment of the present invention;

Fig. 5 illustrates the control of electric locking relays for the respective track switches; and

Fig. 6 illustrates circuits for providing overlap locking indications.

For the purpose of facilitating the disclosure of the present invention as to its mode of operation, the illustrations have been provided principally as schematic wiring diagrams arranged more particularly to clearly illustrate the mode of operation of the system than to specifically illustrate the structure and arrangement of parts that would be provided in practice. Thus, the various relays and their contacts are illustrated in a conventional manner, and certain contacts and windings of relays are shown in the conventional written circuit form for the purpose of simplifying the illustrations, each of the contacts being readily identified with its relay by the use of reference characters of that relay above such contact. The symbols (+) and (-) are employed to indicate the respective positive and negative connections to suitable batteries or other sources of direct current, and the symbol (FL+) is employed to indicate the connection through an interrupter to the positive terminal of a suitable source of energy.

Reference is made from time to time during the description of the present invention to the function of parts of the system of a similar nature by reference to letter reference characters common to all of such parts, rather than identifying each part by its preceding numeral which is generally characteristic of the particular switch or signal with which such part is more directly associated.

*Track layout.*—The track layout used for this embodiment of the present invention as shown in Fig. 3 is selected as of a character to facilitate disclosure of the principles of operation of the system provided by the present invention, and it is to be understood that the present invention is not limited to the specific track layout shown in this embodiment of the present invention. It will be readily apparent as the description progresses that the principles of operation described with respect to the specific track layout shown are readily applicable to other more complex track layouts to be encountered in practice.

With reference to Fig. 3, the track layout of this embodiment of the present invention comprises two parallel main tracks interconnected by crossovers 4, 5 and 6. The upper of the two tracks is divided into track sections including sections 2T, 3T, 4T and 5T; and the lower of the two main tracks is divided into track sections including track sections 6T, 7T, 8T and 9T.

Signals are provided for governing entrance to each of the routes for traffic in both directions, the signals 11, 12, 15 and 16 being provided for governing eastbound traffic, and the signals 17, 18, 13 and 14 being provided for governing westbound traffic. The signals shown are assumed to be of the searchlight type having electrically operated signal mechanisms of the type shown, for example, in the patent to O. S. Field, No. 1,835,150, dated December 8, 1931.

The signals are of the three-indication type having red, yellow and green color light indica-

tions for the respective stop, caution, and proceed or clear indications. It is understood that other types of signals such as color light signals having individual color lamp units, position light signals, or semaphore signals could as well be used in accordance with the requirements of practice.

The track switches are power operated by suitable electrically controlled switch machines which may be of the general type, for example, as is disclosed in the patent to W. K. Howe, No. 1,466,903, dated September 4, 1923. It is to be understood that the switch machine motor is controlled in accordance with the usual practice to provide suitable overload protection and other protective features generally required in practice.

As a means for repeating the positions of the respective track switches, the track switches of each crossover have associated therewith NWP and RWP neutral relays for repeating the respective normal and reverse positions of such track switches. These relays are controlled in accordance with the usual practice, and for the purpose of simplification of the present disclosure, the control of these relays has been merely indicated by dotted lines to show that a pair of relays is associated with each of the respective crossovers. It is therefore provided that each of the relays NWP is energized whenever the track switch or track switches with which it is associated are in their full normal positions, and similarly each relay RWP is energized when its track switch or track switches are in their full reverse positions.

*Control machine.*—A miniature track diagram is provided on a control panel on the control machine corresponding to the track layout for which the system is provided, such diagram being illustrated in Fig. 1. The respective entrance and exit control buttons are disposed at positions along the miniature track diagram corresponding to the respective entrance and exit ends of the routes as defined by the location of the signals of the track layout. Although separate entrance and exit buttons are shown for the respective entrance and exit ends of each of the routes for designation of such ends in the establishment of routes, it is to be understood that single buttons performing the function of both entrance and exit designation, dependent upon the sequence of operation of the buttons, can as well be provided if such are the requirements of practice.

It is to be understood that suitable indicating means is provided on the miniature track diagram to provide all of the information necessary for an operator to intelligently cause the establishment of the various routes, but, for the purpose of simplification of the present disclosure, only certain of the indicator lamps associated with indications concerned with overlap locking are shown. It is to be understood that various well known types of indicating means can be provided on the miniature track diagram in accordance with the requirements of practice, such, for example, as indicating means of the general character disclosed in the patent to T. J. Judge, No. 2,298,946, dated October 13, 1942.

*System devices.*—Entrance and exit relays NR and XR are provided for the ends of the routes to be responsive to the manual designation of such ends in the establishment of routes. Each of the entrance relays NR is provided with a stick circuit so as to be maintained picked up after it is energized upon the actuation of its entrance button NB, such stick circuit being pro-

vided in a manner fully disclosed for the control of relays identified by similar letter reference characters in the above mentioned patent to T. J. Judge. Such circuits are arranged so that each relay NR is maintained picked up until it is caused to be dropped away either by the passage of a train or by a manual restoration operation of the associated entrance button NB.

A conditioning relay Y is provided for each end of each of the crossovers and it is used as a switch conditioning relay in initiating circuits which are energized in response to entrance designation in the process of establishment of routes.

Normal switch position selecting relays AN and BN are provided for each of the crossovers for selecting the normal positions of the track switches of such crossover when they are included in routes to be established. Similarly, a reverse control relay R is provided for each of the crossovers for selecting the reverse positions of the track switches of that crossover when it is required that such crossover be included in a route having its entrance and exit ends designated.

In response to the selective energization of the switch control relays AN, BN and R for each of the respective track switches, switch control relays NWZ and RWZ for the respective normal and reverse positions of the track switches of each of the crossovers are conditioned, and the conditioning of such relays is effective to apply power to the track switches with which such relays are associated for the power operation of such track switches to the selected normal or reverse positions.

Correspondence relays NCR and RCR are provided for each of the crossovers, one or the other of such relays being energized, for each crossover having a track switch included in an established route. Such relays when energized close portions of the signal control circuits to provide that each of the signals can be cleared only when a route has been completely set up extending between that signal location and the next signal location in advance.

Switch lock relays L and LO are provided as required for the respective crossovers, one relay LO being provided for each crossover having track switches required to be locked in accordance with overlap controls.

Having thus considered the general organization of the apparatus, it is believed that the circuit organization will be more readily understood as the circuits are described in accordance with typical operating conditions that would be encountered in practice.

#### Operation

The conditions of energization of relays and signals and the positions of the track switches as illustrated in the drawings are considered as the normal conditions of the apparatus as a basis of consideration of various typical operating conditions to be hereinafter considered. Thus, it is assumed that no routes are established through the track layout, that the last routes established called for the track switches of the respective crossovers to be in their normal positions, and that the trackway of the track layout is unoccupied by trains.

Under normal conditions the relays associated with the route establishing means are deenergized, the electric locking relays are energized, and various relays are energized that are associated with repeating the normal conditions of the system, such as the positions of the track

switches, and the stop positions of the respective signals.

The approach locking relay IAS, for example, is normally energized in accordance with the signal 11 (see Fig. 4) being at stop as indicated by the closure of the front contact 30 of the signal repeater relay IRGP. Thus, the relay IAS is normally energized by a stick circuit extending from (+), including front contact 30 of relay IRGP, winding of thermal relay ITH, front contact 31 of relay IAS, and winding of relay IAS, to (-).

An approach locking relay IASO is also associated with the signal 11, and it is normally energized in accordance with the stop indication of signal 11. Such relay is used in connection with the overlap locking of signal 11 in a manner to be hereinafter described. The relay IASO is maintained normally picked up by its stick circuit extending from (+), including front contact 32 of relay IRGP, winding of the thermal relay ITHO, front contact 33 of relay IASO, and winding of relay IASO, to (-).

