

Dec. 9, 1941.

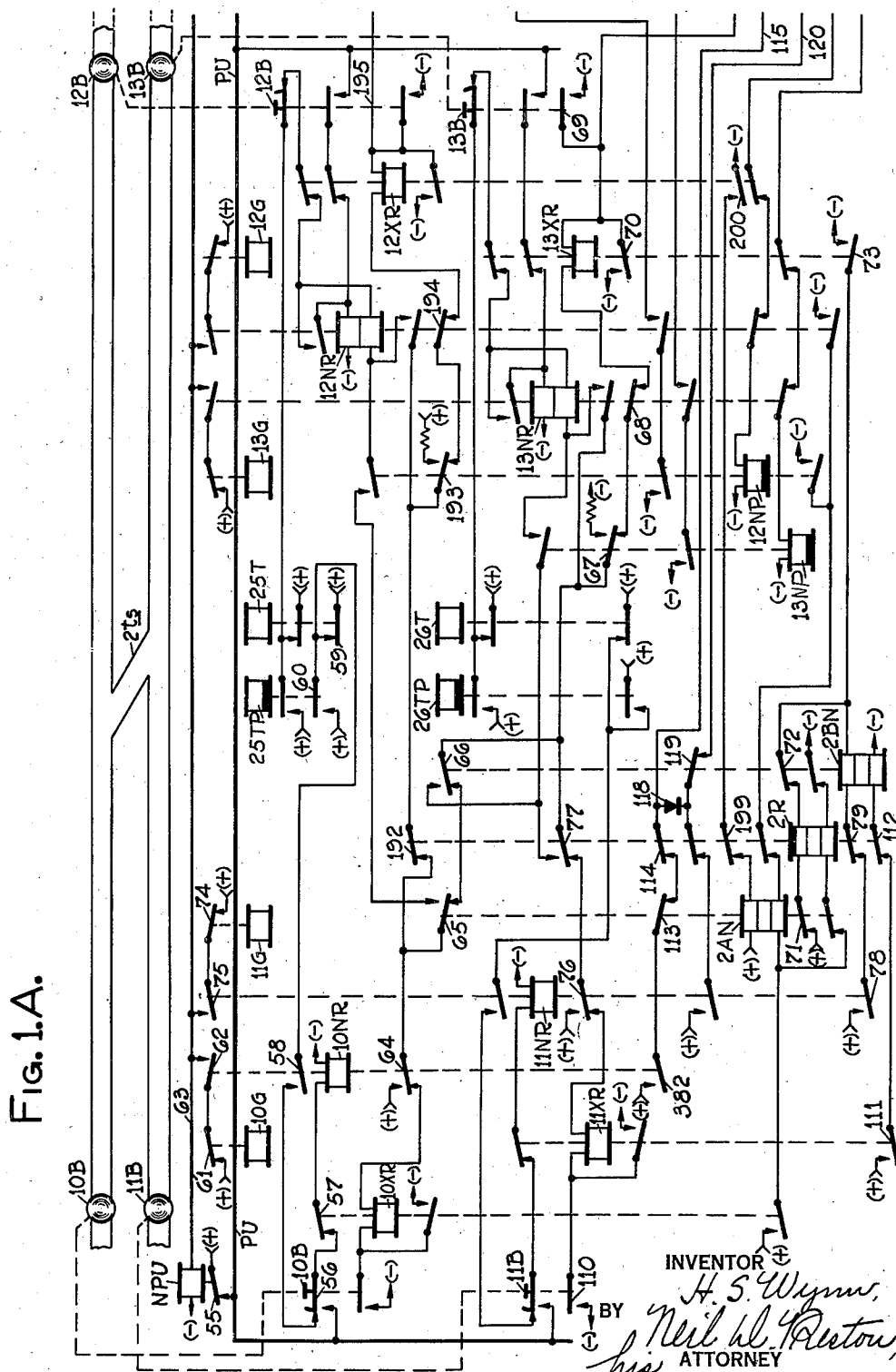
H. S. WYNN

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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed Nov. 5, 1938

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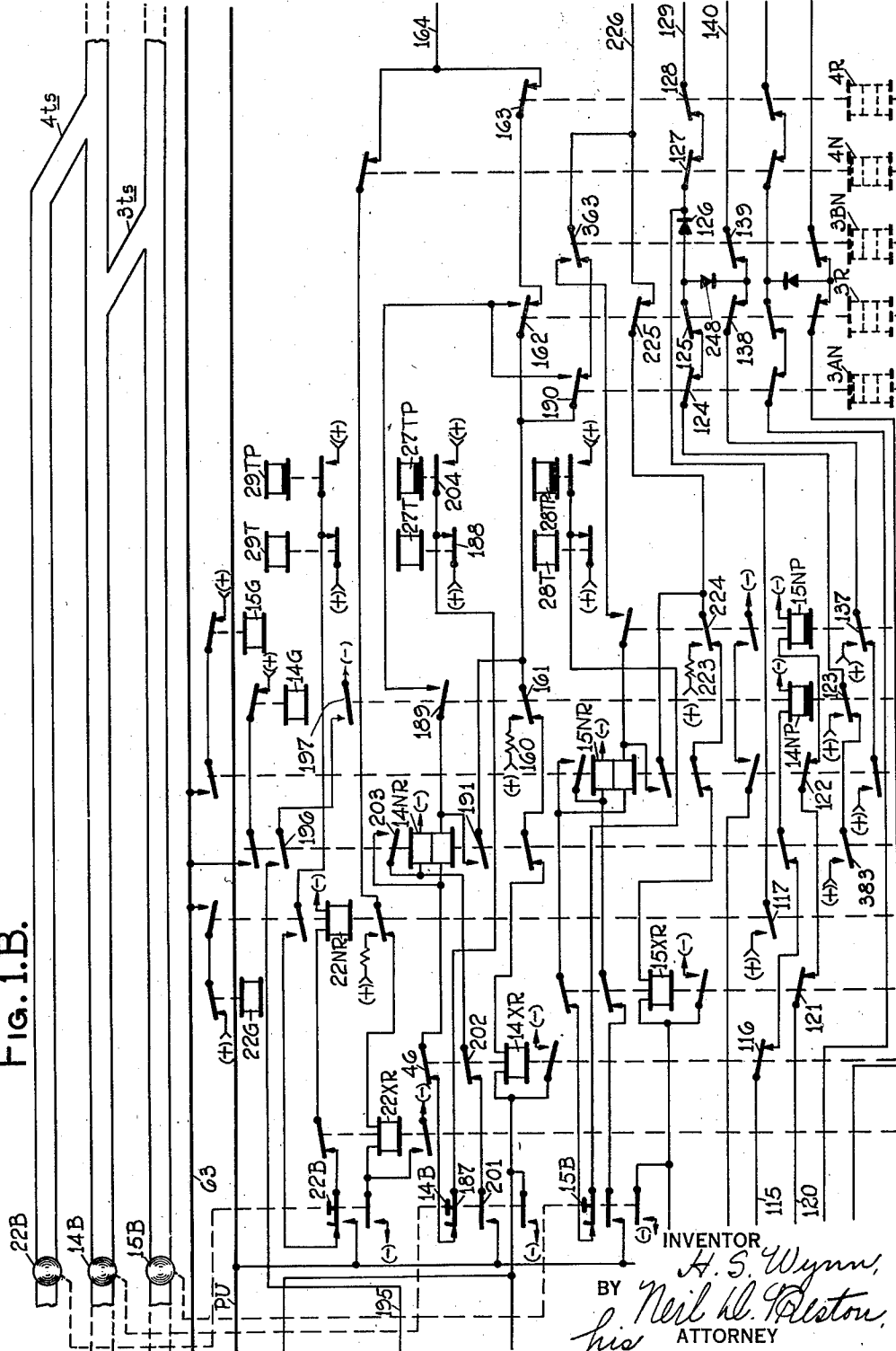
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 1.B.



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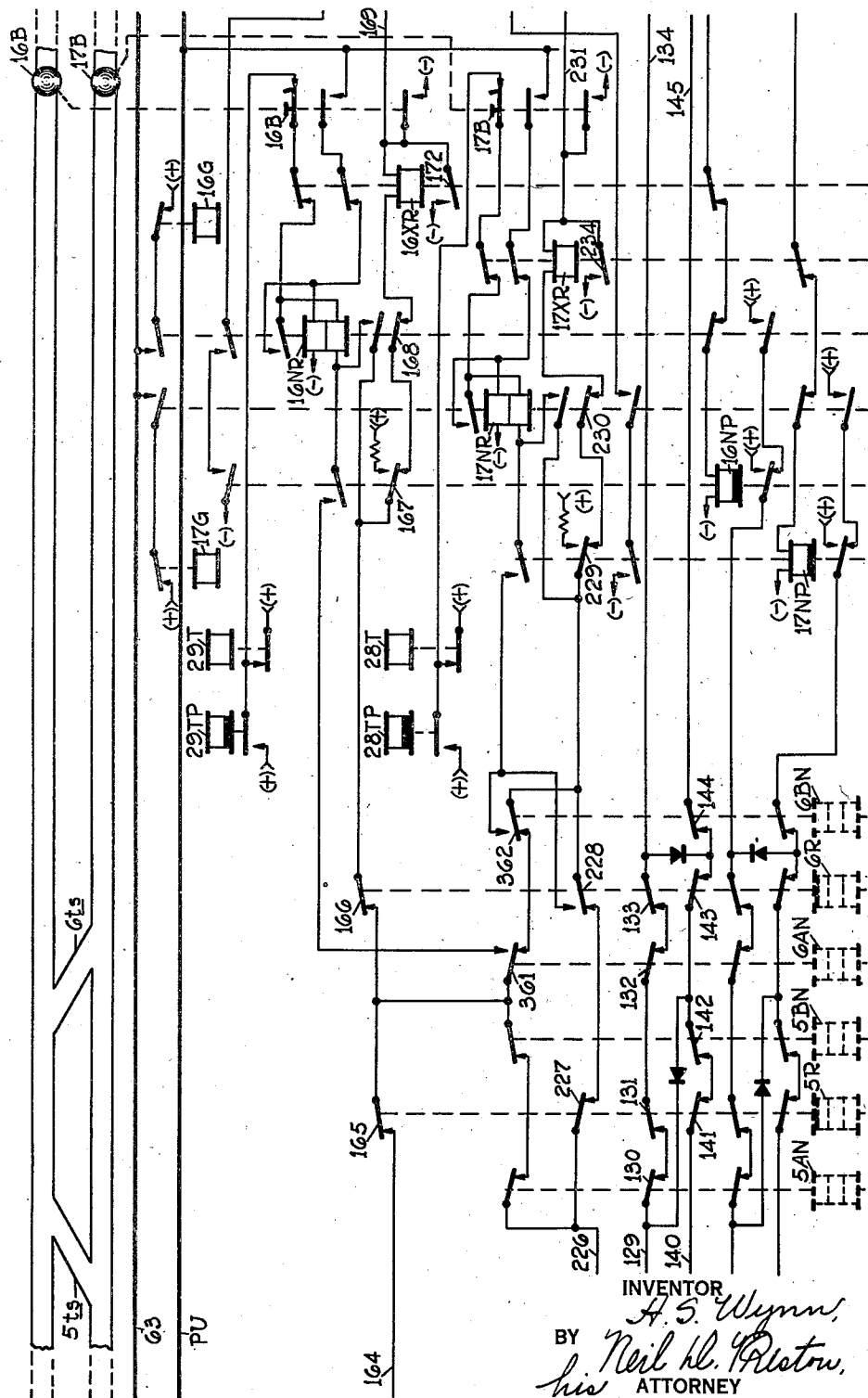
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Fig. 1.C.



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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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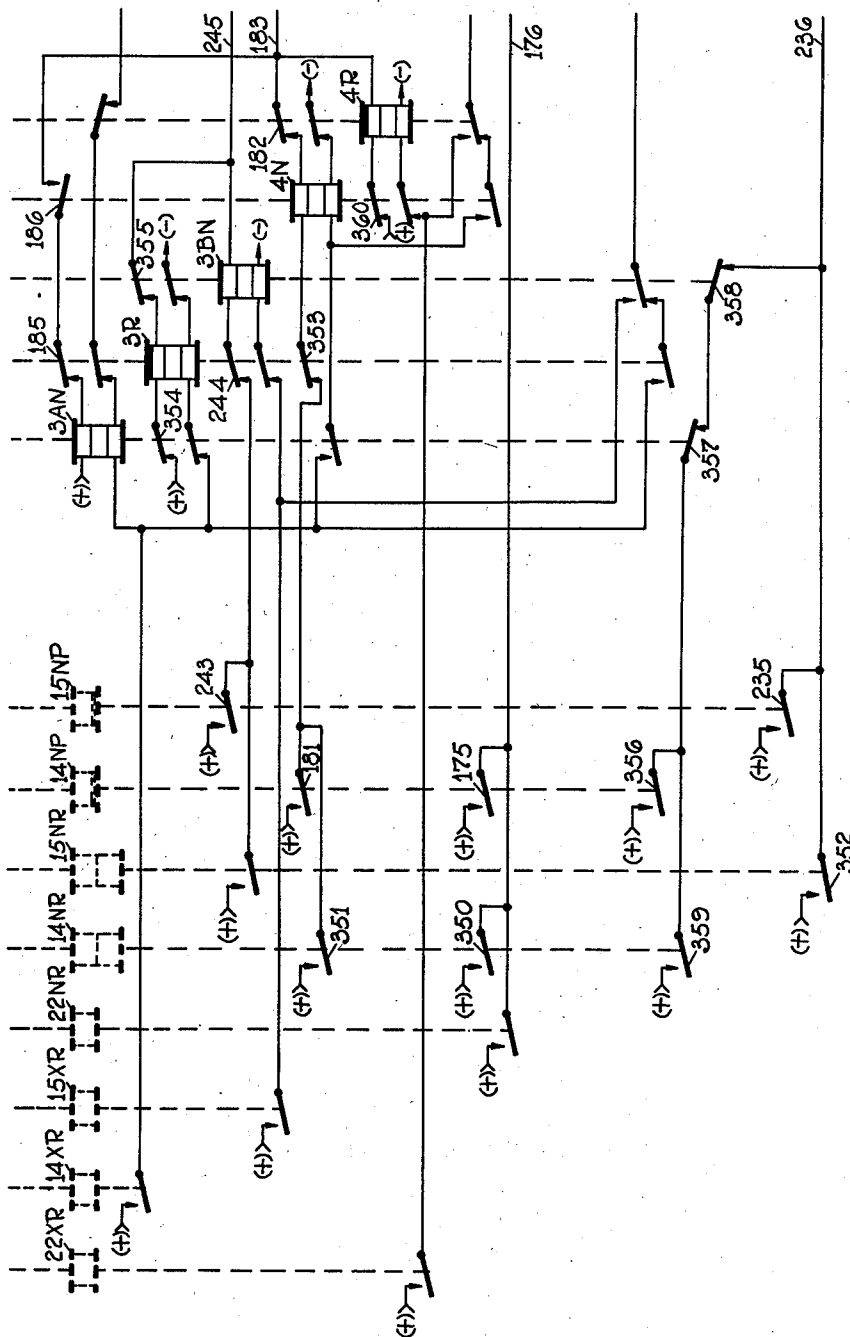


FIG. 1.E.