A lock relay L is normally energized for each crossover except that one relay 5-6L (see Fig. 5) is provided for the crossovers 5 and 6, because, for the purpose of simplification of the present disclosure, such crossovers are assumed to be included in the same track circuits. Thus, the relay 5-6L is normally energized by a circuit extending from (+), including front contact 34 of relay IAS, front contact 35 of relay IAS, front contact 36 of relay ITR, front contact 37 of relay ITR, front contact 38 of relay IAS, front contact 39 of relay IAS, and winding of relay 5-6L, to (-).

An overlap switch lock relay LO is normally energized for each of the crossovers included in an overlap track section. Thus, the relay 5LO is energized, for example, by a circuit extending from (+), including front contact 40 of relay IASO, front contact 41 of relay IASO, front contact 42 of relay ITR, front contact 43 of relay ITR, and winding of relay 5LO, to (-).

With reference to Fig. 1, for the purpose of disclosure of the features of the present invention relative to overlap locking and overlap switch operation, the signals 11 and 12 are assumed to have overlap controls represented by the interconnected arrows 44 and 45 below the miniature diagram of the track layout.

These arrows indicate that the caution control of the signals 11 and 12 governing entrance to the track layout on the respective main tracks for eastbound traffic, extends through the track sections 5T and 9T, respectively, at the right-hand end of the track layout. The overlap control arrows 44 and 45 indicate that neither the signal 11 nor the signal 12 can be controlled to indicate either proceed or caution unless the trackway is unoccupied for a route extending from such signal to the extent of the overlap signal control arrows.

*Route establishment.*—The general mode of operation of the system in the establishment of routes according to the present invention corresponds to the system fully described in the above mentioned prior patent to T. J. Judge, No. 2,298,946, dated October 13, 1942, and reference is to be made to that patent for a more complete disclosure of the route establishing means provided in this embodiment of the present invention. Reference can be made to that case for disclosure of route establishing means which is merely indicated by block diagrams in the Fig. 1

of the present disclosure. Thus, for an understanding of the present invention, it is believed sufficient to consider the general mode of operation of the system in route establishment, and the manner in which the mode of operation as disclosed in the above mentioned Judge patent is modified by the present invention. For the purpose of facilitating reference to that patent, the numbering of the switches and signals, together with letter reference characters of the present disclosure, has been made to agree with that patent.

The route establishing means in general comprises an initiating circuit network for each direction of traffic, and a completion circuit network which is effective to energize switch position selecting relays for either direction of traffic.

Each of the initiating circuit networks is a circuit organization having a structure that is readily comparable to the track layout for which the system is provided in that there is a circuit portion corresponding to each of the main tracks, and another circuit portion corresponding to each of the crossovers. The ends of the initiating circuit networks corresponding to the entrance ends of the respective routes serve as energy feed points for the networks, energy being applied at such points in accordance with the respective designation of such points as entrance points for routes to be established by the actuation of the respective entrance control buttons NB.

In response to the actuation of an entrance control button NB by an operator, an entrance relay NR is picked up for that entrance point, and such relay is maintained picked up by a stick circuit, in a manner corresponding to that fully described in the above mentioned patent to T. J. Judge.

The application of energy at the feed points of an initiating network causes energy to feed through the circuit branches of the network corresponding to the respective available routes emanating from that entrance point. Such energy feeds through the initiating network to the respective exit relays XR associated with the routes that are available for establishment at that time to condition such exit relays in a manner to allow the picking up of one of such relays if an operator actuates the exit control button XB associated with that exit point. It is further provided that energy feeding through the initiating network picks up a switch position selecting relay AY or BY for each track switch that is trailed in a normal position from that entrance point to condition the completion circuit network.

The completion circuit network can also be said to have circuit branches corresponding to the respective tracks and crossovers of the track layout, and such circuit network has feed points corresponding to the respective exit ends of the routes for both directions of traffic where energy can be applied to the circuit network by the picking up of the respective exit relays XR.

As a specific example of how a route can be established, it will be assumed that it is desired to establish a route from the signal 12 to the signal 16, signal 12 being a signal having overlap control. Inasmuch as the overlap control of signal 12, as indicated by the arrow 45 of Fig. 1, extends through the track switch 5BW in its normal position as a trailing switch, it is required that the track switches of crossover 5 be operated to their normal positions as a part of the establishment of the route from signal 12 to signal 16, although the crossover 5 is not included in the

route under consideration. The reason for this operation is to protect the track switch at the lower end of the crossover 5 against damage in case a train passing over the route from signal 12 to signal 16 should overrun the signal 16. It is thus provided that the establishment of a route must include the power operation of each trailing track switch included within the overlap control limits of the signal governing entrance to the route desired to be established. It is further provided that the route cannot be established unless each of the trailing switches which would be included within the overlap limits of control of the signal governing entrance to the route must be free to be operated to its normal position before the route establishing means can become effective to establish the route. That is, subsequent to the designation of the entrance end of a route at signal 12, the designation of an exit point for the route by the depression of the exit button 14XB cannot cause the establishment of that route, even though it is available, unless the track switches of the crossover 5 are free to be operated to their normal positions.

The picking up of relay 12NR in response to entrance designation at the entrance to the route governed by signal 12 applies energy to the initiating circuit network for the establishment of routes for eastbound trains and causes the picking up of the relay 4BY, because the track switch 4BW at the lower end of the crossover 4 is trailed in such route in its normal position. The relay 4BY is energized under such conditions by a circuit extending from (+), including front contact 46 of relay 12NR, back contact 47 of relay 12XR, back contact 48 of relay 4R, and winding of relay 4BY, to (-).

The picking up of relay 4BY closes a portion of the initiating circuit network to condition the relay 14XR so that it can be picked up in response to the actuation of the exit button 14XB. The circuit by which the relay 14XR can be picked up under such conditions extends from (+), including front contact 46 of relay 12NR, back contact 47 of relay 12XR, back contact 48 of relay 4R, front contact 49 of relay 4BY, back contact 50 of relay 5RWZ, winding of relay 14XR, back contact 51 of relay 14NR, and contact 52 of the exit button 14XB, to (-). The picking up of relay 14XR establishes a stick circuit at front contact 53 to shunt the contacts 51 and 52 of relay 14NR and the exit button 14XB, respectively, out of the circuit just described. It will be noted that the back contact 50 of relay 5RWZ is included in the circuit just described for the relay 14XR. Such contact checks that the track switches of the crossover 5 are free to be operated to their normal positions, if they are not already in such positions.

The picking up of the relay 14XR is effective to pick up a relay 5NWZ for causing the power operation of the track switches of the crossover 5 to their normal positions as shown in Fig. 2, and as hereinafter described. After the relay 5NWZ is picked up, a branch of the completion network is closed to provide for the energization of relay 4BN for selecting the normal position of the track switches of the crossover 4 as required in the route under consideration. The relay 4BN is picked up under such conditions, in accordance with the energization of the relay 4BY, by the energization of a circuit extending from (+), including front contact 54 of relay 14XR, front contact 55 of relay 5NWZ, front contact 56 of relay 4BY, and upper winding of relay 4BN, to (-),

thus completing the establishment of the route from signal 12 to signal 16.

Although a simple track layout has been chosen for a disclosure of the operation of the system according to the present invention, it is believed that it will be readily apparent that the same system can be applied in the selection of routes requiring the positioning of a larger number of track switches in accordance with the general principles of route establishment as has been specifically pointed out in the above mentioned prior patent to T. J. Judge.

Upon considering the circuits as they have been described, it will be apparent that the back contact 50 of relay 5RWZ in the initiating circuit network for the establishment of routes for eastbound trains is in a circuit portion of the network that is common to the establishment of routes extending to the exit point at signal 16 from signal 12, or from signal 11 over the crossover 4. This, of course, is desirable because it is required that the track switch 5BW be operated to its normal position whenever it is included, as a switch trailed in its normal position, in the overlap portion of the control of any signal.

The relay 14XR is conditioned for energization by the initiating network, when the entrance button 11NB is actuated for the designation of an entrance point, so as to provide that such relay can be picked up upon the subsequent designation of the exit end of the route by the actuation of the exit button 14XB. The circuit is closed upon the depression of button 14XB extending from (+), including front contact 57 of relay 11NR, back contact 58 of relay 11XR, back contact 59 of relay 4AN, back contact 60 of relay 4BN, back contact 49 of relay 4BY, back contact 50 of relay 5RWZ, winding of relay 14XR, back contact 51 of relay 14NR, and contact 52 of the exit button 14XB, to (-).

It is provided in a similar manner that the track switches of the crossover 6 are operated to their normal positions in accordance with the establishment of a route from signal 11 to signal 15, because the track switch 6AW at the upper end of the crossover 6 is required to be trailed in the overlap portion of the control of signal 11, when such route is established. Thus, the inclusion of the back contact 61 of relay 6RWZ, in the circuit branch of the initiating circuit used in the establishment of a route from signal 11 to signal 15 checks that the track switches of the crossover 6 are free to be operated to their normal positions. After the relay 13XR has been picked up the relay 6NWZ is picked up as shown in Fig. 2 and as hereinafter described. The picking up of relay 6NWZ conditions a completion circuit by which the relay 4AN can be picked up for selecting the normal positions of the track switches of the crossover 4 to provide establishment of the designated route. The relay 4AN is energized by an obvious circuit under such conditions, including front contact 62 of relay 6NWZ.

*Switch control.*—The power operation of the various track switches in accordance with the picking up of the relays AN, BN and R in the establishment of the routes is provided as shown in Fig. 2, although it will be readily apparent to those skilled in the art that various modified means of switch control can be provided in accordance with the requirements in practice. It is also provided that the track switches of each of the crossovers are power operated in response to auxiliary switch control levers provided for the respective crossovers as a means for operating

the track switches to free them of obstructions and for other purposes without requiring the establishment of routes. Reference is to be made to the above mentioned patent to T. J. Judge for a more complete disclosure of the mode of operation of the system in response to the positioning of the auxiliary switch control levers.

The picking up of relay 4BN in the establishment of a route from signal 12 to signal 16 in a manner which has been described, is effective to cause the picking up of the relay 4NWZ for energizing the switch machines SM of the track switches of the crossover 4 with a polarity to operate such track switches to their normal positions. The relay 4NWZ is picked up under such conditions by the energization of a circuit extending from (+), including front contact 63 of relay 4BN, back contact 64 of relay 4R, winding of relay 4NWZ, and front contact 65 of relay 4L, to (-). The inclusion of front contact 65 of relay 4L in the circuit just described provides that the relay 4NWZ can be picked up for the power operation of the track switches only if it is safe to operate the track switches according to the electric locking. In accordance with the picking up of the relay 4NWZ, energy is applied at front contact 66 to the switch operating circuits of a polarity to operate the switch machines to their normal positions.

If an established route calls for the operation of the track switches of the crossover 4 to their reverse positions, the relay 4R is picked up in the establishment of the route in the manner which has been discussed, and the picking up of that relay causes the picking up of the relay 4RWZ to apply power to the switch machines for the track switches of the crossover 4 of a polarity to operate such switch machines to their reverse positions. Thus the picking up of relay 4R is effective to cause the energization of relay 4RWZ upon the closure of a circuit extending from (+), including front contact 67 of relay 4R, back contact 68 of relay 4BN, back contact 69 of relay 4AN, winding of relay 4RWZ, and front contact 65 of the lock relay 4L, to (-). The closure of front contact 70 of the relay 4RWZ applies energy to the control circuit for the switch machines to provide for their operation to their reverse positions.

A similar mode of operation is effective in positioning the track switches of the crossover 5 except that such crossover is included in the overlap control section of the signals 11 and 12 and therefore is subject to overlap locking as is provided by the inclusion of front contact 71 of relay 5LO in the pickup circuits for the relays 5NWZ and 5RWZ.

It is also provided that the relay 5NWZ has a pickup circuit dependent upon the closure of front contact 72 of relay 14XR, because the track switch 5BW of the crossover 5 becomes a trailing switch in the overlap control section for a signal governing entrance to a route having an exit point at signal 16. Thus, when a route is established for eastbound traffic, with signal 16 as the exit point, the relay 14XR is picked up, and the picking up of that relay causes the energization of the relay 5NWZ by a circuit extending from (+), including front contact 72 of relay 14XR, back contact 73 of relay 5R, winding of relay 5NWZ, front contact 74 of relay 5—6L, and front contact 71 of relay 5LO, to (-). The picking up of relay 5NWZ allows the completion of the route establishing means in the completion

network in a manner which has been heretofore described.

In a similar manner the closure of front contact 75 of relay 13XR causes the picking up of the relay 6NWZ to operate the track switches of crossover 6 to their normal positions in accordance with the track switches 6AW at the upper end of the crossover 6 being included as a trailing switch in the overlap control section of the signal 11.

It will be noted that a stick circuit is provided for each of the relays NWZ and RWZ for the purpose of causing the completion of the operation of a track switch when such operation has been initiated. The relay 4NWZ, for example, has a stick circuit which is closed, when the track switches of crossover 4 have initiated their operation from their reverse to their normal positions, to provide that the track switches will complete their operation, even though the route establishing means may be restored before the operation of the track switches has been completed. Thus, the relay 4NWZ is provided with a stick circuit extending from (+), including back contact 76 of the normal switch repeater relay 4NWP, front contact 77 of relay 4NWZ, back contact 64 of relay 4R, winding of relay 4NWZ, front contact 78 of relay 4NWZ, and back contact 79 of relay 4RWZ, to (-). It will be noted that the stick contact 78 of relay 4NWZ shunts the lock contact 65 of relay 4L out of the circuit to provide that operation of the track switch will be completed, even though the lock relay 4L has been dropped away in mid-stroke. In a similar manner the closure of back contact 80 of relay 4RWP in the stick circuit for the relay 4RWZ is effective to cause such relay to remain picked up until the track switches of crossover 4 have completed their operation to their reverse positions.

After the track switches of a crossover have completed their operation to the position called for by the relay AN, BN or R of the route establishing system, a correspondence relay NCR or RCR is picked up to indicate that the track switches of the crossover are in correspondence with the required position for the route established. These relays repeat corresponding positions between the switch control relays NWZ and RWZ and the switch position repeater relays NWP and RWP. The relays NWP and RWP are steadily energized in accordance with the positions of the track switches of the crossover with which they are associated, while the relays NWZ and RWZ are picked up only for the track switches that are included in established routes. Thus, when a route is established through the track switch 4BW at the lower end of the crossover 4 in its normal position, the picking up of the relay 4NWZ causes the picking up of the correspondence relay 4NCR after the track switch has been properly operated to its normal position. The relay 4NCR is energized under such conditions by a circuit extending from (+), including front contact 81 of relay 4NWZ, front contact 82 of relay 4NWP, and winding of relay 4NCR, to (-). In a similar manner the relay 4RCR is energized when the switch repeater relay 4RWP is picked up in correspondence with an established route. The circuit for relay 4RCR extends from (+), including front contact 83 of relay 4RWZ, front contact 84 of relay 4RWP, and winding of relay 4RCR, to (-). It will be readily apparent that a similar means of control is provided for

the correspondence relays associated with the crossovers 5 and 6.

*Signal controls.*—Having thus considered the manner in which routes can be established in accordance with the designation of their respective entrance and exit ends and how the track switches can be power operated to set up such routes, consideration will now be given to the manner in which the signals are controlled for governing entrance to the routes that have been set up.