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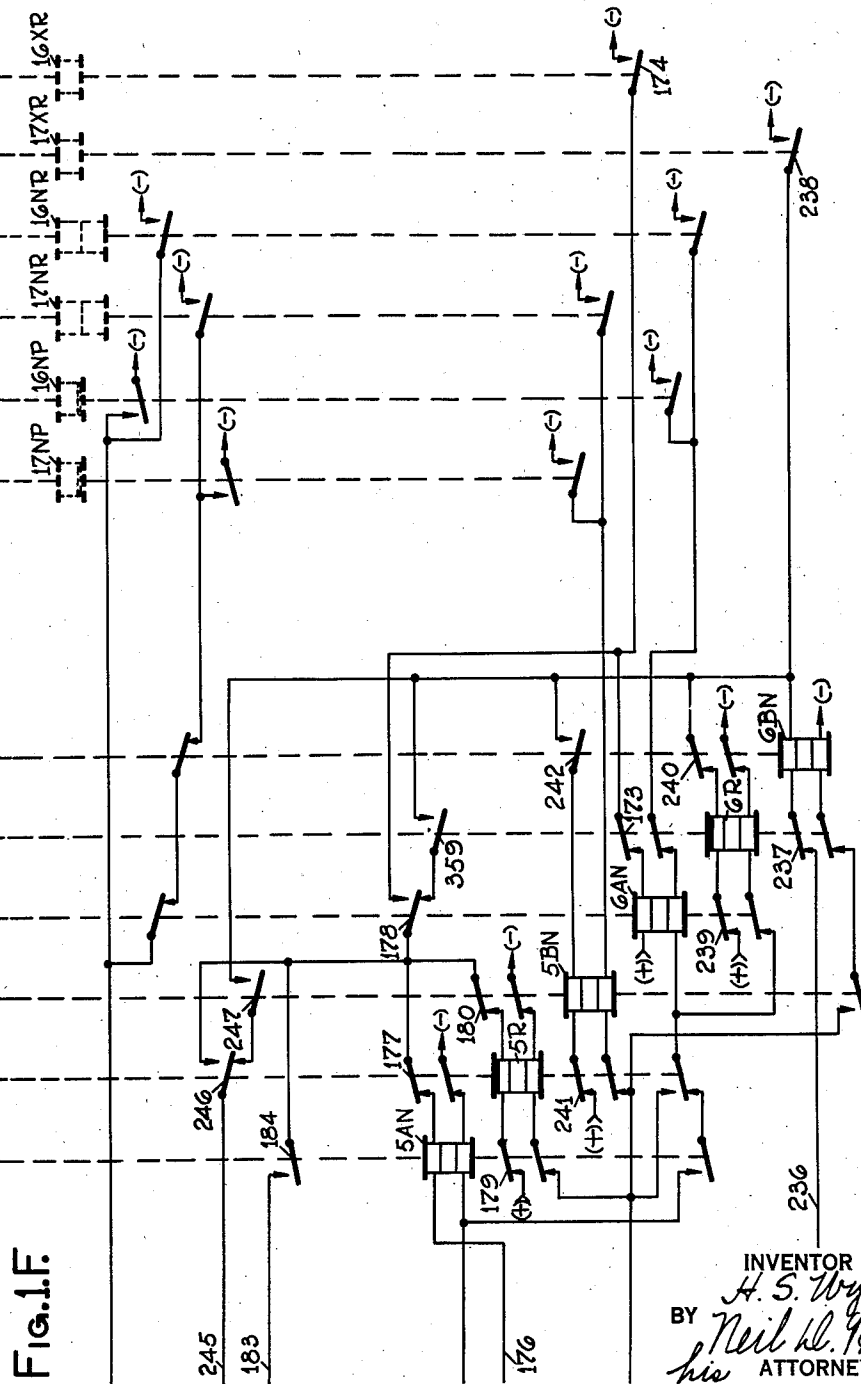
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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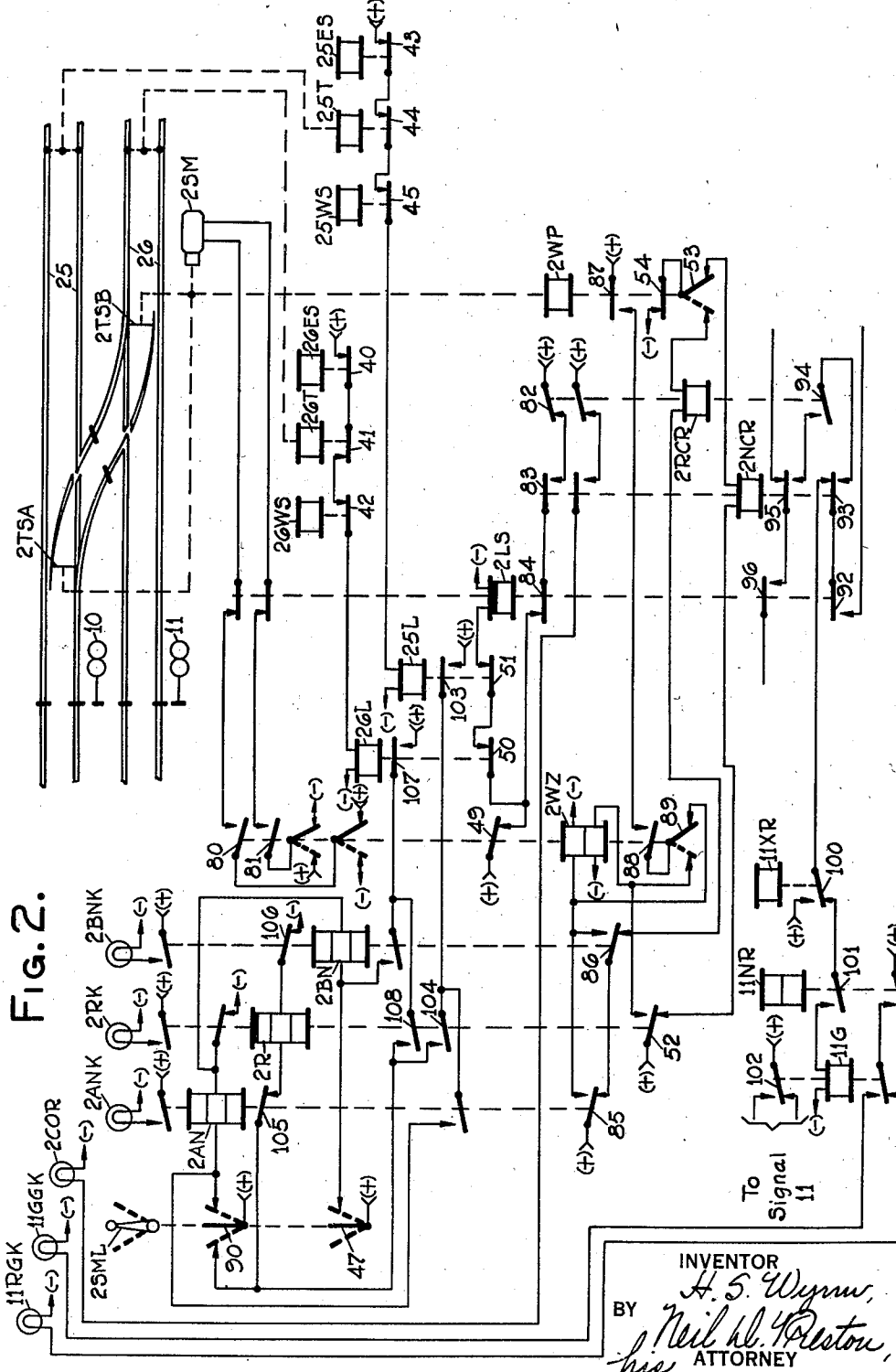
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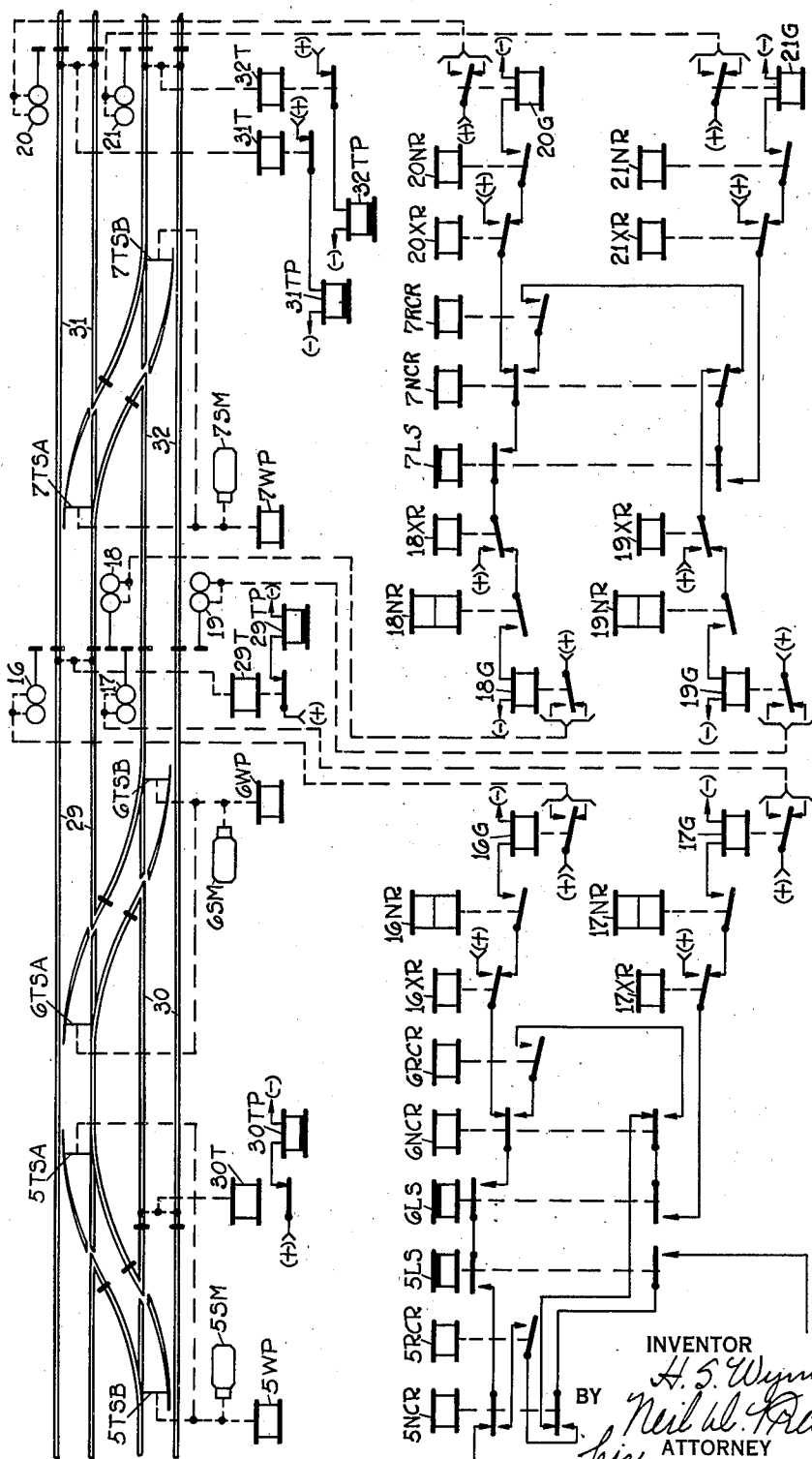


Fig. 3.B.

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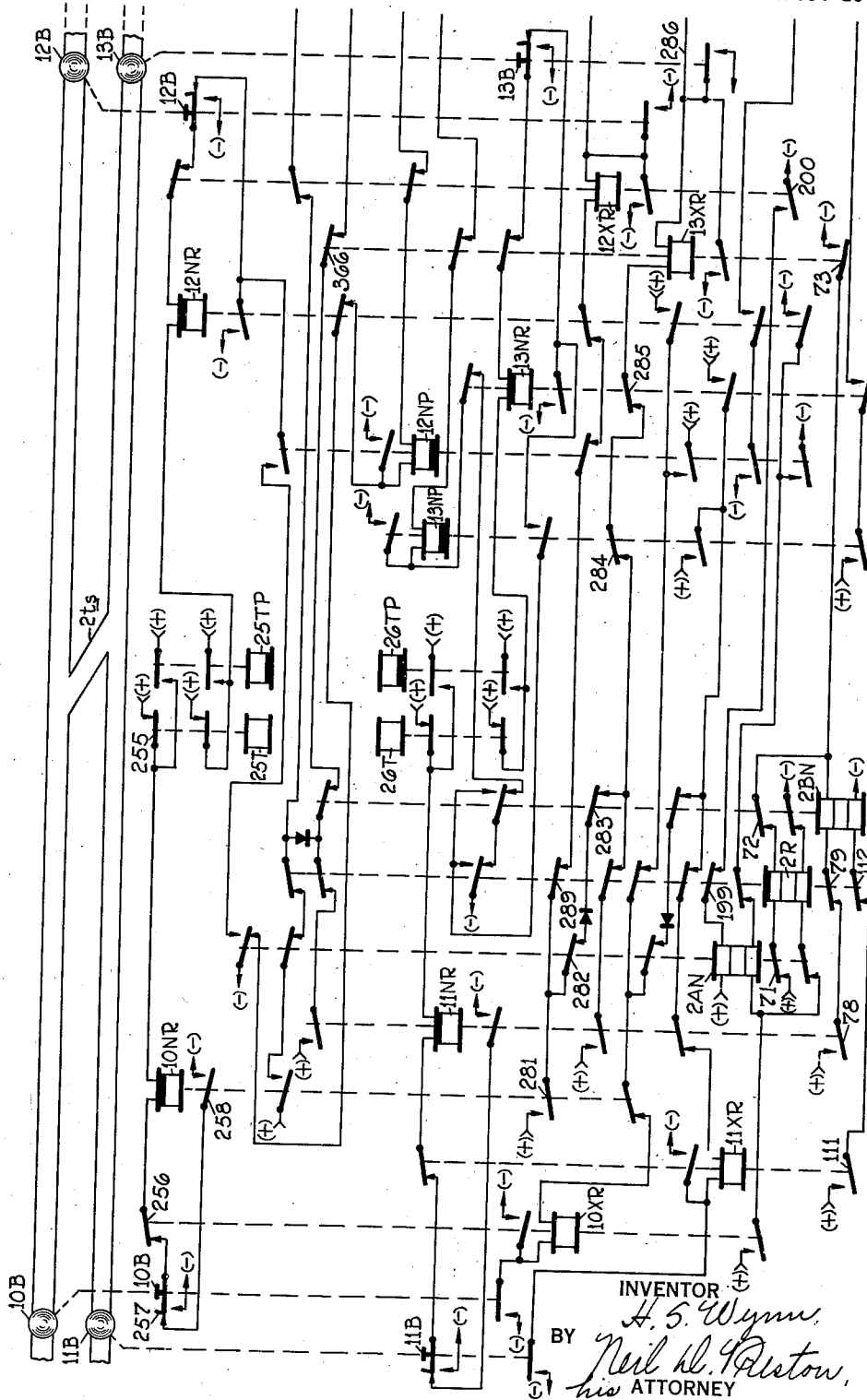
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FIG. 4.A.



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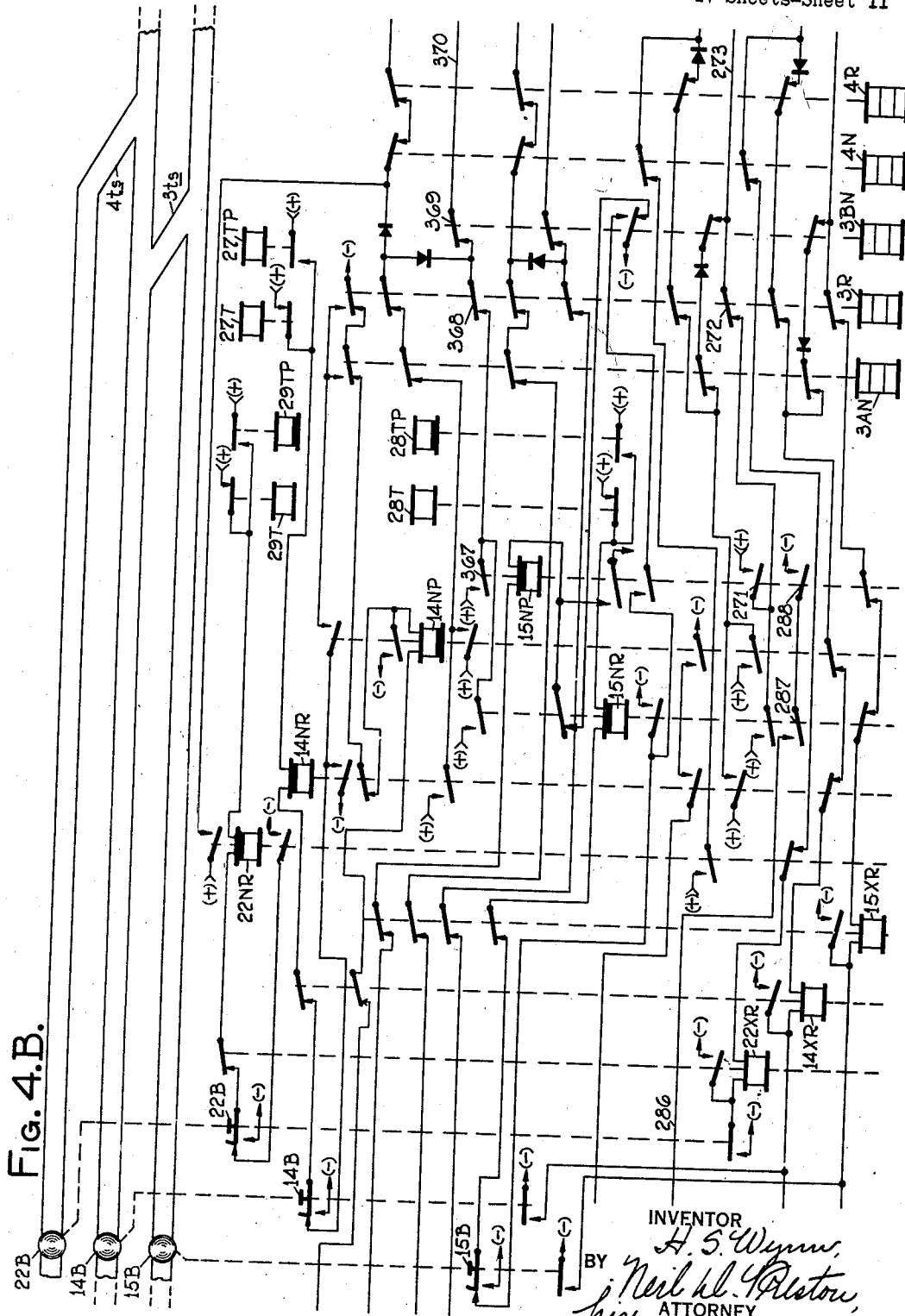
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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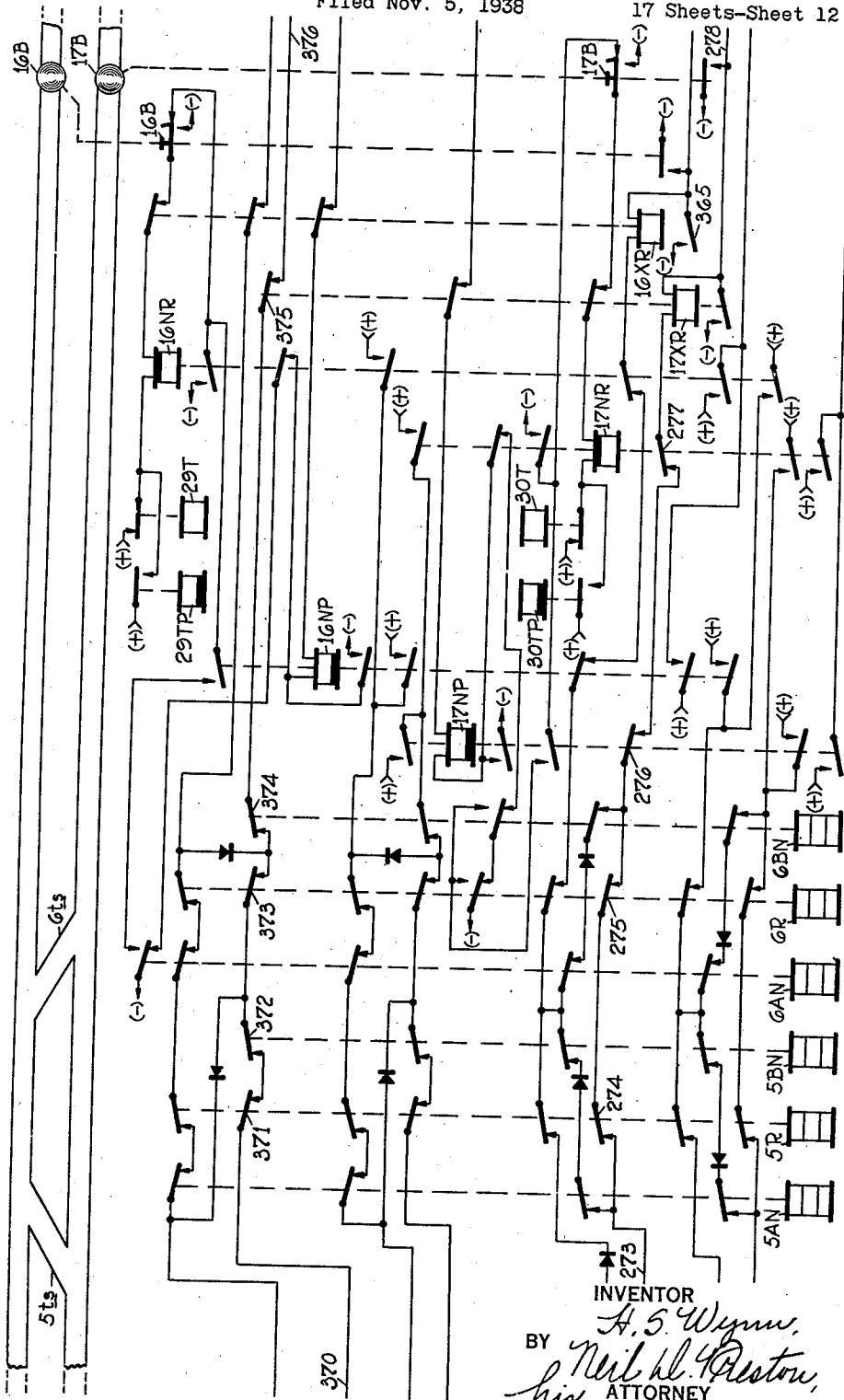
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 4.C.