The signal control relays G for the respective signals are energized from a signal control circuit network organization including contacts of the switch correspondence relays NCR and RCR and track relay contacts to check that the established routes are unoccupied by trains. The inclusion of the switch correspondence contacts in the signal control circuit network provides that the signal control relays can be picked up only after the track switches have been properly positioned in accordance with the designated routes. As a specific example, the signal control relay 12G for the control of signal 12 is picked up when a route is established from signal 12 to signal 16 after the track switches of the crossover 4 have been operated to their normal positions to provide for the picking up of the correspondence relay 4NCR.

Inasmuch as the signal 12 has an overlap control as indicated by the arrow 45 beneath the miniature track diagram of Fig. 1, energy for the control of the relay 12G must feed through a circuit network including track contacts of the respective overlap track sections. It is, therefore, required that the relay 12G check that the track sections are unoccupied from the signal 12 to and including the track section 9T (if the track switches of the crossover 6 are in their normal positions), or to and including track section 5T (if the track switches of crossover 6 are in their reverse positions). Thus, assuming the track switches of crossover 6 to be in their normal positions, the relay 12G can be picked up when a route is set up from signal 12 to signal 16 by the energization of a circuit extending from (+), including front contact 85 of relay 5TR, front contact 86 of relay 4TR, front contact 87 of relay 9TR, front contact 88 of relay 8TR, front contact 89 of relay 5NCR, front contact 90 of relay 14XR, front contact 91 of relay 7TR, back contact 92 of relay 4RCR, front contact 93 of relay 4NCR, back contact 94 of relay 12XR, front contact 95 of relay 12NR, and winding of relay 12G, to (-). It will be noted that the inclusion of the front contact 89 of relay 5NCR in the circuit just described checks that the track switches of the crossover 5 have been operated to their normal positions, because the lower track switch 5BW of that crossover is included as a trailing switch in the overlap control section of the signal 12.

If the track switches of the crossover 6 are in their reverse positions at the time when the route is set up from signal 12 to signal 16, the relay 12G is energized by the circuit just described, assuming that the overlap portion of the trackway is unoccupied by a train.

It will be apparent from the circuit organization of the signal control network that the overlap control of signal 11 is dependent upon the same track contacts and the correspondence contact 89 of relay 5NCR for the establishment of a route from signal 11 to signal 16 over the crossover 4. More specifically, with the track

13

switches of the crossover 6 in their normal positions, the relay 11G is energized after a route is set up from signal 11 to signal 16 by a circuit extending from (+), including front contact 85 of relay 5TR, front contact 86 of relay 4TR, front contact 87 of relay 9TR, front contact 88 of relay 8TR, front contact 89 of relay 5NCR, front contact 90 of relay 14XR, front contact 91 of relay 7TR, front contact 92 of relay 4RCR, back contact 99 of relay 4NCR, front contact 100 of relay 3TR, back contact 101 of relay 11XR, and front contact 102 of relay 11NR, and winding of relay 11G, to (-).

If the track switches of the crossover 6 are in their reverse positions when a route is set up from signal 11 to signal 16 the relay 11G is energized by the circuit just described, assuming that the overlap portion of the trackway is unoccupied by a train.

Upon considering the circuits that have been described, it will be noted that track relay contacts of the track relays associated with the overlap track sections of both tracks have been included in the circuit, and it is provided that certain of such contacts are shunted in accordance with the positions of the track switches of the crossover 6. Thus the contacts 85 and 86 of relays 4TR and 5TR need not be included in the circuit if the track switches of crossover 6 are in their normal positions and therefore such contacts are shunted by front contacts 98 of relay 6NWP, similarly if the track switches of the crossover 6 are in their reverse positions, the front contact 87 of relay 9TR need not be included in the circuit, so it is shunted by front contact 108 of relay 6RWP. By this circuit arrangement the operation of the track switches of crossover 6 when the overlap track sections of both tracks are unoccupied can be accomplished without flashing either signal 11 or signal 12 if such signal is clear at that time.

The organization of the signal control circuit network is such that the circuit for the relay 11G includes the front contact 103 of relay 6NCR when the route is established from signal 11 to signal 15, with the track switches of the crossover 4 in their normal positions, because the track switch 6AW at the upper end of the crossover 6 becomes a trailing switch under such conditions in the overlap control section for the signal 11. Thus, assuming the track switches of the crossover 5 to be in their normal positions, the signal control relay 11G is energized for a route set up from signal 11 to signal 15 by a circuit extending from (+), including front contact 96 of relay 9TR, front contact 97 of relay 8TR, front contact 104 of relay 5TR, front contact 105 of relay 4TR, front contact 103 of relay 6NCR, front contact 106 of relay 13XR, back contact 107 of relay 4RCR, front contact 99 of relay 4NCR, front contact 100 of relay 3TR, back contact 101 of relay 11XR, front contact 102 of relay 11NR, winding of relay 11G, to (-).

If the track switches of the crossover 5 are in their reverse positions at the time when the route is set up from signal 11 to signal 15, the relay 11G is energized by the circuit just described, assuming the overlap track sections of both tracks to be unoccupied by a train.

The contacts 96 and 97 of the track relays 9TR and 8TR respectively are shunted when the track switches of the crossover 5 are in their normal positions by front contact 143 of relay 5NWP, as those track sections are not included in the overlap control of signal 11 when the track

14

switches of crossover 5 are in their normal positions. The contact 104 of relay 5TR is shunted by contact 144 of relay 5RWP when the track switches of the crossover 5 are in their reverse positions because the track section 5T is not included in the overlap control of signal 11 at that time.

It will be noted that the contacts of relays NWP and RWP are used in selecting portions of the circuit network associated with the overlap control through facing point switches, because the contacts associated with selections in accordance with the positions of such switches must be effective even though such track switches are not power operated in accordance with an established route. On the other hand, it will be noted that contacts of the correspondence relays NCR are used in the circuit network for checking the normal positions of the track switches that are trailing in the overlap portion of the signal control circuits, thus checking that the track switches have been properly positioned in accordance with their positions called for by the route establishing means before the signal governing entrance to the route can be cleared.

Inasmuch as only certain of the signals which are for governing relatively high speed traffic are provided with overlap control, only the signals 11 and 12 are assumed to have overlap control provided, and the other signals are assumed to be controlled in a manner corresponding to that fully described in the above mentioned patent to T. J. Judge to which reference is to be made for a disclosure as to the manner in which this control is accomplished. This being the case, the relay 13G for the control of signal 13, for example, is shown as not requiring an overlap control circuit, and thus such relay can be picked up when a route is set up from signal 13 to the exit point at signal 11, energy being applied to the circuit for the relay 13G at front contact 101 of the relay 11XR.

In accordance with the picking up of a signal control relay G, energy is applied through contacts of that relay to a circuit for energizing the mechanism of the searchlight signal with which that relay is associated, the polarity of energization of such mechanism being selected in accordance with the condition of the next signal in advance according to the usual practice. Thus, the picking up of the relay 12G, for example, causes the energization of the mechanism of signal 12 upon the closure of front contacts 109 and 110 with a polarity as selected by the contacts 111 and 152 of the relay 14YGP. The relay 14YGP is picked up only when the mechanism of signal 14 is operated to its caution or clear indicating position.

*Electric locking.*—Although various forms of electric locking can be used with the system provided by the present invention, the electric locking circuits illustrated in Figs. 4 and 5 have been chosen for this disclosure because they are particularly applicable to the conditions under consideration where the signals are spaced close together, and thus overlap locking for some of the signals is required. It is to be understood, however, that the electric locking may be modified as required to fit the requirements of practice.

In accordance with the close spacing of the signals, it is generally provided that a small number of track switches are required to be positioned in any route to be established from one signal to the next signal in advance. Thus, there

is little to be gained by the use of rear release route locking such as is disclosed in the above mentioned patent to T. J. Judge, and there are some advantages in connection with the safety of operation of trains to be obtained by having the locking effective for each entire route until such route becomes entirely unoccupied in the rear of a train.

As a consideration of the mode of operation of the electric locking it will be assumed that the signal 12 is cleared for a route set up from that signal to the signal 16. In accordance with the clearly of that signal the signal repeater relay 12RGP is dropped away, and the dropping away of that relay opens the circuit for the relay 12AS (see Fig. 4) at front contact 112, and also opens the circuit for relay 12ASO at front contact 113, to cause those relays to be dropped away. The inclusion of contact 114 of the relay 12AS in the circuit for the lock relay 4L provides that such lock relay is dropped away to lock the track switches of crossover 4 upon the clearing of the signal 12 governing entrance to the route including the track switch 4BW.

The relay 5LO is the overlap locking relay for the crossover 5, and although the clearing of the signal 12 governing entrance to the route from signal 12 to signal 16 does not cause the dropping away of the conventional switch lock relay 5-6L, the overlap lock relay 5LO is dropped away upon the clearing of that signal by the opening of its circuit at front contact 41 of relay 12ASO to lock the trailing switch 5BW at the lower end of the crossover 5 in its normal position.

The locking of the track switches of the crossover 6 in accordance with the clearing of signal 12 is conditional in that the track switches of crossover 6 should be free to be operated to either position when the operation of such switches cannot throw the overlap portion of the control of signal 12 onto an occupied track section. That is, for example, if the track switches of the crossover 6 are in their normal positions when the signal 12 is cleared, and the track section 5T is occupied by a train on the upper of the two main tracks, upon a consideration of the signal control circuits (see Fig. 3) that have been heretofore described, it will be readily apparent that the power operation of the track switches of the crossover 6 to their reverse positions would be effective to select the track section 5T as being included in the overlap control portion of the circuit for the signal control relay 12G, and if such track section were occupied by a train, the signal 12 would be put to stop. Such control of the signal 12 would be undesirable and unsafe. It is, therefore, provided that the electric locking for a facing point overlap track switch is so arranged as to lock the track switch only when its operation would cause the signal involved to be put to stop by selecting a branch of the signal control circuit containing a deenergized track relay.

To consider the circuit means for accomplishing the above described mode of operation, it will be assumed that the signal 12 has been cleared and that the trackway in advance of that signal is unoccupied, either with the track switches of the crossover 6 in their normal positions, or in their reverse positions. Under such conditions, with the track sections 5T and 9T both unoccupied by a train, the overlap locking relay 6LO is maintained energized by a circuit extending from (+), including front contact 115 of relay 11ASO, front contact 116 of relay 9TR, front contact 117

of relay 5TR, and winding of relay 6LO, to (-). With relay 6LO maintained energized, and with the relay 5-6L picked up, it is provided that the track switches of the crossover 6 are not electrically locked, and therefore can be operated as required in the setting up of routes. This is true because the closure of front contacts 118 and 119 (see Fig. 2) of the relays 5-6L and 6LO respectively in the pick-up circuits for the relays 6NWZ and 6RWZ allows either of such relays to be picked up for operating the track switches of the crossover 6.

Assuming again that a route has been set up from signal 12 to signal 16, at a time when the track switches of the crossover 6 are in their normal positions, and the track section 9T is unoccupied, it will be further assumed that the track section 5T is occupied by a train, and therefore if the track switches of the crossover 6 were operated to their reverse positions, the track section 5T would be included in the overlap portion of the control of signal 12, and such signal would be put to stop. It is therefore desirable under such conditions that the track switches of the crossover 6 be locked in their normal positions when the track section 5T is occupied by a train. Such locking is provided in the control of the relay LO as shown in Fig. 5 in which the front contact 117 of relay 5TR is opened, and the front contact 120 of the relay 6RWP connected in multiple with that track contact is open because the track switches of the crossover 6 are in their normal positions. Thus, assuming the approach locking relay 12ASO to be dropped away at that time because of the signal 12 being clear, the relay 6LO remains dropped away, and the opening of front contact 119 of such relay in the circuits for the relays 6NWZ and 6RWZ as shown in Fig. 2 prevents the picking up of relay 6RWZ for the power operation of the track switches of the crossover 6 to their reverse positions.

Similarly, it is provided that if the track switches of the crossover 6 are in their reverse positions to provide that the signal 12 is cleared by an overlap control extending through front contact 108 of the relay 6RWP (see Fig. 3) at a time when the track section 9T is occupied by a train, it is provided that the track switches of the crossover are locked in such reverse positions, because the relay 6LO is dropped away due to the opening of contacts 116, 121 and 122 of relays 9TR, 6NWP and 12ASO respectively (see Fig. 5). Thus, the relay 6LO is maintained denenergized under such conditions to open the pick-up circuit for the relays 6NWZ and 6RWZ at front contact 119 to prevent the picking up of the relay 6NWZ for changing the position of the track switches of crossover 6.

The use of the contacts 120 and 121 of the relays 6RWP and 6NWP connected in multiple with the contacts 117 and 116 of relays 5TR and 9TR respectively, in the circuit for relay 6LO, provides that the track switches of the crossover 6 are free to be operated when the track switch 6BW is a facing point switch in the overlap control of signal 11 or signal 12, if its position selects a portion of the overlap control of either of such signals as including an occupied track section 5T or 9T to prevent the clearing of either of such signals. This is, assuming that a route is set up from signal 12 to signal 16, and the track switches of the crossover 6 are in their reverse positions with the track section 5T occupied by a train and the

track section 9T unoccupied, the inclusion of front contact 120 of relay 6RWP in multiple with front contact 117 of relay 5TR in the circuit for relay 6LO provides that the track switches of the crossover 6 can be unlocked under such conditions, irrespective of the condition of the approach and time locking relays 11ASO and 12ASO, to allow the track switches of the crossover to be operated to their normal positions and thereby allow the signal 12 to be cleared. Although the relay 5RWP is dropped away as soon as the track switches of the crossover start their operation to their normal positions, the dropping away of the relay 6LO is not effective to prevent the complete operation of the track switches because of stick circuits provided for the relays 6NWZ and 6RWZ in a manner heretofore described when considering more specifically the organization of the switch control circuits.

It will be noted that a similar mode of operation is effective when the track switches of the crossover 6 are in their normal positions, and the track section 9T is occupied by a train to allow the lock relay 6LO to be energized by a circuit including front contact 121 of relay 6NWP, and thereby provide that the track switches of the crossover 6 can be operated to their reverse positions, and in that manner select the overlap control of signal 11 or signal 12 through the track section 5T, which may be unoccupied at that time. Having thus described specific conditions involving the overlap locking of the facing point switch 6BW of the crossover 6, it is believed to be readily apparent that similar conditions apply to the locking of the track switches of the crossover 5 when a route is set up from signal 11 to signal 15, the relay 5LO being provided as an overlap locking relay for the crossover 5 and being controlled in a manner similar to that which has been specifically described with respect to the control of the relay 6LO because the switch 5AW is a facing point switch with respect to that route.

To consider a specific example of the manner in which the overlap locking of the track switches of crossovers 5 and 6 is provided in accordance with the establishment of a route from signal 11 to signal 15, it will be apparent that the track switch 6AW at the upper end of crossover 6 becomes a trailing switch in the overlap section 4T with respect to the signal 11, and therefore the relay 6LO is dropped away upon the dropping away of the relay 11ASO in response to the clearing of signal 11, except when the track switches of the crossover 4 are operated to their reverse positions for the establishment of a route from signal 11 to signal 16. Thus, in the circuit for relay 6LO, the front contact 115 of relay 11ASO interrupts the circuit for relay 6LO, except when the relay 4RWP is picked up, to close front contact 123 at a time when the track switches of the crossover 4 are operated to their reverse positions. The locking of the facing point switch 5AW is provided in a similar manner to that heretofore described with respect to the locking of the track switch 6BW, the relay 5LO being energized dependent upon the closure of front contacts 43 and 42 of the track relays for the overlap track sections 5T and 9T respectively, except when such contacts are shunted by the respective front contacts 124 and 125 of relays 5NWP and 5RWP, corresponding to the positions of the track switches of crossover 5 required for routes extending to and including such overlap track sections.