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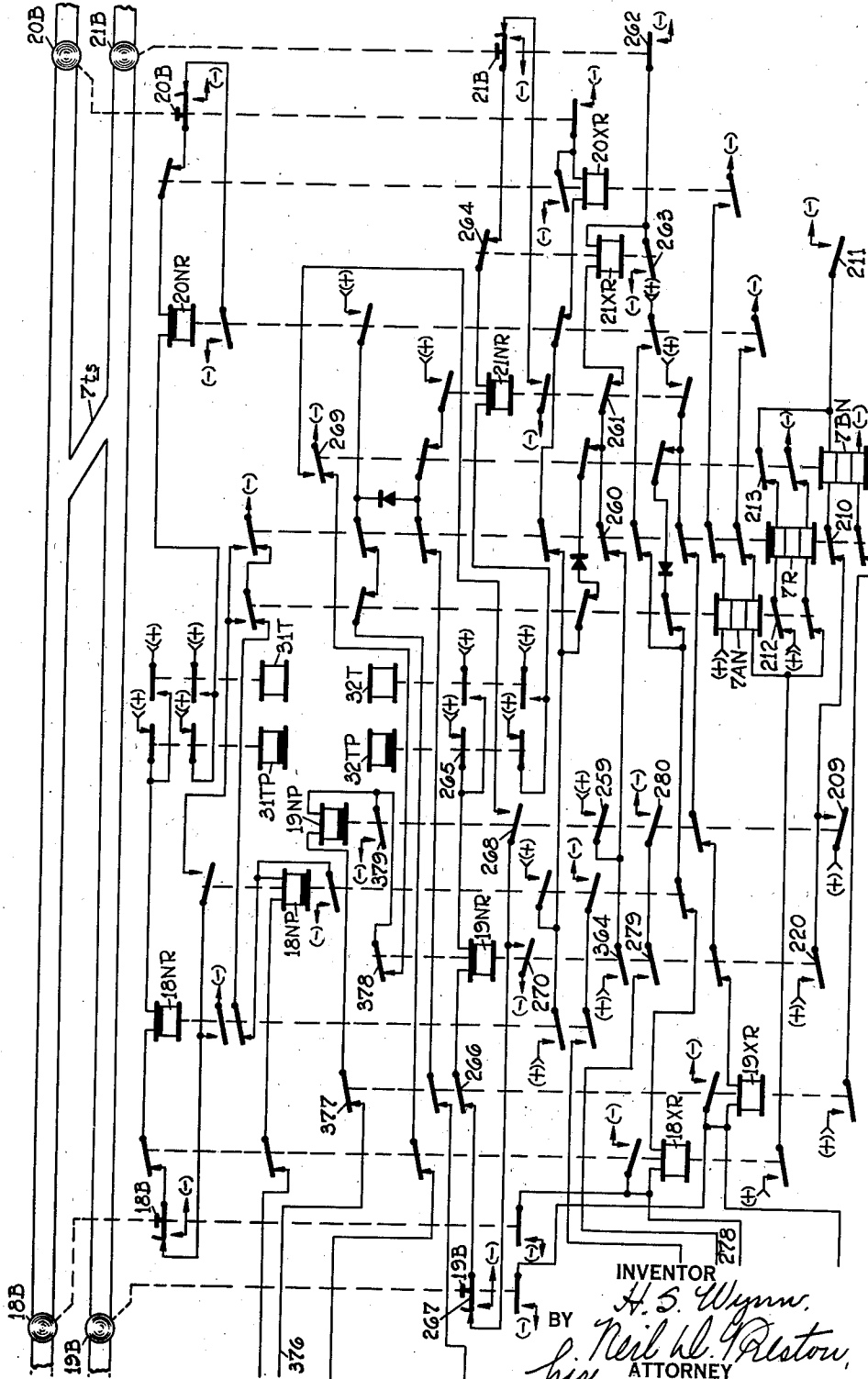
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FIG. 4.D.



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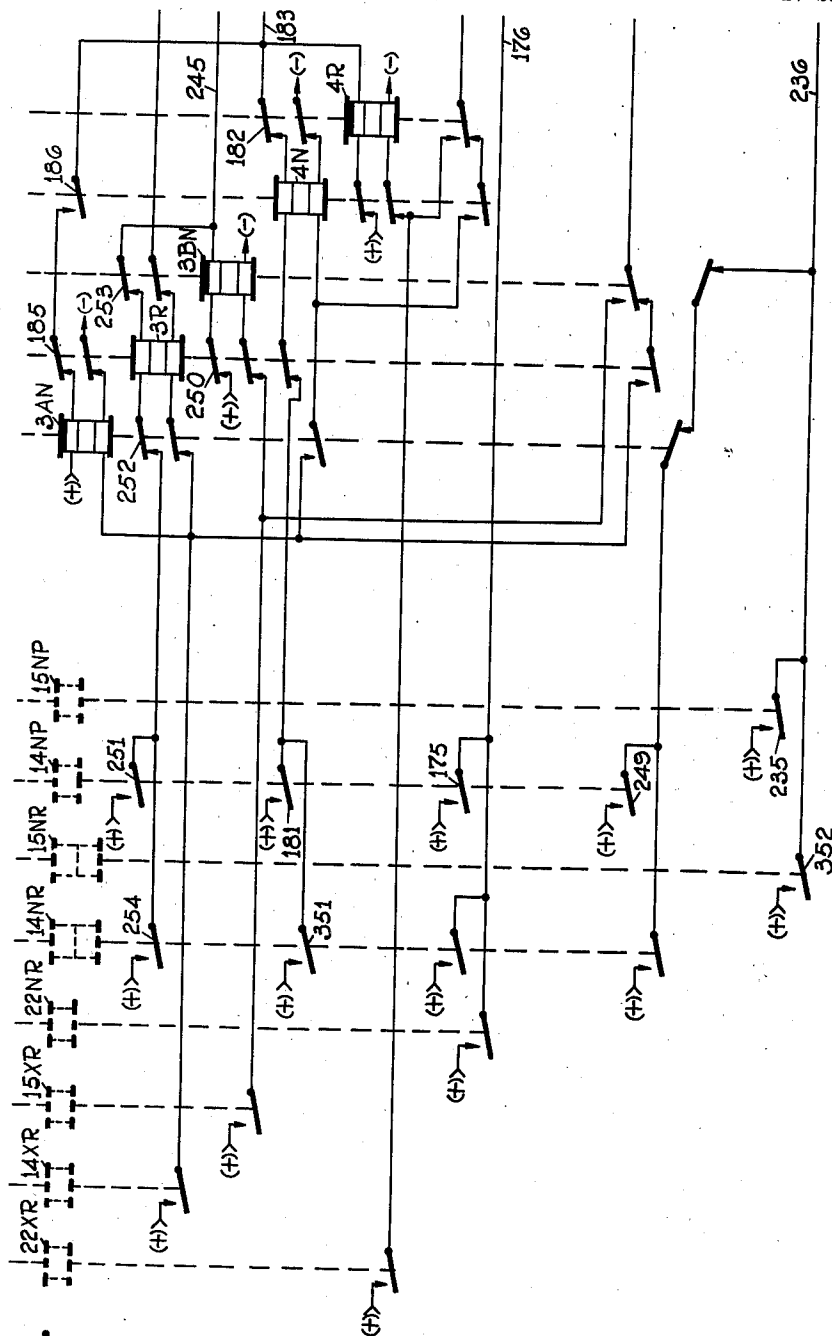


FIG. 5.A.

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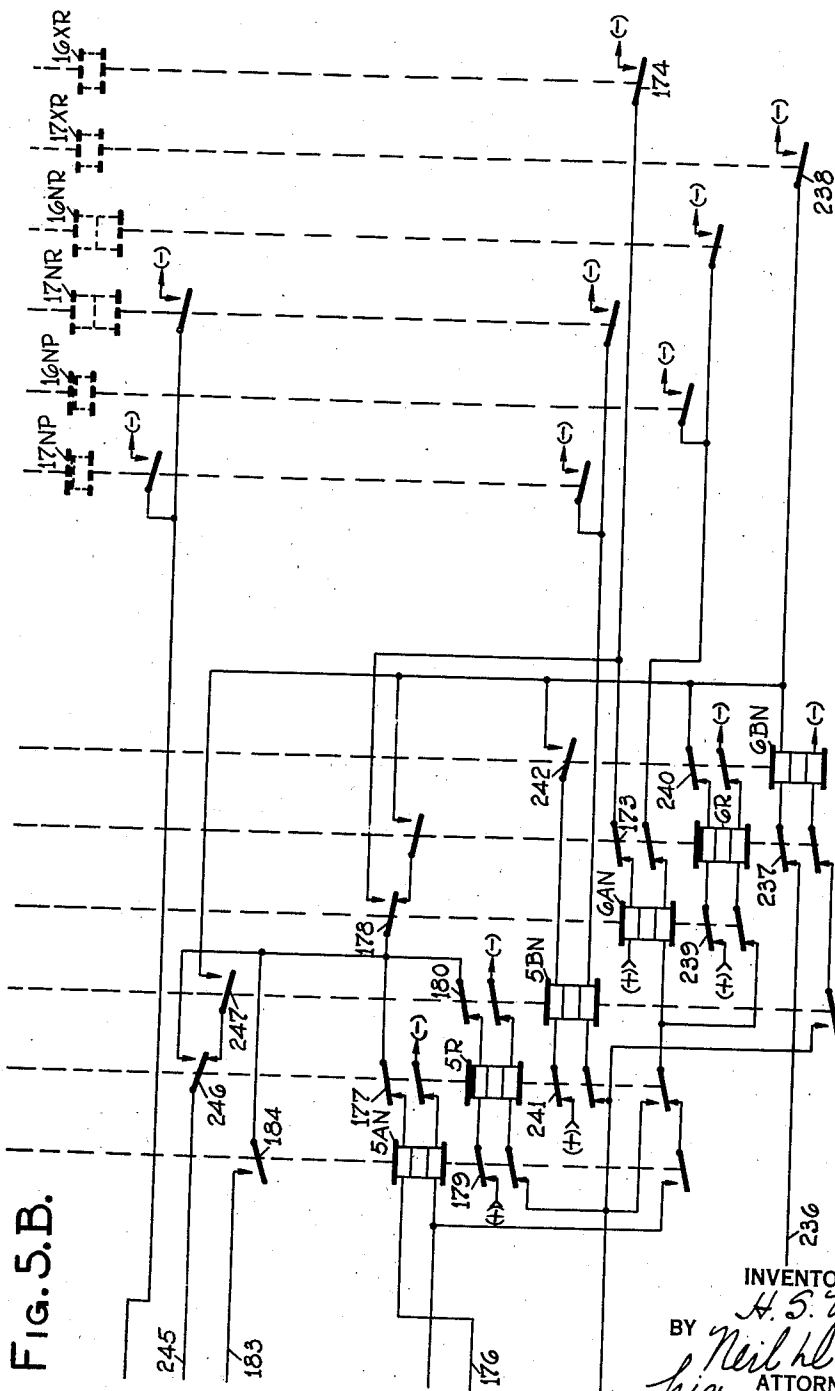
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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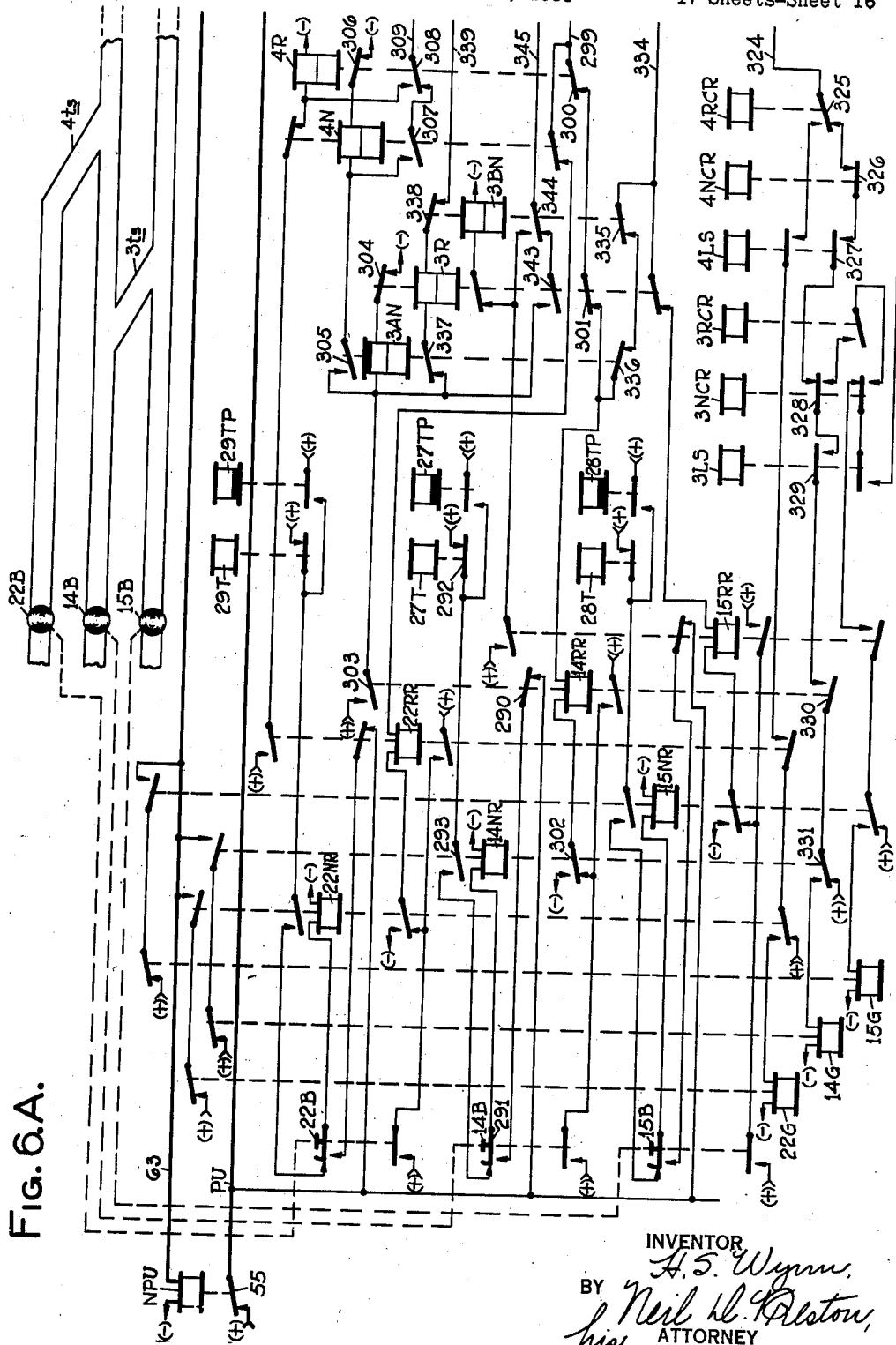
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