*Restoration to normal.*—Generally speaking there are two means by which the route establishing means may be restored to normal, one being the means effective by the slotting of the signals upon passage of trains, and the other being by manual designation of routes to be restored by the actuation of the respective entrance buttons NB for the entrance ends of such routes to restoration positions. This can be accomplished in general in the manner fully described in the above mentioned patent to T. J. Judge.

To consider a typical example of how restoration can be effected by manual designation, it will be assumed that a route is set up as has been heretofore described from signal 12 to signal 16, and that it is desired to cause the restoration to normal of the parts of the system associated with the establishment and setting up of that route. To initiate such restoration the operator actuates the entrance button 12NB to its restoration position and causes the dropping away of the relay 12NR as specifically described in the above mentioned patent to T. J. Judge.

In accordance with the dropping away of relay 12NR, the opening of front contact 46 of that relay (see Fig. 1) opens the circuit by which the relay 14XR has been maintained energized, and thus causes the dropping away of that relay. The relay 14XR in dropping away opens the pick-up circuit for the completion network by which the relay 4BN has been energized at front contact 54, and it also opens the circuit for the relay 5NWZ (see Fig. 2) at front contact 72 to cause that relay to be dropped away.

With reference to Fig. 3, the signal 12 is put to stop subsequent to the dropping away of the entrance relay 12NR because of the opening of front contact 95 of that relay. The dropping away of the relay 12G opens the circuit for signal 12 at front contacts 109 and 110 to deenergize the mechanism of that signal and thus cause such signal to be put to stop. The restoration to stop of the signal 12 causes the picking up of the signal stop repeater relay 12RGP, and the picking up of that relay closes a circuit for picking up the relay 12AS (see Fig. 4) (assuming that the approach track section 6TR is unoccupied) extending from (+), including front contact 112 of relay 12RGP, front contact 126 of relay 6TR, and winding of relay 12AS, to (-). If, however, there is a train in approach of the signal 12 so as to cause the relay 6TR to be dropped away, it will be required that the thermal relay 12TH be operated to pick up the relay 12AS in accordance with the usual practice as fully described in the above mentioned patent to T. J. Judge. It is also provided that the relay 12AS can be restored immediately upon passage of a train in a manner to be hereinafter considered. It is also provided that the relay 12ASO, which is associated with the overlap locking, is immediately restored under the above assumed conditions, such restoration requiring that the track section in the rear and in advance of the signal 12 be unoccupied in order that such relay may be immediately restored. Thus, the relay 12ASO is restored upon the picking up of the signal repeater relay 12RGP by a circuit extending from (+), including front contact 113 of relay 12RGP, front contact 127 of relay 7TR, front contact 128 of relay 6TR, and winding of relay 12ASO, to (-). Should either of the track sections 6T or 7T be occupied by a train, it is required that the relay 12ASO be picked up only

subsequent to the operation of the thermal relay 12THO.

In accordance with the general organization of the locking, the relay 4L (see Fig. 5) is maintained dropped away until the approach locking relay 12AS associated with the signal 12 has been picked up subsequent to the restoration of the signal 12 to stop. Because of the relay 4L being dropped away, the relay 4BN is maintained picked up by its stick circuit (see Fig. 2). Such stick circuit extends from (+), including back contact 129 of relay 4L, front contact 130 of relay 4BN, front contact 131 of relay 4BN, and winding of relay 4BN, to (-).

After the lock relay 4L has been restored to its normally energized position, the stick circuit for the relay 4BN is opened at back contact 129 (see Fig. 2) to cause that relay to be dropped away and thus complete the restoration of the parts of the system associated with the establishment of the route from signal 12 to signal 16.

To consider the mode of operation of the system in its restoration upon passage of a train, it will be assumed that a route is set up as heretofore described from signal 12 to signal 16, and that a train accepts the signal 12 and enters the track section 7T. The dropping away of the track relay 7TR for the track section 7T causes the dropping away of the relay 12NR to open front contact 46 (see Fig. 1) in the circuit for the relay 14XR and thus cause the dropping away of that relay and the restoration in general of the route establishing means as has been described, except that the presence of the train in the track section 7T prevents the picking up of the relay 4L by opening its circuit at front contact 132 of relay 7TR and therefore the stick circuit which has been described for the relay 4BN (see Fig. 2) is maintained closed to provide an interlock in the initiating circuit networks in the route establishing means to prevent the preconditioning of a route over the crossover 4.

With reference to Fig. 4, the presence of the train in the track section 7T causes the dropping away of the relay 7TR to provide a restoration circuit for the relay 12AS upon closing back contact 133, but the relay 12ASO has no such restoration circuit and therefore can be restored only after a time interval. This is true because the immediate restoration of the relay 12ASO is prevented by the opening of front contact 127 of relay 7TR. The reason for this circuit arrangement is to provide that the overlap locking is effective when a train occupies the portion of the trackway in the rear of signal 16 to provide that the overlap locking can be released only after the train has taken sufficient time in the route from signal 12 to signal 16 to have necessarily reduced its speed sufficiently to be able to stop short of the signal 16. After such time interval it is safe to release the overlap locking of the track switches of the crossovers 5 and 6 to allow the operation of the track switches of those crossovers as required to establish desired routes. Thus, after there has been sufficient time for the timing relay 12THO to operate and close its front contact 134, the relay 12ASO is picked up, and the picking up of that relay allows the picking up of the overlap locking relay 5LO (assuming signal 11 to be at stop). The relay 5LO is picked up under such conditions by the energization of a circuit extending from (+), including front contact 40 of relay 11ASO, front contact 41 of relay 12ASO, front contact 135 of relay 11ASO, and winding of relay 5LO, to (-). Similarly, the relay 6LO is picked up upon

the restoration of relay 12ASO to its normally energized position by a circuit extending from (+), including front contact 115 of relay 11ASO, front contact 122 of relay 12ASO, front contact 136 of relay 4NWP, and winding of relay 6LO, to (-).

With reference to Fig. 2, the picking up of the relays 5LO and 6LO allows the selective energization of the switch control relays NWZ and RWZ for the track switches of crossovers 5 and 6 as required in the establishment of routes, dependent of course upon the conventional switch locking relay 5-6L controlled by the track relays for the detector track sections and the approach locking relays associated with the interlocked group including the crossovers 5 and 6.

With the overlap locking thus released, the operator can then proceed to establish routes as required, such as setting up a route for the passage of a train from signal 15 over the track switches of the crossover 5 to leave the lower of the two main tracks ahead of the train which has been assumed to be in approach of the signal 16.

To consider further the restoration of the apparatus associated with the setting up of the route from signal 12 to signal 16, it will be assumed that a route is established to allow the clearing of signal 16 and thus provide that the eastbound train can proceed so as to allow the track section 7T to become unoccupied and thus provide that the relay 4L (see Fig. 5) is picked up in accordance with the closure of front contact 132 of relay 7TR. The picking up of relay 4L opens the stick circuit for the relay 4BN at back contact 129 and thereby allows that relay to be dropped away to complete the restoration to normal conditions of the parts of the system which have been employed in the route assumed to have been set up from signal 12 to signal 16.

*Preconditioning of routes.*—In accordance with the general requirements of practice, it is provided that the track switches included in a route which is occupied by a train are locked in the positions corresponding to that route, and it is further provided that the operation of the route establishing means cannot be effected in a manner to call for an opposite position of any of those track switches, because of the possibility that the loss of shunt under a train for a detector track section could momentarily allow the picking up of a track relay which would allow the operation, or partial operation, of a track switch under a train. The initiating circuit networks which have been more specifically considered heretofore when considering the establishment of routes are particularly provided in a manner to prevent the preconditioning of positions of the track switches when such track switches are included in established routes in view of the above described desirability for prevention preconditioning.

To consider a specific example in which the preconditioning of a route is prevented, it will be assumed that a route has been set up from signal 12 to signal 16 and such route has been entered by a train as has been described. Under such conditions the relay 4BN is maintained picked up by its stick circuit. With reference to Fig. 1, the picking up of relay 4BN opens back contact 60 in the initiating circuit network for the establishment of routes for eastbound trains to prevent the conditioning of a route from signal 11 to signal 16 over the crossover 4 by opening the circuit which would be required to be closed in

order that the exit relay 14XR could be responsive to the designation of the exit end of that route. Thus, it is provided that the route establishing networks will not condition a circuit to provide for the picking up of the relay 4R when the relay 4BN is energized, and therefore the track switches of the crossover 4 cannot be conditioned for operation to their reverse positions until the track switches of that crossover are unlocked and are free to be operated. A more complete description of the mode of operation for the prevention of preconditioning is found in the above mentioned patent to T. J. Judge.

To consider now the conditions of locking of the track switches included in an overlap section, it will be noted that conditions with respect to the preconditioning of routes are different in that the preconditioning of routes can be safely allowed involving track switches that are locked by overlap locking, but not included in routes that are set up. This is true because the conditions above described in which it would be possible to operate a track switch under a train are not involved in that the track switches under consideration are not included in routes that are set up and therefore the detector track sections of such track switches are unoccupied by trains. It is therefore provided that the prevention of preconditioning is effective for the various routes that can be set up through the right-hand interlocked group of this embodiment of the present invention in a manner similar to that which has been specifically described with respect to the preconditioning of routes in the left-hand interlocked group, but the overlap locking of the track switches of the crossovers 5 and 6 is so provided that preconditioning of routes is allowed in the right-hand interlocked group, only if the track switches of the crossovers 5 and 6 are locked by reason of overlap locking rather than by reason of routes set up including such track switches within that interlocked group.

To consider a specific example of the allowable preconditioning described above, it will be assumed that a route has been set up from signal 12 to signal 16 requiring the power operation of the track switches of the crossover 5 to their normal positions and providing overlap locking for the track switches of that crossover. It will also be assumed that an operator desires to set up a route for the passage of a train from signal 15 to signal 23 over the track switches of the crossover 5 in their reverse positions and thus proceeds to designate such route by the actuation of the respective entrance and exit buttons 15NB and 18XB for the designation of that route. Although the track switches of the crossover 5 have been operated to their normal positions and locked in such positions, they have been operated in accordance with the picking up of the exit relay 14XR as shown in Fig. 2 rather than by the picking up of the relay 5BN, as would be the case if the track switches were operated to their normal positions in accordance with the setting up of a route within that immediate interlocked group. Thus, although the track switches of the crossover are locked in their normal positions, the relay 5BN has not been picked up, and therefore there is no interlock in the initiating circuit network to prevent the picking up of the relay 18XR in response to the actuation of the exit button 18XB. In other words, although the track switches of the crossover 5 are locked in their normal positions, there has been nothing accomplished in the control of those track

switches to their normal positions for overlap locking to disturb the conditions of route establishment according to the general principles of operation of the route establishing means as has been specifically described with respect to the establishment of routes through the left-hand interlocked group, and as has been specifically described in the above mentioned patent to T. J. Judge for the setting up of the route under consideration extending from signal 15 to signal 23.

The conditions which have been described with respect to preconditioning of positions of the trailing overlap track switch 5BW are applicable also to the allowance of preconditioning of the track switches of the crossover 6 where the facing point switch 6BW of that crossover is locked by overlap locking. It will be readily apparent that the preconditioning of the track switches of the crossover 6 under such conditions can be readily accomplished because the overlap locking of such track switches is of no particular concern with the route establishing means provided for the selection of the position of such track switches in accordance with the establishment of routes within that interlocked group.

*Indications.*—It is assumed that indications are provided on the miniature track diagram in accordance with the requirements of practice to indicate the condition of occupancy of the respective track sections, the positions of the track switches, and the various routes established. Such conditions may be indicated by any suitable manner such, for example, as by indicator lamps disposed on the miniature diagram at points representative of the devices or route portion with which they are associated, or by providing a continuous line of light for the respective routes established and track sections occupied by trains in a manner similar to that which is described in detail in the above mentioned patent to T. J. Judge. For the purpose of simplification of the present disclosure these indications have not been disclosed as they can be readily provided by those skilled in the art in accordance with the requirements of practice.

With reference to Fig. 1, indicator lamps have been shown, however, disposed on the miniature track diagram at points comparable to the respective normal and reverse positions of the track switches of the respective crossovers 5 and 6 for the purpose of providing a distinctive indication when the track switches of the crossovers with which such lamps are associated are included in routes designated for establishment but are locked by overlap locking of routes set up in the adjoining interlocked group. Thus the lamps 5ANE and 5BNE are provided for indicating the overlap locking of the track switches of the crossover 5 in their normal positions, and the lamp 5RE is provided for indicating the overlap locking of the track switches of the crossover 5 in their reverse positions. Similarly, the lamps 6ANE and 6BNE are associated with the indication of overlap locking of the track switches of crossover 6 in their normal positions, and the lamp 6RE is associated with the overlap locking of the track switches of the crossover 6 in their reverse positions. It is to be understood that these lamps can be provided on the miniature track diagram as illustrated, or they may be combined with other indicating means in accordance with the requirements of practice. For example, if the indications of the various established routes are provided by a continuous line of light, the indicator lamps shown in this embodiment

of the present invention may be combined with the lighting portions associated with the respective normal and reverse positions of the various track switches, the lamps shown in this disclosure being added to the complement of lamps provided in such an indication system, or the control circuits of the lamps of this disclosure being applied to the control of lamps already incorporated into the strip lighting system.

With reference to Fig. 6, control circuits are shown for the indicator lamps shown on the miniature track diagram of Fig. 1. These lamps are normally deenergized, and are energized only when the track switches of the crossover with which they are associated are locked by overlap locking and also are included in routes set up or designated for establishment. Although the lamps could provide a distinctive indication by steady energization when they are used as shown in this embodiment of the present invention, the lamps are shown to be energized by intermittently interrupted energy to cause them to flash for the purpose of calling attention to an operator of the indication as compared to other indications which may be provided as associated with the respective positions of the track switches.

To consider an example of the manner in which the overlap locking indications are provided, it will be assumed that the track switches of the crossover 5 are locked in their normal positions by overlap locking and that an operator designates a route for establishment from signal 15 to signal 23, extending over the track switches of the crossover 5 in their reverse positions. Upon the picking up of the relay 5R in the establishment of that route, a circuit is closed for energizing the lamps 5ANE and 5BNE intermittently in accordance with the closure of back contact 137 of relay 5LO. Such circuit extends from (FL+), including front contact 138 of relay 5R, back contact 137 of relay 5LO, front contact 139 of relay 5NWP, and the lamps 5ANE and 5BNE, to (-). It will be noted that the lamp 5RE remains dark because of its circuit being open at front contact 140 of relay 5RWP, and therefore the flashing of the indicator lamps 5ANE and 5BNE indicates to an operator that the route extending from signal 15 to signal 23 cannot be immediately set up because of the overlap locking of the track switches of crossover 5 in their normal positions, but the operator will be aware of the fact that the route can be set up subsequent to the release of such overlap locking. When the overlap locking is released under such conditions, the relay 5LO is picked up, and the opening of back contact 137 of that relay extinguishes the lamps 5ANE and 5BNE. It will be noted that the energization of the lamps 5ANE, 5BNE and 5RE as selected by the positions of the track switches of the crossover 5 is dependent upon the closure of either front contact 147 of relay 5AN, front contact 142 of relay 5BN, or front contact 138 of relay 5R as a means for applying energy to the circuit only when a route is established including one or both of the track switches of that crossover.