Filed Nov. 5, 1938

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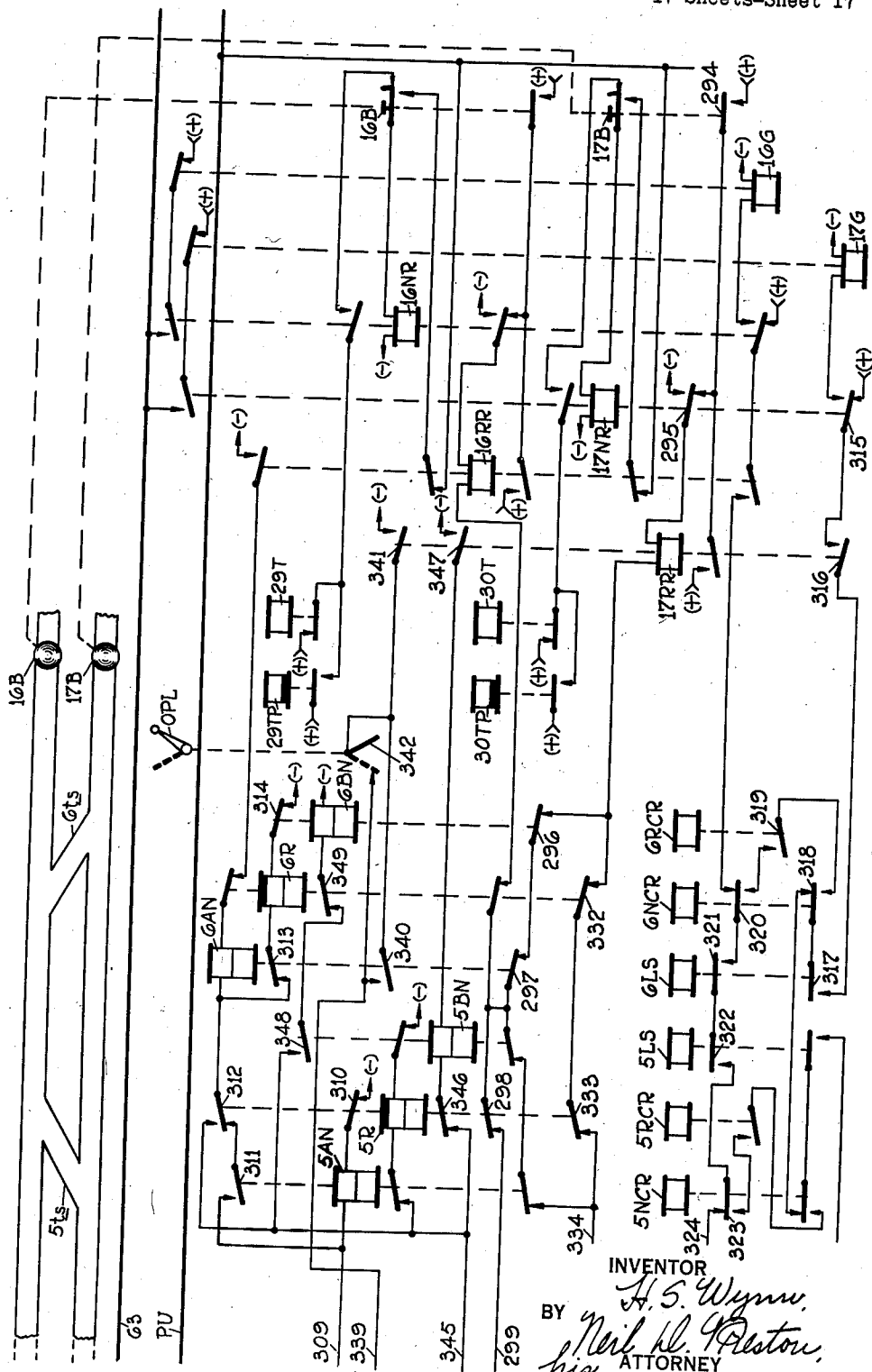
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 6.B.



UNITED STATES PATENT OFFICE

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SWITCH AND SIGNAL CONTROL SYSTEM
FOR RAILROADSHarold S. Wynn, Rochester, N. Y., assignor to
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Application November 5, 1938, Serial No. 239,140

33 Claims. (Cl. 246—134)

This invention relates to interlocking systems for railroads, and it more particularly pertains to an interlocking system of the entrance-exit type which is characterized by the manner in which routes are set up through complex track layouts by merely the designation of the entrance and exit ends of such routes by an operator in a control office.

In such a system, a control panel having a miniature track diagram of the actual track layout is provided with control buttons at points on the diagram corresponding to the ends of the various routes through the track layout. The operation of the control buttons for the opposite ends of any route causes the operation of all the track switches required to set up that route and effects the clearing of a signal at the entrance end to such route. The track diagram control panel is also usually provided with various indicator lamps located at suitable positions for indicating the routes established, the occupancy of the various track sections, and the clear or stop conditions of the various signals.

For the purpose of describing the present invention, the track layout of a complete interlocking plant is considered to be divided into "interlocked groups," each comprising one or more track switches of the track layout for providing routes between signal locations for governing traffic over those track switches, those signal locations constituting entrance and exit points to such routes. A plurality of such interlocked groups, located end-to-end, provide "through routes" having intermediate signal locations which are the signal locations at the ends of the routes of the several interlocked groups. The setting up of a through route including intermediate signals by the designation of the extreme ends of the through route only is conveniently called end-to-end or through route control.

One object of this invention is to provide an improved entrance-exit system for the setting up of routes in the individual interlocked groups in a manner which provides that a plurality of such interlocked groups may be interconnected for end-to-end or through route control.

The system can be said to have two different types of circuit selecting networks individual to the several interlocked groups. One of those types, conveniently called initiating networks, provides control circuits for entrance and exit relays associated with entrance and exit points for routes. The other type, conveniently called completion networks, provides control circuits for

normal and reverse switch control relays used in controlling the track switches.

When setting up a route within an interlocked group, the depression of a button for an entrance point causes the picking up of an entrance relay for that point, which entrance relay in picking up causes energy to be fed through an initiating network toward an exit relay for the exit point for each of the available routes within that interlocked group emanating from that entrance point. The depression of a button for the exit point for one of those available routes causes the picking up of an exit relay associated with that point.

A through route control network is also energized upon the picking up of each entrance relay in setting up a route if there is an available through route extending through a plurality of interlocked groups from that designated entrance point. This energy is fed over the through route network towards the next intermediate signal which is included in an available through route emanating from the designated entrance point at which intermediate signal an entrance repeater relay is energized. The picking up of the entrance repeater relay for any given intermediate signal location causes energy to be fed to the initiating network for the next interlocked group the same as if an entrance relay for that entrance point had been picked up. The entrance repeater relay for any given entrance point also feeds energy to the through route network for its interlocked group when such entrance repeater relay is rendered active from some preceding entrance point. Energy can be fed over the through route network for any interlocked group only so far as such through route circuit network is closed to signify that the portion of the through route up to that point is available for use.

The completion networks are provided for energizing normal and reverse switch control relays, one network being provided for each direction of traffic for each interlocked group. Two switch control relays are provided in the completion networks for each single track switch and three switch control relays are provided for each crossover. The circuits of the completion networks for the switch control relays provide that the picking up of the switch control relays for each route initiated by the designation of entrance and exit points is effected in a cascade order, starting with the switch control relay for the track switch nearest the exit point.

The completion circuit networks for energiz-

ing the normal and reverse switch control relays are organized to provide that a reverse switch control relay is energized for each track switch having its points facing a designated exit point when a route being set up is selected up to that track switch, that a normal switch control relay is energized for each track switch having its points facing a designated exit point when a route being set up is selected up to that track switch from the exit point designated, if a route is available between the designated entrance and exit points over that track switch in a normal position, and that either a normal or a reverse switch control relay is energized for each track switch that would be trailed depending upon the position in which it would be trailed if a train were to pass over that track switch from the designated exit point, when a route being set up is selected up to that track switch from the exit point designated.

Whenever a normal and a reverse switch control relay for a track switch facing the exit point are both energized at the same time in setting up a route, under conditions above pointed out, only one of those relays can be picked up because of a circuit interlock between them. To provide that the normal switch control relay is given preference over the reverse switch control relay, under such conditions, the reverse switch control relay for each track switch is made slow in picking up with respect to the pick up period of the normal switch control relay for that track switch.

It will be noted that the usual terminology used with regard to a train passing over a switch, is to speak of such train movement as a facing or a trailing point movement. However, it is more convenient in the present specification to speak of the switch points as facing a given exit point or a given entrance point than it is to speak of train movements. In other words, when a switch is spoke of as facing a given exit point, it means that it is so positioned that if a train were to move from the exit point over such switch it would of necessity make a facing point movement.

Thus, the completion circuit network, by giving the normal switch control relays time preference over the reverse switch control relays, provides a mean for selecting one of a plurality of optional routes as being preferred. The route given preference is always the available route diverging nearest the designated entrance point because the completion network provides that, in the cascade energization of the switch control relays, the route is selected in such a manner that, it follows the main track from the exit point designated as far as a route is available between the designated entrance and exit points on that track. This characteristic selection of one of a plurality of optional routes in a single interlocked group is similarly applied to optional through routes which extend through a plurality of interlocked groups.

There are conditions encountered in practice, however, where it is desirable to provide that a particular route is always given preference over other optional routes, irrespective of whether or not that route diverges nearest the designated entrance point. Such a condition encountered in practice can be, for example, when a particular high speed track switch common to a plurality of routes is desired to be used, when available, in preference to lower speed track switches providing optional routes. When such prefer-

ence is to be given a particular track switch, the reverse switch control relay associated therewith is energized only when a route is available over the track switch reverse, and the normal switch control relay for that track switch is made slow acting with respect to the reverse switch control relay. Thus, whenever a route is available over that track switch in either a normal or a reverse position, the normal and reverse relays are both energized but the reverse switch control relay is given preference.

In setting up a through route by end-to-end control the actuation of a control button for the entrance point to that route effects the picking up of an entrance relay, and the picking up of that relay causes the picking up of an entrance repeater relay for each intermediate entrance point included in each available through route emanating from that designated entrance point. The actuation of a control button for the exit point to that route starts the cascade of the completion network upon the picking up of the exit relay for that point. When the switch control relays are positioned for the interlocked group including the designated exit point, the entrance relay for that portion of the through route is picked up, which in turn causes the dropping away of the entrance repeater relay for that entrance point. The entrance repeater relay is made slow in dropping away, however, to provide a momentary energization of a circuit for the picking up of the exit relay for the adjoining exit point included in the through route being set up, the same as if the control button for that exit point had been actuated. Thus, routes are set up successively in the interlocked groups included in the through route, starting with the interlocked group including the designated exit point. When the through route is entirely set up, the entrance repeater relays are all dropped away as they are used only during the setting up of a route by end-to-end control.

When setting up a route by end-to-end control, it is possible to energize entrance repeater, or through route relays, for a plurality of intermediate signals within an interlocked group, if optional routes are available extending through a plurality of interlocked groups between the designated entrance and exit points. Under such conditions one of those intermediate entrance points for the route being set up, by the switch control relays in the completion network in accordance with the time preference means effective for giving preference to the route diverging nearest the designated entrance point as mentioned above.

Another object of the present invention is to provide a means for limiting the end-to-end control to such an extent that, in setting up a route for an approaching train by end-to-end control, a signal cannot be cleared for a preceding train occupying a part of that proposed route. Such mode of operation is provided by the initiating network for the control of the entrance repeater relays in which energy can be fed through the network for the control of an entrance repeater relay for an intermediate signal only if a route is available between the designated entrance point and that intermediate entrance point, and only if no portion of that route is set up or is locked by the presence of a train in that section.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in

part pointed out as the description of the invention progresses:

In 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, similar letter reference characters being used to designate parts having similar functions which are generally made distinctive by preceding numerals, and in which:

Figs. 1A, 1B, 1C and 1D, when placed end-to-end with Figs. 1E and 1F placed below Figs. 1B and 1C respectively, illustrate a self-selecting network system for governing the track layout illustrated in Fig. 3.

Fig. 2 illustrates various switch and signal control circuits for the track switches of a particular crossover as typical of the circuits provided for each crossover and single track switch included in the track layout for which the system is provided;

Figs. 3A and 3B, when placed end-to-end, illustrate the track layout for which the present embodiment of the invention is provided, together with the control circuits for the signals associated with that track layout;

Figs. 4A, 4B, 4C and 4D, when placed end-to-end, illustrate a modification of the self-selecting network illustrated in Figs. 1A, 1B, 1C and 1D;

Figs. 5A and 5B, when placed end-to-end, and beneath Figs. 1B and 1C respectively, or beneath Figs. 4B and 4C respectively, illustrate a modification of the completion network shown in Figs. 1E and 1F to provide that preference is given to a particular one of several optional routes between entrance and exit points; and

Figs. 6A and 6B, when placed end-to-end, illustrate a means by which the present invention can be applied to governing a track layout in which end-to-end control is not required.

In order to simplify this disclosure as much as possible, reference is made from time to time to functions common to all parts of a similar kind or class by use of the letter reference characters without preceding numerals. Such a reference is to be understood to apply to any parts designated in the drawings by reference characters that are similar except for preceding numerals associated therewith.

The various parts and circuits constituting the embodiment of the present invention have been shown diagrammatically and certain conventional illustrations have been employed for the purpose of simplifying the illustrations and facilitating in the explanation thereof. The drawings have been made more for the purpose of facilitating the disclosure of the present invention as to the principles and mode of operation, than for the purpose of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus, the various relays and their contacts are illustrated in a conventional manner, certain circuit details well known to those familiar with the art are illustrated by dotted lines, and symbols are used to indicate connections to the terminals of batteries, or other sources of electric current instead of showing all of the wiring connections to those terminals.

The symbols (+) and (−) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current, and the circuits with which those symbols are used always have current flowing in the same direction. If alternating cur-

rent is used instead of direct current the symbols shown are to be considered as representative of instantaneous relative polarities.

Apparatus

Track layout.—With reference to Figs. 3A and 3B, two parallel tracks have been illustrated as connected at various points by crossovers having track switches 2TSA, 2TSB, 3TSA, 3TSB, 5TSA, 5TSB, 6TSA, 6TSB, 7TSA and 7TSB; and one of those parallel tracks is illustrated as connected to a third track by a track switch 4TS.

The track switches are positioned by power operated switch machines which can be of any suitable type, such, for example, as the switch machine shown in the patent to W. K. Howe, Patent No. 1,466,903, dated September 4, 1923. The motors of the switch machines are assumed to be controlled in a suitable manner, preferably providing over-load protection, such as is shown for example, in the patent to W. H. Hoppe, et al., Patent No. 1,877,876, dated September 20, 1932. If the switch machine motors are controlled in accordance with that Hoppe et al. patent, the relay WZ of the present disclosure for each track switch, controls the relay CR illustrated in that patent.

For the purpose of simplifying the present disclosure, only one switch machine SM has been illustrated for each of the crossovers because it is well known to those familiar with the art that both track switches of a crossover are positioned simultaneously, but it is to be understood that a separate switch machine can be provided for governing the operation of each of the track switches associated with each crossover when required in practice. The switch machine 2SM has been provided for positioning track switches 2TSA and 2TSB, 3SM for positioning track switches 3TSA and 3TSB, 5SM for positioning track switches 5TSA and 5TSB, 6SM for positioning track switches 6TSA and 6TSB, 7SM for positioning track switches 7TSA and 7TSB, and 4SM for positioning track switch 4TS.

A polar-neutral relay WP is illustrated as associated with each crossover and each single track switch, and that relay is used for repeating the locked position of the switch points in correspondence with the locked position of the switch machine in a manner well known to those familiar with the art. The relay WP is energized with one polarity when the switch points and switch machine are locked in a normal position, and it is energized with the opposite polarity when the switch points and switch machine for that track switch are locked in the opposite position. Whenever the switch points and/or the switch machine are unlocked, the relay WP is deenergized.

For the purpose of selecting such control for each relay WP, point detector contact mechanisms are provided such as the type shown, for example, in the patent to C. S. Bushnell, Patent No. 1,517,236, dated November 25, 1924.

Signals have been provided for governing traffic through the interlocking plant in both directions, signals 10, 11, 22, 14, 15, 18 and 19 having been provided for governing east bound traffic to the right, and signals 20, 21, 16, 17, 12 and 13 having been provided for governing west bound traffic to the left.

The signals have been illustrated as being of the color light type having individual color lamp units, the lower lamp unit providing a red indication for danger, and the upper unit pro-

viding a green indication for clear. It is to be understood, however, that other types of signals, such as semaphore or search light signals could as well be used, in accordance with the requirements of practice, and it is also to be understood that a third caution indication can be provided where required.

The track layout has been illustrated as divided into track sections to provide double rail track circuits in the usual manner. Track sections 25, 26, 27, 28, 29, 30, 31 and 32 have been illustrated as being provided for track circuits assumed to be provided in the usual manner for track relays 25T, 26T, 27T, 28T, 29T, 30T, 31T and 32T respectively. It is to be understood that proper bonding connections are provided in the usual manner for fouling protection and that other types of track circuits could as well be employed.

Control machine.—A principal part of the control machine for governing traffic through the track layout described above, is a vertical control panel located within convenient reach of an operator, upon which is constructed a miniature track diagram, as illustrated at the top of Figs. 1A, 1B, 1C and 1D, corresponding to the actual track layout for which the system is provided. Upon the miniature track diagram are located suitable indicator lamps, or equivalent devices, for keeping an operator well informed as to the routes established through the track layout, as to the condition of occupancy of the various track sections, and as to the indications displayed by the various signals. In order to simplify the present disclosure only certain ones of those indicator lamps have been shown as typically illustrated in Fig. 2, the present invention being more particularly concerned with the means for setting up the various routes. Further detail description as to how the indications can be provided is shown in the prior application of F. B. Hitchcock, Ser. No. 74,709, filed April 16, 1936, to which reference can be made.