It is believed to be readily apparent with reference to the circuits shown for the energization of the indicator lamps 6ANE, 6BNE and 6RE for the crossover 6 that such lamps are controlled in a manner corresponding to that which has been specifically described with respect to the control of the lamps associated with the crossover 5.

Having described one embodiment of the pres-

ent invention as applied to the control of track switches and signals for a particular track layout as one embodiment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms the invention may assume, and it is to be further understood that various alterations, adaptations and modifications may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What I claim is:

1. In a switch and signal control system of the character described for a track layout providing by adjoining interlocked groups first and second adjoining routes respectively, each of such routes having a signal for governing entrance to that route for a given direction of traffic, and said second route having a trailing track switch for given direction of traffic, manually operable means for designation of the respective entrance and exit ends of each of said routes, an exit relay for the exit end of said first route, route initiating means responsive to the designation of the entrance end of said first route for conditioning said exit relay for that route so that it can be picked up in response to the designation of the corresponding exit end only if the route is available extending between the respective entrance and exit ends thus designated, said route initiating means being effective to pick up said exit relay in response to exit designation only if said trailing switch in said second route is free to be operated to its normal position, route establishing means responsive to the picking up of said exit relay for said first route for selecting the positions required for the respective track switches to align a route between the designated entrance and exit ends, means responsive to the picking up of said exit relay for causing the power operation of said trailing switch in said second route to its normal position, and means for clearing said signal governing entrance to said first route only if said trailing switch of said second route is operated to its normal position.

2. In a switch and signal control system of the entrance-exit type for a track layout having a signal governing entrance to a first interlocked group and having a second adjoining interlocked group including a facing point switch with respect to said signal for selecting one overlap track section to be included in the control of said signal when in its normal position and another overlap track section to be included in the control of said signal when in its reverse position, route establishing means for each of said interlocked groups for automatically selecting the positions of the respective track switches required to set up any desired route in response to the manual designation of the entrance and exit ends of that route, switch operating means for positioning each track switch in accordance with the position selected for that track switch by said route establishing means, and overlap locking means for allowing the operation of said facing point switch when said signal is clear if each of said overlap track sections is unoccupied by a train, but said overlap locking means being effective to prevent the operation of said facing point switch when said signal is clear if said overlap track section selected by the opposite position of said facing point switch is occupied by a train.

3. In a switch and signal control system of the

character described for a track layout having a signal governing entrance to a first interlocked group including power track switches and having a second adjoining interlocked group including a facing point power operated switch with respect to said signal for selecting one overlap track section to be included in the control of said signal when in its normal position and another overlap track section to be included in the control of said signal when in its reverse position, overlap locking means for said facing point switch for preventing the power operation of that switch when said signal is clear if said overlap track section selected by the opposite position of that track switch from its last operated position is occupied by a train, manually operable contact means for the respective entrance and exit ends of each of the routes in each interlocked group for the designation of the ends of routes to be established, and route establishing means for each of the interlocked groups for selecting the positions of the respective track switches required to set up each route in response to the manual designation of the entrance and exit ends of that route, such means being effective only if each track switch required to set up that route is free to be operated to its required position except that said route establishing means is effective for a route in said second interlocked group requiring the power operation of said facing point switch even though the power operation of that switch is prevented by said overlap locking means, whereby the preconditioning of a track switch is allowed only when that track switch is locked by said overlap locking means.

4. In a switch and signal control system, the combination with a track layout having a signal governing entrance to a first interlocked group and having a second adjoining interlocked group including an overlap track switch with respect to said signal, of a time element device initiated by the restoration of said signal to stop upon the acceptance of that signal by a train, route establishing means responsive to the manual designation of the respective entrance and exit ends of each route in each interlocked group for selecting the positions of the track switches required to establish that route, switch operating means for causing the power operation of each track switch in correspondence with the position selected by said route establishing means, and overlap locking means effective to prevent the power operation of said overlap track switch in said second interlocked group when said signal governing entrance to said first interlocked group is clear, irrespective of whether or not said overlap track switch is included in an established route in said second interlocked group, said overlap locking means being effective subsequent to the restoration of said signal by the passage of a train for a predetermined time interval as measured by said time element device.

5. In a switch and signal control system for a track layout having a signal governing entrance to a first interlocked group and having a second adjoining interlocked group including an overlap track switch with respect to said signal, overlap locking means for preventing the power operation of said overlap track switch when said signal is clear, said overlap locking means being effective upon the restoration of said signal to stop for a predetermined time interval subsequent to such restoration, route establishing means responsive to the manual designation of the respective entrance and exit ends of each

route in said first and said second interlocked groups for selecting the positions of the track switches required to establish that route, said route establishing means for said second interlocked group being effective to select positions of said overlap track switch irrespective of the effectiveness of said overlap locking means, switch operating means for causing the power operation of said overlap track switch in accordance with the position selected for that track switch by said route establishing means, said switch operating means being effective subject to limitation by said overlap locking means.

6. In a switch and signal control system of the entrance-exit type for a track layout having a signal governing entrance to one interlocked group with its control dependent upon an overlap track section including a track switch in a second interlocked group, overlap locking means for locking said track switch when said signal is clear, route establishing means responsive to the manual designation of the respective entrance and exit ends of each route in said one and said second interlocked groups for selecting the position of each track switch required to set up that route, and indication means for providing a distinctive indication on a control panel when said track switch is contemporaneously locked by said overlap locking means and is selected to be included in an established route by said route establishing means.

7. In a switch and signal control system of the character described, the combination with a track layout having a signal governing entrance to one interlocked group and its control dependent upon a selection by a track switch in a second interlocked group, of overlap locking means for locking said track switch in said second interlocked group when said signal is clear, route establishing means effective in response to the manual designation of the respective entrance and exit ends of each route in said one and said second interlocked groups for selecting the position of each track switch required to set up that route, an indicator lamp for said track switch, and means for intermittently energizing said indicator lamp when that track switch is locked by said overlap locking means provided that said track switch is selected as being included in an established route by said route establishing means.

8. In a switch and signal control system for railroads for a track layout having a signal governing entrance to one interlocked group with its control dependent upon a track circuit selection provided by a track switch in a second interlocked group, overlap locking means for locking said track switch when said signal is clear, route establishing means responsive to manual designation of the respective entrance and exit ends of each route in said one and said second groups for selecting the position of each track switch required for the establishment of a route extending between the manually designated entrance and exit points, indication means for distinctively indicating on a control panel the normal or reverse position in which said track switch is locked by said overlap locking means at a time when a route is selected by said route establishing means requiring that track switch to be in either its normal or reverse position.

9. In a switch and signal control system of the entrance-exit type, the combination with a track layout having a signal governing entrance

27

to one interlocked group and having its control dependent upon a selection by a track switch in a second interlocked group, of overlap locking means for locking said track switch when said signal is clear, route establishing means effective in response to the manual designation of the respective entrance and exit ends of each route in said one and said second interlocked groups for selecting the position of each track switch required for the setting up of that route, indicator lamps for the respective normal and reverse positions of said track switch, means for energizing said indicator lamp associated with the normal position of said track switch when that track switch is locked by said overlap locking means in its normal position and said route establishing means is effective to select a position required for that track switch in an

28

established route, and means for energizing said indicator lamp associated with the reverse position of said track switch when that track switch is locked by said overlap locking means in its reverse position and said route establishing means is effective to select a position required for that track switch in an established route.

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The following references are of record in the file of this patent:

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Number	Name	Date
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