A control button B is associated with each route end, and is located on the miniature track diagram at a position corresponding to the route end in the track layout for which it is provided. The route ends, are of course, determined by the location of the signals at the track layout, one button B being provided at the control office for each signal. Thus buttons 10B, 11B, 12B, 13B, 14B, 15B, 16B, 17B, 18B, 19B, 20B, 21B and 22B have been illustrated as associated with route ends at signals 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21 and 22 respectively. Each of the buttons B is of the push-pull type, and it is biased to a normal position from which it can either be depressed or pulled out. There is a normally closed contact on that button which is maintained closed whenever the button is depressed, and which is opened whenever that button is pulled out from its normal position. There is another contact associated with the button which is closed only when that button is depressed. The contact closed when the button is depressed is illustrated in some cases as being independent of the contact normally closed, and in other cases it can be associated with the normally closed contact. The construction of the buttons B can be provided in any suitable manner, such, for example, as is shown in the prior application of J. F. Merkel, Ser. No. 158,720, filed August 12, 1937.

Although only one push button B is used for each signal, it is to be understood that separate

buttons can be provided for each entrance and each exit point, and that types of buttons having other distinctive operating positions could as well be used.

In addition to the means of control for the track layout provided by the self-selecting network, an auxiliary switch control level SML is provided for each crossover and for each single track switch for use in attempting to free the track switches from obstructions, such, for example, as snow and ice, and for setting up routes in case of failure of the self-selecting network. Inasmuch as the auxiliary switch control levers SML are provided in a similar manner for each of the crossovers and single track switches, lever 2SML illustrated in Fig. 2 is to be considered as typical of the levers of a similar character provided for governing the other track switches.

System devices.—Associated with the entrance point in the track layout at each signal is an entrance relay NR at the control office (see Figs. 1A, 1B, 1C and 1D). A slow acting entrance repeater relay NP is also provided for each intermediate signal between extreme ends of the interlocking plant. An entrance relay NR is picked up for each signal used in governing traffic through a route set up, and it is maintained picked up until the route to be set up is restored to normal, either upon the passage of a train or by the manual control of an operator. The entrance repeater relays NP are picked up only during the setting up of routes.

An exit relay XR is provided for the exit point at each signal location, and that relay is picked up when the exit point with which it is associated has been designated by an operator in setting up a route.

In response to the picking up of the exit relays XR, completion network relays AN, BN, N and R are positioned for causing the operation of the track switches included in the route to be set up. Relays AN, BN and N are provided for causing the operation of their respective track switches to a normal position, and relays R are provided for causing the operation of their respective track switches to a reverse position. One normal control relay and one reverse control relay are provided for each single track switch, and two normal and one reverse control relays are provided for each crossover.

Associated with the control circuits for the self-selecting network relays are suitable rectifiers and resistances to provide the desired mode of operation of the system.

With reference to Fig. 2, two lock relays L and one slow acting lock repeater relay LS are associated with each crossover for providing the safe operation of the track switches. It is of course apparent that only one lock relay L is required for a single track switch.

A polar-neutral switch control relay WZ is provided for each crossover and each single track switch for causing the operation of the switch machine associated therewith in accordance with the position of the relays of the completion network. Correspondence relays NCR and RCR are provided for repeating the correspondence position of the track switches and their associate control relays.

With reference to Figs. 3A and 3B, a signal control relay G is provided for each signal for governing its indication. When that relay is dropped away, its associated signal displays a danger indication, and when that relay is picked up, its associated signal displays a clear indication.

With reference to the modification shown in Figs. 4A, 4B, 4C and 4D, the control machine has been illustrated the same as heretofore described, and the relays provided are used for the same general purposes heretofore set forth.

With reference to the modification shown in Figs. 6A and 6B, the control machine is constructed in a similar manner to that heretofore described, and the control panel has associated therewith an optional control lever OPL for determining preference between two optional routes. Relays are provided for the same general purposes as has been heretofore described, and relays RR are substituted in the network system for the relays XR to which reference has heretofore been made. A relay RR is associated with each route end, and is picked up only when energized in series with the RR-relay for an opposite route end.

Having thus considered the apparatus provided in accordance with the present invention, it is believed that a clear understanding of the mode of operation of the system can best be had by considering various typical operating conditions.

Operation

Normal conditions.—The normal conditions of the system can be defined as those conditions which exist when all of the signals display danger indications, the track sections illustrated are unoccupied by trains, and there are no routes set up or partially set up in the interlocking plant. Such conditions are indicated to an operator by the indicator lamps on the control panel which are normally dark. The track switches are in the position to which they were last operated for a route set up, and they have been illustrated (see Figs. 4A and 4B) as having been in alignment for through routes set up on the two through parallel tracks.

The route locking relays are normally energized as is typically shown in Fig. 2, and the lock relays L and LS are also normally picked up. Relay 26L is normally energized by a circuit closed from (+), through a circuit including front contact 40 of relay 26ES, front contact 41 of relay 26T, front contact 42 of relay 26WS, and winding of relay 26L, to (—). Relay 25L is normally energized by a circuit closed from (+), through a circuit including front contact 43 of relay 25ES, front contact 44 of relay 25T, front contact 45 of relay 25WS, and winding of relay 25L, to (—). Relay 2LS is normally energized by a circuit closed from (+), through a circuit including back contact 49 of relay 2WZ, front contact 50 of relay 26L, front contact 51 of relay 25L, and winding of relay 2LS, to (—).

When the track switches 2TSA and 2TSB are in their normal locked position as illustrated, relay 2NCR is energized by a circuit closed from (+), through a circuit including back contact 52 of relay 2R, winding of relay 2NCR, polar contact 53 of relay 2WP in a right hand position, and front contact 54 of relay 2WP, to (—).

Self-selecting network.—To consider the general principles involved in the mode of operation of the self-selecting network, the mode of operation will first be described for setting up routes through a simple interlocked group, and it will be hereinafter pointed out how those principles are applied to the control of more complex track layouts under various operating conditions that might be encountered in practice.

For an example of the mode of operation of

the system within an interlocked group, assume an operator to set up a route from signal 10 to signal 13 at a time when the above described normal conditions of the system exist. After checking the indicator lamps on the control panel to see that the proposed route is available, the operator defines the entrance point for that route by the depression of button 10B (see Fig. 1A). As a result of such operation relay 10NR is picked up by the energization of a circuit closed from (+), through a circuit including back contact 55 of relay NPU, an entrance relay pick up bus PU, contact 56 of button 10B closed in a depressed position, back contact 57 of relay 10XR, and winding of relay 10NR, to (—). A stick circuit is closed, upon the picking up of relay 10NR, for that relay, from (+), through a circuit including front contact 59 of relay 25T, front contact 58 of relay 10NR, contact 56 of button 10B closed when that button is either depressed or in its normal position, back contact 57 of relay 10XR, and winding of relay 10NR, to (—). Included in that circuit is back contact 60 of relay 25TP to provide that the stick circuit for relay 10NR can be closed when detector track section 25 is occupied, for the purpose of allowing the setting up of a route for a following train when the detector track section is occupied by a first train.

Upon the picking up of relay 10NR, relay NPU is picked up by the energization of a circuit closed from (+), through a circuit including back contact 61 of relay 10G, front contact 62 of relay 10NR, bus 63, and winding of relay NPU, to (—). The picking up of relay NPU disconnects energy from the pick up bus PU by the opening of back contact 55, to provide that the actuation of other route end buttons is ineffective for picking up entrance relays. It is obvious, from the circuit described, that relay NPU is maintained picked up until signal 10 at the designated entrance point has been cleared, to cause the opening of that circuit at back contact 61 of relay 10G, relay 10G being energized only when its associate signal is to be cleared in a manner hereinafter described when considering the details of the signal control circuits.

Thus, it is obvious, that the relay NPU is maintained energized to prevent the energization of other entrance relays after one entrance point has been designated, until the route thus initiated has been completely set up, or an operator has caused the restoration to normal of the portion of the route establishing means conditioned. An advantage of such a mode of operation is that, in allowing an operator to set up only one route at a time, only designated routes can be set up. If it were possible for an operator to cause the picking up of a plurality of entrance relays without having completed routes including those entrance points, there would be the possibility of inadvertently setting up a wrong route by the combination of an exit point designated for a proposed route with an entrance point for a route different from the proposed route, which had been previously designated. The requiring of an operator to set up only one route at a time, and the requiring of that route to be completed or completely restored, before another route can be set up, allows the interlocking system to assume more of the responsibility for setting up only routes designated, and places less responsibility on the operators.

After the entrance-point for a route has been designated as heretofore described, assume an

operator to designate an exit point for that route at signal 13 by the depression of button 13B. As a result of such operation, the relay 13XR is energized by a circuit closed from (+), through a circuit including front contact 64 of relay 10NR, back contact 65 of relay 2AN, back contact 66 of relay 2BN, back contact 67 of relay 13NP, back contact 68 of relay 13NR, winding of relay 13XR, and contact 69 of button 13B in a depressed position, to (-). The picking up of relay 13XR, closes a stick circuit for that relay from (+), through a circuit including front contact 64 of relay 10NR, back contact 65 of relay 2AN, back contact 66 of relay 2BN, back contact 67 of relay 13NP, back contact 68 of relay 13NR, winding of relay 13XR and front contact 70 of relay 13XR, to (-).

In response to the picking up of relay 13XR, relay 2R is picked up by the energization of a circuit closed from (+), through a circuit including back contact 71 of relay 2AN, upper winding of relay 2R, back contact 72 of relay 2BN, and front contact 73 of relay 13XR, to (-). The picking up of relay 2R causes the operation of the track switches for crossover 2ts to reverse positions, and causes the clearing of signal 10 in a manner to be hereinafter described in detail.

To consider another example of how a route is selected by the self-selecting network, assume an operator to set up a route from signal 11 to signal 13, when that route is available and the normal conditions of the system heretofore described are in effect. The actuation of the entrance button 11B for defining the entrance point causes the energization of a circuit for relay 11NR comparable to the circuit heretofore described for relay 10NR, and the picking up of relay 11NR closes a circuit for relay NPU, from (+), through a circuit including back contact 74 of relay 11G, front contact 75 of relay 11NR, bus 63, and winding of relay NPU, to (-). When relay NPU is picked up, the opening of back contact 55 of that relay effects the deenergization of the entrance relay pick up bus PU to provide that the actuation of a button for defining the exit point for the route being set up is ineffective for picking up an entrance relay associated with that route end. Relay 11NR is maintained picked up by a stick circuit similar to the stick circuit above described for relay 10NR.

Upon the depression of button 13B for designation of the exit point for the route being set up between signal 11 and signal 13, a circuit is closed for the energization of relay 13XR, from (+), through a circuit including front contact 76 of relay 11NR, back contact 77 of relay 2R, back contact 67 of relay 13NP, back contact 68 of relay 13NR, winding of relay 13XR, and contact 69 of button 13B closed in a depressed position, to (-). When relay 13XR is picked up, under such conditions, a stick circuit is closed for that relay from (+), through a circuit including front contact 76 of relay 11NR, back contact 77 of relay 2R, back contact 67 of relay 13NP, back contact 68 of relay 13NR, winding of relay 13XR, and front contact 70 of relay 13XR, to (-).

Upon the picking up of relay 13XR, in setting up a route from signal 11 to signal 13, relay 2R is energized by the closing of a circuit heretofore described, and relay 2BN is also energized at that time by a circuit closed from (+), through a circuit including front contact 78 of relay 11NR, back contact 79 of relay 2R, and front contact 73 of relay 13XR, to (-). Relay 2R is made slow

in picking up with respect to relay 2BN to provide that whenever relays 2R and 2BN become energized at the same time, as in setting up a route from signal 11 to signal 13, relay 2BN will pick up in preference to relay 2R and open the circuit for relay 2R at back contact 72. The picking up of relay 2BN causes the operation of the track switches associated with the crossover 2ts to normal positions, and causes the clearing of signal 11 at the entrance point of the route being set up.

The mode of operation of the system in setting up each of the above described routes is typical of the mode of operation of the network relays for each of the track switches which faces the designated exit point in a route being set up. If the route desired calls for the track switch to be reversed, only the reverse switch control relay R is energized, and if the route desired calls for the track switch to be normal, the normal and reverse switch control relays for that track switch are both energized if that track switch faces the designated exit point, but only the normal control relay is picked up, because of a difference in the operating characteristics of the two relays and a circuit interlock between those relays. Use is made of this feature of the network system in selecting a preferred route of a plurality of optional routes as is hereinafter considered in detail.

Switch control.—Inasmuch as the means provided for positioning the track switches in accordance with their position selected by the self-selecting network relays is similar for each track switch, all of the circuit details are shown and described for the track switches associated with one particular crossover as typical of the circuits provided for causing the positioning of each of the other track switches. Thus, it is considered expedient at this time to consider those typical circuits as applied to the control of the track switches 2TSA and 2TSB.

To consider the details of the circuits by which the switch machines are operated in accordance with the positioning of the self-selecting network relays AN, BN, N and R, assume the heretofore described normal conditions of the system to exist except for a route to be assumed to have been selected by the self-selecting network, extending from signal 10 to signal 13. In selecting such a route by the self-selecting network, relay 2R is energized in a manner heretofore described, and the picking up of that relay causes the picking up of relay 2WZ (see Fig. 2), and the picking up of relay 2WZ causes the positioning of the track switches 2TSA and 2TSB by the switch machine 2SM.

To consider the circuit details for accomplishing such a mode of operation, assume relay 2R to be picked up, under such conditions, to cause the picking up of relay 2WZ by the energization of a circuit closed from (+), through a circuit including front contact 52 of relay 2R, and lower winding of relay 2WZ, to (-). Such energization causes the polar contacts of relay 2WZ to be closed in a left hand position, and causes the energization of the switch machine 2SM to cause its operation to a reverse position when front contacts 80 and 81 of relay 2WZ close an obvious control circuit for that switch machine.

The picking up of relay 2R causes the dropping away of relay 2NCR by opening the circuit for that relay at back contact 52, and the dropping away of relay 2NCR closes a stick circuit for the

lock repeater relay 2LS, from (+), through a circuit including back contact 82 of relay 2RCR, back contact 83 of relay 2NCR, front contact 84 of relay 2LS, front contact 50 of relay 26L, front contact 51 of relay 25L, and winding of relay 2LS, to (-). The characteristics of the relays are such that the stick circuit for relay 2LS is closed prior to the picking up of relay 2WZ and the opening of the circuit for relay 2LS normally energized at back contact 49 of relay 2WZ.

After the switch machine 2SM has completely operated the track switches 2TSA and 2TSB to reverse locked positions, relay 2WP is picked up when energized with such a polarity as to operate its polar contacts to a left hand position, and relay 2RCR is picked up by the energization of a circuit closed from (+), through a circuit including back contact 85 of relay 2AN, back contact 86 of relay 2BN, winding of relay 2RCR, polar contact 53 of relay 2WP in a left hand position, and front contact 54 of relay 2WP, to (-). The picking up of relay 2RCR opens the above described stick circuit for relay 2LS at back contact 82 to cause that relay to drop away and close the signal control circuit as herein-after described.

To provide that energy is applied to the switch machine 2SM to cause it to complete its operation to a reverse position, irrespective of whether or not relay 2R is restored to normal, a stick circuit is provided for relay 2WZ closed from (+), through a circuit including back contact 87 of relay 2WP, front contact 88 of relay 2WZ, polar contact 89 of relay 2WZ in a left hand position, and lower winding of relay 2WZ, to (-). If the track switches 2TSA and 2TSB were already in their reverse locked positions when relay 2R was picked up, relay 2LS would be dropped away immediately upon the picking up of relay 2WZ, because relay 2RCR would be picked up to open its stick circuit at back contact 82, and the pick up circuit for relay 2LS would, of course, be open at back contact 49 of relay 2WZ.

To consider how the track switches 2TSA and 2TSB are operated to a normal position in accordance with the picking up of either of relays 2AN or 2BN, assume a route to be selected by the self-selecting network extending from signal 11 to signal 13 at a time when the prior operated position of the track switches 2TSA and 2TSB was in reverse locked positions.

Under such conditions, the picking up of relay 2BN causes the picking up of relay 2WZ by the energization of a circuit closed from (+), through a circuit including back contact 85 of relay 2AN, front contact 86 of relay 2BN, and upper winding of relay 2WZ, to (-). Such energization causes the operation of the polar contacts of relay 2WZ to a right hand position, and the picking of the neutral contacts 81 and 80 to close an obvious circuit for switch machine 2SM energized with the proper polarity to operate the track switches 2TSA and 2TSB to a normal locked position.

Relay 2RCR is dropped away upon the picking up of relay 2BN by the opening of back contact 86, and the dropping away of that relay closes the above described stick circuit for relay 2LS to provide that relay 2LS is maintained picked up until the track switches 2TSA and 2TSB have been operated to their normal locked positions to cause the energization of a circuit heretofore described for relay 2NCR. The picking up of relay 2NCR opens that stick circuit for relay 2LS at

back contact 83 and causes relay 2LS to drop away and close the signal control circuits.

A stick circuit is closed for relay 2WZ to maintain it picked up, irrespective of the self-selecting network relays, until the track switches have completed their operation, from (+), through a circuit including back contact 87 of relay 2WP, front contact 88 of relay 2WZ, polar contact 89 of relay 2WZ in a right hand position, and upper winding of relay 2WZ, to (-).

If the track switches 2TSA and 2TSB are locked in a normal position at a time when either of the normal switch control relays 2AN or 2BN are picked up, relay 2LS is dropped away upon the picking up of relay 2WZ because its circuit is opened by the picking up of relay 2WZ at back contact 49, and a stick circuit is held open at back contact 83 of relay 2NCR.

It is obvious that relay 2AN, when picked up, in setting up a route on the top track including track switch 2TSA in a normal position, effects a similar mode of operation of the system in causing the positioning of the track switch when a circuit is closed at front contact 85 of relay 2AN to cause the energization of relay 2WZ.

Auxiliary switch control. To provide a means by which an operator can cause the operation of any particular track switches without clearing the signals, as is desirable in freeing track switches of obstructions such, for example, as snow and ice, and in order that an operator can have an auxiliary means for setting up routes in case of failure of the self-selecting network, a switch control lever SML is provided for each of the crossovers and single track switches as is typically shown in Fig. 2 for the lever 2SML associated with the crossover having the track switches 2TSA and 2TSB.

The lever 2SML, for example, has been illustrated as having three positions, a center normal position, a right-hand normal operating position, and a left-hand reverse operating position.

The operation of the lever 2SML to a right-hand position at a time when the normal conditions of the system exist as described causes the center winding of relay 2AN to be energized by an obvious circuit including contact 90 of lever 2SML in a right-hand position, and the center winding of relay 2BN is also energized by an obvious circuit including contact 47 of lever 2SML in a right-hand position. The picking up of those relays, due to such energization, causes the energization of relay 2WZ and the positioning of the track switches in the same manner as has been heretofore described.

If the lever 2SML is operated to a left-hand position at a time when the normal conditions of the system exist, an obvious circuit is closed for the energization of the center winding of relay 2R including contact 90 of lever 2SML closed in a left-hand position, and the picking up of relay 2R, due to such energization, causes the positioning of the track switches 2TSA and 2TSB in a manner similar to that heretofore described.

Signal controls.—Inasmuch as the signal control circuits for each interlocked group are provided in a similar manner, the signal controls will be described for the routes heretofore assumed to be set up, as typical of the signal control circuits provided for governing the energization of entering signals for each of the other possible routes included in this embodiment of the present invention.

Thus, assume as a typical example, that a

route has been set up from signal 10 to signal 13 as heretofore described, that the track switches 2TSA and 2TSB have been operated to their reverse locked positions, and the relay 2LS is dropped away to close a circuit for the energization of relay 10G (see Fig. 3A) from (+), through a circuit including front contact 91 of relay 13XR, back contact 92 of relay 2LS, back contact 93 of relay 2NCR, front contact 94 of relay 2RCR, back contact 95 of relay 2NCR, back contact 96 of relay 2LS, back contact 97 of relay 10XR, front contact 98 of relay 10NR, and winding of relay 10G, to (-). The picking up of relay 10G, due to such energization, causes the extinguishing of the red lamp in signal 10 by the opening of back contact 99, and causes the illumination of the green lamp in signal 10 by the closing of front contact 99.

In a similar manner, relay 11G is picked up and signal 11 is cleared when a route is set up from signal 11 to signal 13. When relay 2LS is dropped away, after track switches 2TSA and 2TSB have been operated to their normal position in setting up such a route, a circuit is closed for relay 11G, from (+), through a circuit including front contact 91 of relay 13XR, back contact 92 of relay 2LS, front contact 93 of relay 2NCR, back contact 100 of relay 11XR, front contact 101 of relay 11NR, and winding of relay 11G, to (-). The picking up of relay 11G causes the extinguishing of the red lamp in signal 11 and the illumination of the green lamp by the shifting of contact 102.

Thus, it should be readily apparent to those familiar with the art that similar circuits are provided for each of the signals, each signal control circuit including contacts of each lock repeater relay LS for each track switch included in the route set up for that interlocked group, and contacts of the correspondence repeater relays NCR and RCR positioned for the track switches in that route, the same circuit selections being used for opposing signals.

Route and approach locking.—In order to simplify the present disclosure, the form of route locking shown in the prior patent of Langdon, Patent No. 2,148,865, dated February 28, 1939, has been used, thus providing that reference can be made to that application for the details of the typical means by which the route locking relays ES and WS (shown in this disclosure bearing similar letter reference characters to route locking relays of that application) are controlled. It is to be understood, however, that other forms of route locking can as well be employed, and that approach locking can be provided when required in a manner similar to that shown, for example, in the patent to E. F. Stoltz, Patent No. 2,115,511, dated April 26, 1938.

For the purpose of understanding the present invention, it is believed sufficient to assume the relays ES and WS (see Fig. 2) to be normally energized directional stick route locking relays provided for the various track sections and controlled in such a manner that they are dropped away for the portion of a route set up in advance of each train, and that they are picked up for each section released by a passing train. The dropping away of the route locking relays ES and WS causes the dropping away of the lock relay L associated with that track section. The dropping away of the lock relays L, under such conditions, effects the electric locking of the respective track switches.

Restoration to normal.—The restoration to normal of a signal and the parts of the system associated with setting up a route, is largely dependent upon the relay NR for the entrance point of the route to be restored. Each entrance relay NR has a stick circuit that can be opened either by the manual control of an operator, or by automatic control upon the passage of a train.

To illustrate how each route is restored by manual control, assume a route to be set up as heretofore described from signal 10 to signal 13, and signal 10 to be cleared. To restore signal 10 to stop, and the parts of the system associated with setting up that route to normal, assume that an operator pulls out button 10B (see Fig. 1A) to cause the dropping away of relay 10NR by opening its stick circuit at normally closed contact 56 of button 10B. The dropping away of relay 10NR causes the dropping away of relay 10G (see Fig. 3A) by opening the circuit for that relay at front contact 98 and the dropping away of relay 10G causes the extinguishing of the green lamp in signal 10 by the opening of front contact 99, and causes the illumination of the red lamp in signal 10 by the closing of back contact 99.

When relay 10NR drops away (see Fig. 1A), the circuit for relay 13XR heretofore described when considering the mode of operation of the self-selecting network, is opened at front contact 64 to cause that relay to drop away. Upon the dropping away of relay 13XR, the circuit for the upper winding of relay 2R is opened at front contact 73 to cause that relay to drop away, and thus complete the restoration to normal of the self-selecting network relays associated with the setting up of a route from signal 10 to signal 13.

Upon the restoration of signal 10 to stop, in restoring to normal a route set up from signal 10 to signal 13, the directional stick route locking relays 25ES and 26ES are picked up by the energization of circuits provided as is typically shown in the above mentioned prior Langdon application, Ser. No. 176,466, filed November 26, 1937. When relay 25ES picks up, the normally energized circuit heretofore described for relay 25L is closed at front contact 43 (see Fig. 2), and when relay 26ES is picked up, the normally energized circuit for relay 26L is closed at front contact 40 to cause the picking up of that relay.

The dropping away of relay 2R, under such conditions, opens the circuit for relay 2WZ at front contact 52 to cause that relay to drop away, and after relay 2WZ has dropped away and relays 25L and 26L have been picked up, the lock repeater relay 2LS is picked up by the energization of its normally energized circuit heretofore described.

Thus, in a similar manner, each of the signals, and the relays associated with setting up each of the routes can be restored to normal at the will of an operator.

A very similar mode of operation is employed when automatic restoration is effective upon passage of a train. That is, the stick circuit for the entrance relay NR for the route to be restored is opened by the entering of a train into the route, the dropping away of that entrance relay effects the restoration of the associated signal to stop, and it also causes the restoration of the self-selecting network relays associated with that route set up, to normal. It is provided, however, that the relays AN, BN, N and R included in the route restored upon passage of a

train are delayed in dropping away until that train has left the detector track section associated with the track switch for which that relay is provided. Such mode of operation is provided in order to prevent the preconditioning of the self-selecting network in a manner and for purposes hereinafter set forth.

To consider a typical example of how each signal is automatically restored to stop, and the relays associated with each route, upon the passage of a train, assume a route to have been set up as heretofore described extending from signal 10 to signal 13, and assume an approaching train to enter track section 25 after accepting signal 10. The dropping away of relay 25T opens the circuit for relay 10NR (see Fig. 1A) at front contact 59, prior to the closing of back contact 60 of relay 25TP, to provide that relay 10NR is dropped away. The dropping away of relay 10NR opens the circuit for relay 13XR at front contact 64, and the dropping away of relay 13XR opens the circuit for the upper winding of relay 2R at front contact 73. The center winding for relay 2R is, however, maintained energized, because relay 25L is dropped away, due to the opening of front contact 44 of relay 25T (see Fig. 2), from (+), through a circuit including back contact 103 of relay 25L, front contact 104 of relay 2R, back contact 105 of relay 2AN, center winding of relay 2R, and back contact 106 of relay 2BN, to (-).

Relay 26L is in a dropped away position because of the opening of front contact 40 of the route locking relay 26ES, thus, stick energy is also provided for the center winding of relay 2R by a circuit closed from (+), through a circuit including back contact 107 of relay 26L, front contact 108 of relay 2R, back contact 105 of relay 2AN, center winding of relay 2R, and back contact 106 of relay 2BN, to (-).

When the passing train leaves track section 25, the picking up of relays 25T and 25ES causes the picking up of relay 25L by closing the circuit for that relay at contacts 44 and 43 respectively, and the picking up of relay 25L opens one of the above described stick circuits for relay 2R at back contact 103, the other stick circuit heretofore described for relay 2R is, however, maintained energized until the passing train leaves track section 26 to cause the picking up of relay 26L when its circuit is closed at front contacts 41 and 40 of relays 26T and 26ES respectively. After relay 26L is picked up, the other stick circuit for relay 2R is opened at back contact 107 to provide that relay 2R is restored to normal.

The stick circuits thus described for relay 2R, are typical of the stick circuits provided for each of the other self-selecting network switch control relays AN, BN, N and R, the stick circuits for the normal switch control relays being associated with only the lock relay associated with that track switch. That is, relay 2BN can be maintained by a stick circuit closed by relay 26L, associated with the lower track, and relay 2AN can be maintained by a stick circuit closed by relay 25L associated with the upper track.

The relays AN, BN, N and R are restored to normal after their stick circuits are opened, because their pick up circuits are opened by the dropping away of the entrance relay NR for that route in the same manner as has been heretofore described in considering how those relays are restored to normal under the manual control of an operator.

Prevention of preconditioning of routes.—Inasmuch as it is considered undesirable to allow the

self-selecting network to be conditioned for routes before they are available, the system provided in accordance with the present invention has been arranged to prevent such preconditioning. A reason why the preconditioning of routes is not desirable is that, if it were allowed, the momentary loss of shunt, due, for example, to rusty rails, could cause the positioning of track switches at a time when such positioning is unsafe and undesirable.

The delay in the dropping away of the relays AN, BN, N and R in the self-selecting network by the stick circuits dependent upon the route locking, provides the means by which the preconditioning of the network is prevented. That is, the self-selecting network relays for positioning the track switches are maintained picked up for that section of each route for which the route locking is effective, and the opening of the normally closed contacts in the initiating network, due to those relays being picked up, prevents the energization of any exit relay for setting up a route conflicting with any route already set up.

To consider an example of such mode of operation, assume relay 2R (see Fig. 1A) to be maintained picked up by the route locking, due to the presence of a train in track section 25 or 26. Also, assume that, at that time, an operator attempts to set up a route from signal 11 to signal 13. The depression of button 11B for the entrance point at signal 11 causes the picking up of relay 11NR, but the depression of button 13B for the exit point is ineffective for causing the picking up of relay 13XR because the circuit for that relay is opened at back contact 77 of relay 2R. The entrance relay 11NR must be restored by the pulling out of button 11B in order to cause the dropping away of relay NPU to allow the picking up of another entrance relay in setting up the next route.

To prevent the preconditioning of the system, other than allowing the picking up of an entrance relay, which in itself is not objectionable, when buttons are depressed for an impossible route, such, for example, as from signal 10 to signal 11, it is provided that the self-selecting network automatically cuts off the control of the exit relay for that impossible route, and causes restoration to normal of all of the relays except the relay for the entrance point, which must be restored by an operator in the usual manner before another entrance relay can be picked up for setting up the next proposed route.

To consider an example of such a mode of operation, assume an operator to depress button 10B and cause the picking up of relay 10NR at a time when the heretofore described normal conditions of the system exist. Also, assume an operator to depress the button 11B, following the picking up of relay 10NR, under such conditions. The depression of button 11B causes the picking up of relay 11XR by the energization of a circuit closed from (+), through a circuit including front contact 64 of relay 10NR, back contact 65 of relay 2AN, back contact 66 of relay 2BN, back contact 77 of relay 2R, back contact 76 of relay 11NR, winding of relay 11XR, and contact 110 of button 11B closed in a depressed position, to (-).

The picking up of relay 11XR, under such conditions, causes the picking up of relay 2BN, when a circuit is closed for the energization of that relay from (+), through a circuit including front contact 111 of relay 11XR, back contact 112 of relay 2R, and lower winding of relay 2BN, to (-). When relay 2BN is picked up, the above described

circuit for relay 11XR is opened at back contact 66, to cause that relay to drop away.

Thus, it is provided, that, upon restoration of the button for the exit point to normal, when an impossible or an unavailable route has been defined, the exit relay associated with that exit point is dropped away, as, for example, relay 11XR is dropped away upon the picking up of relay 2BN, and the dropping away of that exit relay opens the circuit for the completion network relays picked up at that time, dependent upon that exit relay as, in the example considered, when the dropping away of relay 11XR opens the circuit for relay 2BN, at front contact 111 to cause relay 2BN to drop away.

In addition to the above described means provided for the prevention of the preconditioning of routes, it is further provided, by the slow action in the lock repeater relay LS (see Fig. 2), that all switch control relays for each track switch must be dropped away for an interval of time before the picking up of a switch control relay can be effective for causing the positioning of the track switch with which it is associated. Thus, if the picking up of a switch control relay is preconditioned as, for example, by the positioning of the auxiliary switch control lever SML for that track switch at a time when the switch control relay for the opposite position of the track switch is picked up, that relay is picked up as soon as the relay energized for the opposite position of that track switch is dropped away, before the relay LS for that track switch has had time to pick up. Such mode of operation provides that the lock relay LS does not have a chance to be picked up to render effective the positioning of the track switch. Under such conditions the lever SML must be restored to normal to allow the picking up of relay LS before it can be effective for causing the positioning of the associated track switch. The control of a track switch to provide the above described mode of operation is conveniently called "lever lock equivalent."

To consider a typical example of such a condition, assume relay 2R to be maintained picked up by the dropped away position of relay 25L and/or relay 26L. Also, assume an operator to operate lever 2SML to a right-hand position. Upon the picking up of the lock relays L, relay 2R is dropped away by the opening of its circuit at back contacts 103 and 107 of relays 25L and 26L respectively, and the dropping away of that relay effects the dropping away of relay 2WZ by opening the circuit for that relay at front contact 52. The dropping away of relay 2R also closes an obvious circuit for the picking up of relays 2AN and 2BN, which, in turn, cause the picking up of relay 2WZ by closing the circuit for that relay at front contact 85 of relay 2AN. Due to the slow acting characteristics of relay 2LS, that relay does not have time to pick up during the short interval of time in which its pick up circuit is closed at back contact 49 of relay 2WZ. Thus, it is provided that the relay WZ must be dropped away for an interval of time greater than that required for the shifting from one switch control relay to the other, when the dropping away of the first switch control relay closes a circuit for the energization of the switch control relay for the opposite position of the track switch.

End-to-end control.—To consider the general mode of operation of the system in setting up a route by end-to-end control, the principles of

which are applicable to practically any condition encountered in practice, assume an operator to set up a route by end-to-end control, for example, from signal 10 to signal 20, at a time when the normal conditions of the system exist as illustrated.

The picking up of relay 10NR (see Fig. 1A), due to the depression of button 10B, applies energy to the initiating network for the control of the entrance repeater relays NP.

In accordance with the principles of the end-to-end system for control, an entrance repeater relay NP is energized for each intermediate entrance point included in each available possible route emanating from the designated entrance point. Thus, the entrance repeater relays 14NP and 15NP (see Fig. 1B) are picked up because they are associated with possible entrance points in routes emanating from signal 10, and the picking up of those entrance repeater relays feeds energy through the initiating network to the entrance repeater relays 18NP and 19NP (see Fig. 1D) for the next interlocked group. In a similar manner, the picking up of entrance repeater relays NP is effected in a cascade manner from the entrance relay associated with the designated entrance point through each possible route for any particular track layout encountered in practice, irrespective of the number of interlocked groups included in the system, and irrespective of the number of possible routes emanating from the designated entrance point.

The picking up of the entrance repeater relays NP applies energy to the initiating network for the control of the exit relays XR for the particular interlocked group with which those relays are associated in a very similar manner to that by which the entrance relays NR apply energy to that initiating network for the control of the exit relays XR.

When an operator depresses button 20B (see Fig. 1D), after the entrance repeater relays NP have been picked up, relay 20XR is picked up, because energy is supplied to that relay through the initiating network from entrance repeater relay 18NP. When relay 20XR is picked up, the picking up of the switch control relay 7AN in the completion network is effected as if a route was being set up within the interlocked group from signal 18 to signal 20, and the picking up of relay 7AN closes a circuit to cause the picking up of the entrance relay 18NR for the entrance point at signal 18.

Upon the picking up of relay 18NR, a circuit is closed for the energization of relay 16XR (see Fig. 1C), because that relay receives energy through the initiating network from entrance repeater relay 14NP as well as from entrance repeater relay 15NP. After relay 16XR has had time to pick up, relay 18NP is dropped away, and the portion of the through route being set up from signal 18 to signal 20 is established and the self-selecting network maintained in a manner similar to that when a route is set up between those entrance and exit points by the actuation of the buttons 18B and 20B respectively.

Upon the picking up of relay 16XR, relay 6AN is picked up (see Fig. 1F), and the picking up of that relay effects the picking up of relay 5AN. When relay 5AN is picked up, relay 4N is energized, and the picking up of that relay causes the energization of relay 3AN.

After relay 3AN has been picked up, the circuit is closed for the energization of relay 14NR (see Fig. 1C), and the picking up of that relay,

in combination with the picked up position of relay 14NP, causes the picking up of relay 12XR (see Fig. 1A), which also is dependent for energization upon energy supplied through the initiating network from entrance relay 10NR.

After relay 12XR has had time to pick up, the entrance repeater relay 14NP is dropped away, to cause the self-selecting network for the portion of the route from signal 14 to signal 16 to assume the same conditions as would be assumed if a route between those entrance and exit points was set up within that interlocked group by the actuation of buttons 14B and 16B respectively.

The picking up of relay 12XR (see Fig. 1A) causes the picking up of relay 2AN, the picking up of which completes the selection of the through route extending from signal 10 to signal 20.

The control of the entrance repeater relays NP is so selected that the relays provided for entrance points included in the route which is actually set up are dropped away when the entrance relays for the intermediate points are picked up in building back in the circuits toward the entrance relay for the entrance point designated, and the relays NP for the intermediate points not included in the route which is actually set up are dropped away by the opening of the circuits for those relays at points of conflict in the initiating network with the route set up.

To consider the details of the circuits by which the above described general mode of operation of the system is provided in setting up a route by end-to-end control from signal 10 to signal 20, assume an operator to depress button 10B (see Fig. 1A), and cause the picking up of relay 10NR by the energization of the circuit heretofore described, and the picking up of that relay 10NR to close a stick circuit for that relay.

Upon the picking up of relay 10NR a circuit is closed for the energization of relay 14NP (see Fig. 1B), from (+), through a circuit including front contact 382 of relay 10NR (see Fig. 1A), back contact 113 of relay 2AN, back contact 114 of relay 2R, wire 115, back contact 116 of relay 14XR, back contact 117 of relay 14NR, and winding of relay 14NP, to (-). A circuit is also closed at the same time for relay 15NP, from (+), through a circuit including front contact 382 of relay 10NR (see Fig. 1A), back contact 113 of relay 2AN, back contact 114 of relay 2R, rectifier 118, back contact 119 of relay 2BN, wire 120, back contact 121 of relay 15XR, back contact 122 of relay 15NR, and winding of relay 15NP, to (-).

Upon the picking up of relay 14NP, a circuit is closed for relay 18NP (see Fig. 1D), from (+), through a circuit including front contact 123 of relay 14NP (see Fig. 1B), back contact 124 of relay 3AN, back contact 125 of relay 3R, rectifier 126, back contact 127 of relay 4N, back contact 128 of relay 4R, wire 129, back contact 130 of relay 5AN, back contact 131 of relay 5R, back contact 132 of relay 6AN, back contact 133 of relay 6R, wire 134, back contact 135 of relay 18XR, back contact 136 of relay 18NR, and winding of relay 18NP, to (-).

The picking up of relay 15NP causes the picking up of relay 19NP (see Fig. 1D) by the energization of a circuit closed from (+), through a circuit including front contact 137 of relay 15NP (see Fig. 1B), back contact 138 of relay 3R, back contact 139 of relay 3BN, wire 140, back contact 141 of relay 5R, back contact 142 of relay 5BN, back contact 143 of relay 6R, back contact 144 of relay 6BN, wire 145, back contact 146 of relay

19XR, back contact 147 of relay 19NR, and winding of relay 19NP, to (-).

Upon depression of the exit button 20B (see Fig. 1D), relay 20XR is picked up by the energization of a circuit closed from (+), through a circuit including resistance 148, front contact 149 of relay 18NP, back contact 150 of relay 7R, back contact 151 of relay 20NR, winding of relay 20XR, and contact 152 of button 20B, closed in a depressed position, to (-). A stick circuit is closed upon the picking up of that relay at front contact 153 to shunt contact 152 of button 20B out of the circuit just described.

The picking up of relay 20XR causes the picking up of relay 7AN by closing an obvious circuit for the upper winding of that relay at front contact 153, and the picking up of relay 7AN causes the picking up of relay 18NR by the energization of a circuit closed from (+), through a circuit including front contact 156 of relay 30T, normally closed contact 154 of button 18B, back contact 155 of relay 18XR, lower winding of relay 18NR, front contact 157 of relay 18NP, front contact 158 of relay 7AN, back contact 150 of relay 7R, back contact 151 of relay 20NR, winding of relay 20XR, and front contact 153 of relay 20XR, to (-).

Upon the picking up of relay 18NR, a stick circuit is closed for maintaining that relay and relay 20XR energized, dependent upon passage of a train, from (+), through a circuit including front contact 156 of relay 30T, normally closed contact 154 of relay 18B, back contact 155 of relay 18XR, lower winding of relay 18NR, front contact 159 of relay 18NR, back contact 150 of relay 7R, back contact 151 of relay 20NR, winding of relay 20XR, and front contact 153 of relay 20XR, to (-).

Upon the picking up of relay 18NR, the circuit for relay 18NP is opened at back contact 136 to cause that relay to drop away, but, due to the slow drop away characteristics of relay 18NP, a circuit is closed for the energization of relay 16XR (see Fig. 1C), long enough to allow that relay to pick up and close a stick circuit prior to the dropping away of relay 18NP, from (+), through a circuit including resistance 160 (see Fig. 1B), front contact 161 of relay 14NP, back contact 162 of relay 3R, back contact 163 of relay 4R, wire 164, back contact 165 of relay 5R, back contact 166 of relay 6R, back contact 167 of relay 16NP, back contact 168 of relay 16NR, winding of relay 16XR, wire 169, front contact 170 of relay 18NR, and front contact 171 of relay 18NP, to (-). Stick energy is applied to that circuit at front contact 172 of relay 16XR to maintain that relay picked up after relay 18NP has dropped away.

Upon the picking up of relay 16XR, relay 6AN (see Fig. 1F) is picked up by the energization of a circuit closed from (+), through a circuit including upper winding of relay 6AN, back contact 173 of relay 6R, and front contact 174 of relay 16XR, to (-). After relay 6AN is picked up, a circuit is closed for the energization of relay 5AN from (+), through a circuit including front contact 175 of relay 14NP (see Fig. 1E), wire 176, upper winding of relay 5AN, back contact 177 of relay 5R, front contact 178 of relay 6AN, and back contact 174 of relay 16XR, to (-). Front contact 350 of relay 14NR (see Fig. 1E) is connected in multiple with front contact 175 of relay 14NP to maintain the circuit for relay 6AN closed after relay 14NP is dropped away. A circuit is also closed at the same time for the en-

energization of relay 5R from (+), through a circuit including back contact 179 of relay 5AN (see Fig. 1F), upper winding of relay 5R, back contact 180 of relay 5BN, front contact 178 of relay 6AN, and front contact 174 of relay 16XR, to (-). Due to the slow acting characteristics of relay 5R, as compared to relay 5AN, relay 5AN picks up and opens the circuit just described for relay 5R at back contact 179, to provide that the normal position for the track switches associated with crossover 5ts is selected.

Upon the picking up of relay 5AN, a circuit is closed for the energization of relay 4N (see Fig. 1E), from (+), through a circuit including front contact 181 of relay 14NP, back contact 353 of relay 3R, upper winding of relay 4N, back contact 182 of relay 4R, wire 183, front contact 184 of relay 5AN, front contact 178 of relay 6AN, and front contact 174 of relay 16XR, to (-). Front contact 351 of relay 14NR (see Fig. 1E) is connected in multiple with front contact 181 of relay 14NP to maintain the circuit for relay 4N closed after relay 14NP is dropped away.

The inclusion of back contact 353 of relay 3R in the circuit for relay 4N provides that relay 4N cannot be picked up in setting up a route from signal 22 to signal 18 when relay 14NR is picked up for a parallel route set up, such, for example, as for a route set up from signal 14 to signal 19.

Upon the picking up of relay 4N, a circuit is closed for the energization of relay 3AN, from (+), through a circuit including upper winding of relay 3AN, back contact 185 of relay 3R, front contact 186 of relay 4N, wire 183, front contact 184 of relay 5AN, front contact 178 of relay 6AN, and front contact 174 of relay 16XR, to (-).

After the last of the switch control relays (relay 3AN) has been picked up for that particular interlocked group, the entrance relay 14NR (see Fig. 1B) is picked up by the energization of a circuit closed from (+), through a circuit including front contact 188 of relay 27T, normally closed contact 187 of button 14B, back contact 46 of relay 14XR, lower winding of relay 14NR, front contact 189 of relay 14NP, front contact 190 of relay 3AN, back contact 162 of relay 3R, back contact 163 of relay 4R, wire 164, back contact 165 of relay 5R, back contact 166 of relay 6R, back contact 167 of relay 16NP, back contact 168 of relay 16NR, winding of relay 16XR, and front contact 172 of relay 16XR, to (-). The picking up of relay 14NR, due to such energization, closes a stick circuit for that relay and for relay 16XR, from (+), through a circuit including front contact 188 of relay 27T, contact 187 of button 14B closed in a normal position, back contact 46 of relay 14XR, lower winding of relay 14NR, front contact 191 of relay 14NR, back contact 162 of relay 3R, back contact 163 of relay 4R, wire 164, back contact 165 of relay 5R, back contact 166 of relay 6R, back contact 167 of relay 16NP, back contact 168 of relay 16NR, winding of relay 16XR, and front contact 172 of relay 16XR, to (-).

The picking up of relay 14NR causes the dropping away of relay 14NP, but prior to the dropping away of that relay, relay 12XR (see Fig. 1A) is picked up by the energization of a circuit closed from (+), through a circuit including front contact 64 of relay 10NR, back contact 192 of relay 2R, back contact 193 of relay 12NP, back contact 194 of relay 12NR, winding of relay 12XR, wire 195, front contact 196 of relay 14NR, and front contact 197 of relay 14NP, to (-). The picking up of relay 12XR closes a

stick circuit for that relay at front contact 198 to maintain that relay picked up after relay 14NP has dropped away.

Relay 2AN is picked up, upon the picking up of relay 12XR, when a circuit is closed for that relay from (+), through a circuit including winding of relay 2AN, back contact 199 of relay 2R, and front contact 200 of relay 12XR, to (-).

Responsive to the picking up of relays 2AN, 3AN, 4N, 5AN, 6AN and 7AN, the respective track switches associated with those relays are operated to a normal locked position, and signals 10, 14 and 18 are cleared by the energization of circuits similar to the signal control circuit heretofore described as typical.

The picking up of relay 2AN causes the dropping away of relay 15NP by opening the circuit for that relay at back contact 113, and the dropping away of relay 15NP opens the circuit for relay 19NP at front contact 137 to cause that relay to drop away.

Assuming the track switches to require comparatively the same time for operation, signal 10 will be the last signal to clear in setting up the route, and the clearing of that signal causes the dropping away of the entrance pick up bus relay NPU by opening the circuit for that relay at back contact 61 of relay 10G (see Fig. 1A). If, however, there is a difference in the operating time of the track switches, the entrance pick up bus relay NPU is maintained energized until the last of the signals included in the composite route being set up is cleared, irrespective of whether or not that is an intermediate or an entering signal.

It is believed to be expedient at this time to point out the reason for some of the circuit selections included in the circuits for providing end-to-end control. It will be noted that the initiating network for controlling the relays NP includes, so to speak, positive as well as inverse selections. That is, it includes back contacts of switch control relays that must be picked up in the portion of the route between a designated entrance point and the entrance point associated with the relay NP to be energized, and it includes back contacts of switch control relays for conflicting positions of track switches included in that portion of the route. Thus, for example, the circuit for relay 14NP includes back contact 113 of relay 2AN (see Fig. 1A) as a positive selection to provide that relay 14NP cannot be picked up if a route is set up between signal 10 and signal 12, or if a train is in that section; and the circuit for relay 14NP also includes back contact 114 of relay 2R, as an inverse selection to provide that relay 14NP cannot be picked up if the proposed route conflicts with a route already set up.

It will be noted that, in the shifting of the means for supplying energy for the exit relay from the relay NP to the relay NR, the exit relay remains continuously energized. That is, for example, energy is supplied, in setting up the above described route, for relay 20XR (see Fig. 1D) at front contact 149 of relay 18NP until relay 18NR is picked up to supply stick energy for relay 20XR through the winding of relay 18NR and front contact 159. The resistance 148 connected to front contact 149 of relay 18NP is merely for the purpose of maintaining constant the operating current values for the exit relays energized through that portion of the initiating network.

In passing energy through to the exit relay for

an intermediate interlocked group when setting up a route by end-to-end control, it is necessary that the entrance relay NR and the entrance repeater relay NP be picked up for the intermediate entrance point in the adjacent interlocked group, before that exit relay can be picked up; for example, relays 18NR and 18NP must be picked up to close contacts 170 and 171 respectively before relay 16XR can be picked up in setting up a route by end-to-end control from signal 10 to signal 20. This particular selection of the circuits provides that a route initiated by the defining of an entrance point only, cannot be completely set up by energy feeding through the network from the relays for another interlocked group energized for a route set up, or energized on account of the route locking being effective due to the presence of a train in that interlocked group.

Thus, for example, if a route is set up from signal 18 to signal 20 and an operator actuates button 10B for designating an entrance point for a proposed route, relay 16XR (see Fig. 1C) can be energized only by the depression of button 16B, because the circuit by which that relay is automatically picked up in setting up a route past that point by end-to-end control, is open at front contact 171 of relay 18NP (see Fig. 1D). Relay 18NP is not picked up under such conditions because the circuit for that relay is open at back contact 136 of relay 18NR, if an approaching train had passed signal 18 when a route was set up for that train from signal 18 to signal 20, and when relay 10NR is picked up, relay 18NP would pick up, but relay 18NR would be dropped away to hold the circuit open for relay 16XR at front contact 170.

Upon consideration of the general mode of operation of the end-to-end system of control, it will be readily apparent that the system can be extended through as many interlocked groups as desired, and that it is possible to set up a route by end-to-end control between intermediate points as well as between the extreme ends of the interlocking plant. That is, for example, an operator can set up a route by end-to-end control from signal 14 to signal 20 by actuation of contact buttons 14B and 20B successively.

The depression of button 14B, under such conditions, causes the picking up of relay 14NR (see Fig. 1B) by the energization of a circuit closed from (+), through a circuit including back contact 55 of relay NPU, entrance relay pick up bus PU, contact 201 of button 14B closed in a depressed position, back contact 202 of relay 14XR, and upper winding of relay 14NR, to (-). The picking up of relay 14NR closes a stick circuit for that relay from (+), through a circuit including front contact 183 of relay 27T, contact 187 of button 14B closed in a depressed and a normal position, back contact 46 of relay 14XR, front contact 203 of relay 14NR, and upper winding of relay 14NR, to (-). Back contact 204 of relay 27T is included in that stick circuit in multiple with front contact 188 of relay 27T to allow the setting up of a route for a following train when the preceding train occupies track section 27.

The picking up of relay 14NR closes a circuit for relay 18NP from (+), through a circuit including front contact 323 of relay 14NR, back contact 123 of relay 14NP, and the same circuit as heretofore described for relay 18NP, to (-). Upon depression of button 20B, following the picking up of relay 18NP, the route is set up

from signal 18 to signal 20 and relay 18NR picked up in the same manner as has been heretofore described. The picking up of relay 18NR causes the picking up of relay 16XR by the energization of a circuit closed from (+), through a circuit including front contact 183 of relay 27T, contact 187 of button 14B closed in a normal position, back contact 46 of relay 14XR, lower winding of relay 14NR, front contact 191 of relay 14NR, back contact 162 of relay 3R, back contact 163 of relay 4R, wire 164, back contact 165 of relay 5R, back contact 166 of relay 6R, back contact 167 of relay 16NP, back contact 168 of relay 16NR, winding of relay 16XR, wire 169, front contact 170 of relay 18XR, and front contact 171 of relay 18NP, to (-). When relay 16XR is picked up, relays 6AN, 5AN, 4N and 3AN are successively picked up by the energization of the same circuits heretofore described, and the completion of the operation of the switch machine in accordance with the positions required for the route to be set up causes the clearing of signal 14 and signal 18.

Optional route selection.—In accordance with the main embodiment of the present invention it is provided that, in selecting a particular one of several optional routes as being preferred, the route available diverging nearest the entrance point is set up in preference to optional routes. In the modified form shown in Figs. 5A and 5B, however, a means is disclosed whereby any particular route can be given preference over optional routes, irrespective of whether or not that route diverges nearest either the entrance or exit point in the route being set up.

To consider the general mode of operation by which the route diverging nearest the entrance point is always given preference to optional routes, assume an operator to designate entrance and exit points at signals 10 and 21 respectively by the depression of buttons 10B and 21B successively at a time when the normal conditions of the system exist as shown and described.

The depression of button 10B causes the picking up of relay 10NR, and the picking up of that relay causes the picking up of the entrance repeater relay NP for each intermediate entrance point included in each available route emanating from signal 10. Thus, relays 14NP, 15NP, 18NP and 19NP are picked up.

The depression of button 21B for designating the exit point in the route being set up causes the energization of relay 21XR (see Fig. 1D) due to energy fed through the initiating network to that relay from entrance repeater relays 18NP and 19NP, both relays supplying energy to the initiating network in multiple. Upon the picking up of relay 12XR, relays 7R and 7BN are momentarily both energized, but relay 7BN gains preference over relay 7R by picking up and opening the circuit for relay 7R, due to relay 7R being comparatively slow in picking up. Thus, of the two optional routes available having signal 21 as an exit point, either from signal 18 to signal 21 or from signal 19 to signal 21, the route requiring the track switches of the crossover 7ts to be normal is selected in preference to the route requiring those track switches to be in their reverse positions.

The picking up of relay 7BN effects successively the picking up of relays 19NR and 17XR and the dropping away of relay 19NP in accordance with the system for end-to-end control.

Upon the picking up of relay 17XR, relays 6BN and 6R are both momentarily energized.

because of available routes between the entrance and exit points designated over the track switches of the crossover 6ts in either normal or reverse positions. Relay 6BN gains preference over relay 6R and picks up because of a difference in the operating characteristics of the two relays, and the picking up of that relay feeds energy through the completion network to relay 5BN and causes that relay to be picked up. Upon the picking up of relay 5BN, relays 3BN and 3R become both momentarily energized, but relay 3BN gains preference over relay 3R and is picked up because it is predetermined by the operating characteristics of the two relays that whenever a route is available over the track switches which they govern in both normal and reverse positions, the route is set up via the route including the track switches in normal positions.

The picking up of relay 3BN effects successively the picking up of relays 15NR and 13XR and the dropping away of relay 15NP. The picking up of relay 13XR causes the picking up of relay 2R in preference to relay 2BN, because relay 2BN is dependent for energization upon the picking up of relay 11NR, which, under the assumed conditions, is in a dropped away position. Thus, the switch control relays are picked up for setting up the complete route from signal 10 to signal 21 via crossover 2ts.

To consider the description of the circuits by which such mode of operation is effected, assume relay 10NR to be picked up, due to the depression of button 10B for the defining of the entrance point for the route being set up, and the picking up of that relay to cause the energization of relays 14NP, 15NP, 18NP and 19NP by the closing of the same circuits heretofore described in considering the mode of operation of the system for end-to-end control.

Upon depression of the exit button 21B, the circuit is closed for relay 21XR (see Fig. 1D), from (+), through a circuit including resistance 221, front contact 222 of relay 19NP, back contact 219 of relay 7R, back contact 206 of relay 21NR, winding of relay 21XR and back contact 207 of button 21B closed in a depressed position, to (-). Upon the picking up of relay 21XR a stick circuit is closed for that relay at front contact 208 connected in multiple with contact 207 of button 21B. When relay 21XR is picked up, a circuit is closed for the energization of relay 7BN, from (+), through a circuit including front contact 209 of relay 19NP, back contact 210 of relay 7R, upper winding of relay 7BN and front contact 211 of relay 21XR, to (-). At the same time a circuit is closed for relay 7R, from (+), through a circuit including back contact 212 of relay 7AN, upper winding of relay 7R, back contact 213 of relay 7BN, and front contact 211 of relay 21XR, to (-). Relay 7BN picks up before relay 7R has had time to pick up and opens the circuit for relay 7R at back contact 213.

Upon the picking up of relay 7BN, relay 19NR is picked up by the energization of a circuit closed from (+), through a circuit including front contact 216 of relay 31T, contact 214 of button 19B closed in a normal position, back contact 215 of relay 19XR, lower winding of relay 19NR, front contact 217 of relay 19NP, front contact 205 of relay 7BN, back contact 206 of relay 21NR, winding of relay 21XR and front contact 208 of relay 21XR, to (-). The picking up of relay 19NR closes a stick circuit for the relay from (+), through a circuit including front contact 216 of relay 31T, contact 214 of button 19B closed in a

normal position, back contact 215 of relay 19XR, lower winding of relay 19NR, front contact 218 of relay 19NR, back contact 219 of relay 7R, back contact 206 of relay 21NR, winding of relay 21XR, and front contact 208 of relay 21XR, to (-).

The picking up of relay 19NR opens the circuit for relay 19NP at back contact 147, and also closes the circuit for relay 7BN at front contact 220 to cause that circuit to remain energized after the dropping away of relay 19NP and the opening of front contact 209.

Relay 17XR (see Fig. 1C) is picked up prior to the dropping away of relay 19NP by the energization of a circuit closed for that relay from (+), through a circuit including resistance 223 (see Fig. 1B), front contact 224 of relay 15NP, back contact 225 of relay 3R, wire 226, back contact 227 of relay 5R, back contact 228 of relay 6R, back contact 229 of relay 17NP, back contact 230 of relay 17NR, winding of relay 17XR, wire 231, front contact 232 of relay 19NR, and front contact 233 of relay 19NP, to (-). A stick circuit is closed for relay 17XR at front contact 234 for maintaining that relay energized after relay 19NP has dropped away.

Upon the picking up of relay 17XR, a circuit is closed for relay 6BN (see Fig. 1F), from (+), through a circuit including front contact 235 of relay 15NP, wire 236, back contact 237 of relay 6R, upper winding of relay 6BN, and back contact 238 of relay 17XR, to (-). At the same time a circuit is closed for relay 6R, from (+), through a circuit including back contact 239 of relay 6AN, upper winding of relay 6R, back contact 240 of relay 6BN, and front contact 238 of relay 17XR, to (-). The picking up of relay 6BN opens the circuit for relay 6R before that relay has time to pick up at back contact 240. Relay 6BN is maintained picked up after relay 15NP is dropped away by energy applied at front contact 352 of relay 15NR.

A circuit is closed for relay 5BN upon the picking up of relay 6BN, from (+), through a circuit including back contact 241 of relay 5R, upper winding of relay 5BN, front contact 242 of relay 6BN, and front contact 238 of relay 17XR, to (-). When relay 5BN is picked up, a circuit is closed for the energization of relay 3BN from (+), through a circuit including front contact 243 of relay 15NP, back contact 244 of relay 3R, upper winding of relay 3BN, wire 245, back contact 246 of relay 5R, front contact 247 of relay 5BN, and front contact 238 of relay 17XR, to (-). At the same time a circuit is closed for the energization of relay 3R from (+), through a circuit including back contact 354 of relay 3AN, upper winding of relay 3R, back contact 355 of relay 3BN, wire 245, back contact 246 of relay 5R, front contact 247 of relay 5BN, and front contact 238 of relay 17XR, to (-). Relay 3BN picks up in preference to relay 3R because of the difference in the operating characteristics of the two relays.

The picking up of relay 3BN causes the picking up of relay 15NR and 13XR and the dropping away of relay 15NP by energization of circuits similar to those heretofore described in considering a similar mode of operation for picking up similar relays for an intermediate point in a route being set up by end-to-end control. When relay 13XR is picked up, the circuit heretofore described is closed for relay 2R to cause that relay to be picked up because the circuit for relay 2BN is held open at front contact 78 of relay 11NR. After the track switches are positioned in ac-

cordance with the switch control relays thus picked up, signals 10, 15 and 19 are cleared for the through route from signal 10 to signal 21 via crossover 2ts.

If a route is not available from signal 10 to signal 21 via crossover 2ts, due, for example, to a route set up from signal 13 to signal 11, or any other condition which will cause relay 2BN to be picked up, the next available route will be set up from signal 10 to signal 21 which, for the purpose of illustration, is assumed to be via crossover 3ts. This condition is established because the entrance repeater relay 15NP cannot be picked up if relay 2BN is picked up to open its circuit at back contact 119.

Upon the picking up of the entrance relay 10NR in setting up that route, entrance repeater relays 14NP, 18NP and 19NP are picked up by the energization of the same circuits heretofore described, except the circuit for relay 19NP which is energized from (+), through a circuit including front contact 123 of relay 14NP, back contact 124 of relay 3AN, back contact 125 of relay 3R, rectifier 248, and a portion of the same circuit heretofore described for the energization of relay 19NP, to (-).

The depression of the exit button 21XR causes the picking up of relay 21XR by the energization of the same circuit heretofore described, the picking up of that relay causes the picking up of relay 7BN, and the picking up of relay 7BN causes the successive picking up of relay 19NR and 17XR and the dropping away of relay 19NP, all in the same manner as heretofore described. The picking up of relay 17XR causes the picking up of relay 6BN by the energization of a circuit closed from (+), through a circuit including front contact 356 of relay 14NP, back contact 357 of relay 3AN, back contact 358 of relay 3BN, wire 236, back contact 237 of relay 6R, upper winding of relay 6BN, and front contact 238 of relay 17XR, to (-). Front contact 359 of relay 14NR supplies energy to that circuit when it is picked up after the normal and reverse switch control relays for that interlocked group have all been picked up. Relay 6R is energized at the same time by a circuit heretofore described, but the relative quick action of relay 6BN prevents the picking up of that relay. Relay 5BN is picked up after its circuit is closed by the picking up of relay 6BN at front contact 242. Upon the picking up of relay 5BN, the above described circuit for relay 3R is closed at front contact 247, but the circuit for relay 3BN is held open at front contact 243 of relay 15NP; thus, relay 3R is picked up, and the picking up of that relay causes the picking up of relay 14NR by the energization of a circuit closed from (+), through a circuit including front contact 188 of relay 27T, normally closed contact 187 of button 14B, back contact 46 of relay 14XR, lower winding of relay 14NR, front contact 189 of relay 14NP, front contact 162 of relay 3R, back contact 190 of relay 3AN, back contact 363 of relay 3BN, wire 226, back contact 227 of relay 5R, back contact 228 of relay 6R, back contact 229 of relay 17NP, back contact 230 of relay 17NR, winding of relay 17XR, and front contact 234 of relay 17XR, to (-). The picking up of relay 14NR closes a stick circuit for that relay at front contact 191 for shunting contact 189 of relay 14NP out of the circuit just described. The picking up of relay 14NR effects the picking up of relay 12XR and the dropping away of relay 14NP, all in a manner similar to that heretofore described. The pick-

ing up of relay 12XR causes the picking up of relay 2AN to complete the selection of the route from signal 10 to signal 21 via crossover 3ts.

If a route is available from signal 10 to signal 21 via crossovers 6ts and 7ts only, because, for example, of a route set up from signal 13 to signal 11, and because of the presence of a train approaching signal 13 in track section 28, the available route diverging nearest the entrance point is set up which is via crossover 6ts.

Such a route is set up because the entrance repeater relay 15NP cannot be energized on account of its circuit being open at back contact 119 of relay 2BN, and because relay 6BN cannot be energized, due to its circuit being opened at front contact 235 of relay 15NP (see Fig. 1E) and at back contact 358 of relay 3BN. Relay 3BN is maintained picked up because of the presence of the train in track section 28 which causes the closing of the stick circuit for the center winding of that relay.

In setting up a route, under such conditions, the relays are picked up by the energization of the same circuits as heretofore described for setting up a route between the same entrance and exit points via the crossover 3ts, up to the point when the switch control relays for crossovers 6ts are energized. The relay 6R for the crossovers 6ts is energized by the same circuit as heretofore described, but relay 6BN cannot be energized because its circuit is opened as described above. Thus, the relay 6R is picked up, and the picking up of that relay causes the energization of relays 5AN and 5R. Relay 5AN is energized by a circuit closed from (+), through a circuit including front contact 175 of relay 14NP, wire 176, upper winding of relay 5AN, back contact 177 of relay 5R, back contact 178 of relay 6AN, front contact 359 of relay 6R, and front contact 238 of relay 17XR, to (-). At the same time, relay 5R is energized by a circuit closed from (+), through a circuit including back contact 179 of relay 5AN, upper winding of relay 5R, back contact 180 of relay 5BN, back contact 178 of relay 6AN, front contact 359 of relay 6R, and front contact 238 of relay 17XR, to (-). Relay 5AN is picked up in preference to relay 5R because of a difference in the operating characteristics of the two relays, and the picking up of relay 5AN opens the circuit for relay 5R at back contact 179.

The picking up of relay 5AN causes the energization of a circuit for relay 4N closed from (+), through a circuit including front contact 181 of relay 14NP (see Fig. 1E), back contact 353 of relay 3R, upper winding of relay 4N, back contact 182 of relay 4R, wire 183, front contact 184 of relay 5AN, back contact 178 of relay 6AN, front contact 359 of relay 6R, and front contact 238 of relay 17XR, to (-). At the same time relay 4R is energized by a circuit closed from (+), through a circuit including back contact 360 of relay 4N (see Fig. 1E), upper winding of relay 4R, wire 183, front contact 184 of relay 5AN, back contact 178 of relay 6AN, front contact 359 of relay 6R, and front contact 238 of relay 17XR, to (-). Relay 4N is picked up in preference to relay 4R because of a difference in the operating characteristics of two relays, and the picking up of relay 4N opens the circuit for relay 4R at back contact 360.

When relay 4N is picked up, relay 3AN is picked up by the energization of a circuit closed from (+), through a circuit including upper winding of relay 3AN (see Fig. 1E), back contact 185 of relay 3R, front contact 186 of relay

4N, wire 183, front contact 184 of relay 5AN, back contact 178 of relay 6AN, front contact 359 of relay 6R and front contact 238 of relay 17XR, to (-). The picking up of relay 3AN causes the picking up of relay 14NR (see Fig. 1B) by the energization of a circuit closed from (+), through a circuit including front contact 188 of relay 27T, contact 187 of button 14B closed in a normal position, back contact 46 of relay 14XR, lower winding of relay 14NR, front contact 189 of relay 14NP, front contact 190 of relay 3AN, back contact 162 of relay 3R, back contact 163 of relay 4R, wire 164, back contact 165 of relay 5R, back contact 361 of relay 6AN, back contact 362 of relay 6BN, back contact 229 of relay 17NP, back contact 230 of relay 17NR, winding of relay 17XR, and front contact 234 of relay 17XR, to (-). The picking up of relay 14NR closes a stick circuit at front contact 191 for shunting front contact 189 of relay 14NP out of the circuit just described.

When relay 14NR is picked up, relay 12XR becomes energized by the closing of a circuit heretofore described, and the picking up of that exit relay causes the picking up of relay 2AN, thus completing the selection of the route from signal 10 to signal 21 via crossover 6ts. After the track switches have completed their operation to the position selected by their switch control relays, the signals 10, 14 and 19 are cleared.

If a route is not available from signal 10 to signal 21 via either of crossovers 2ts, 3ts or 6ts, due, for example, to a route set up from signal 15 to signal 17, the available route will be set up from signal 10 to signal 21 via crossover 7ts. Such a route is set up because the entrance repeater relay 19NP has no source of energy on account of its circuit being open at back contact 144 of relay 6BN, thus, after the exit relay 21XR is picked up, relay 7R is picked up in preference to relay 7BN because the circuit for relay 7BN is open at front contact 209 of relay 19NP. The picking up of relay 7R effects the picking up of relay 18NR, which in turn causes the picking up of relay 16XR and the dropping away of relay 18NP, all in a similar manner to that heretofore described as typical for the relays associated with intermediate entrance and exit points. The picking up of relay 16XR initiates the building up of the completion network to complete the route by the picking up of relays energized the same as has been heretofore described.

Inasmuch as the circuit selections are similar in principle for setting up routes for west bound traffic, some contacts being used in common for traffic in both directions, it is believed to be readily apparent that the route diverging nearest the entrance point is always given preference as long as the reverse switch control relay for each track switch is made slow acting with reference to the normal switch control relays, irrespective of the direction of traffic.

If it is desired in practice that a particular crossover or track switch be used in preference to others providing optional routes, preference can be given that crossover or track switch by making the normal control relays for that track switch slow acting with respect to the reverse control relays, and providing the circuits accordingly.

To illustrate such a condition, assume that it is desirable in setting up a route between signals 10 and 21 to set up that route via crossover 3ts whenever that route is available, thus not

unnecessarily tying up a route between signal 22 and signal 20.

To provide such mode of operation, only the completion network circuits for relays 3AN, 3BN and 3R need be modified from the form already described and illustrated in Figs. 1E and 1F. Thus, to consider the modified form of control for relays 3AN, 3BN and 3R, Figs. 5A and 5B are to be considered as replacing Figs. 1E and 1F beneath Figs. 1B and 1C respectively.

Assume, for example, that an operator depresses successively buttons 10B and 21B for setting up a route from signal 10 to signal 21 at a time when the normal conditions of the system exist as described, and the completion network circuits are provided according to Figs. 5A and 5B. In setting up that route, the relays are positioned as heretofore described in setting up a route between those designated entrance and exit points up to and including the picking up of relay 5BN. The picking up of relay 5BN causes the energization of relay 3BN (see Fig. 5A) by a circuit closed from (+), through a circuit including back contact 250 of relay 3R, upper winding of relay 3BN, wire 245, back contact 245 of relay 5R, front contact 247 of relay 5BN, and front contact 238 of relay 17XR, to (-). At the same time, a circuit is closed for relay 3R, from (+), through a circuit including front contact 251 of relay 14NP (see Fig. 5A), back contact 252 of relay 3AN, upper winding of relay 3R, back contact 253 of relay 3BN, wire 245, back contact 246 of relay 5R, front contact 247 of relay 5BN, and front contact 238 of relay 17XR, to (-). Due to the quick acting characteristics of relay 3R with respect to relay 3BN, relay 3R is picked up, due to such energization, and the picking up of that relay opens the circuit just described for relay 3BN at back contact 250 to cause relay 3BN to remain in a dropped away position.

Responsive to the picking up of relay 3R, relay 14NR is picked up, and the picking up of that relay effects the picking up of relay 12XR and the dropping away of relay 14NP. The picking up of relay 14NR closes front contact 254 connected in multiple with front contact 251 in the circuit for relay 3R to maintain that relay energized after relay 14NP has dropped away. Relay 2AN is picked up, due to the picking up of relay 12XR, and the track switches are operated to their positions corresponding with the self-selecting network relays for governing those track switches, thus providing a route from signal 10 to signal 21 via crossover 3ts. In a similar manner, for the opposite direction of traffic, crossover 3ts is preferred for a route from signal 21 to signal 10, relays 3AN and 3R being both energized in setting up that route, but relay 3R gaining preference over relay 3AN because of the difference in the operating characteristics of the two relays.

Modifications.—In disclosing an invention of this kind that is apparently broad in scope, it is difficult to disclose in one embodiment all of the features of the system which can be employed in practice in adapting the system to various requirements. Thus, two modified forms of control for the relays are shown as examples of the changes that can be made in the system as heretofore disclosed, in order to adapt the system most advantageously to the particular problems encountered in practice.

Although it is of a particular advantage under some conditions encountered in practice to al-

low the setting up of only one route at a time, as described above, it is believed that there are other conditions where it is desirable to place more of a responsibility for setting up the proper routes upon the operators, and allowing them to set up several routes contemporaneously, thus allowing the interlocking plant to be controlled more efficiently with respect to the time required for the setting up of a plurality of routes. To satisfy such conditions, the circuits can be provided in a manner similar to that shown in Figs. 4A, 4B, 4C and 4D, in which the bus system for effecting the proper energization of the entrance and exit relays is replaced by a different system of control in which the entrance relays are made slow acting with respect to the exit relays to provide the desired mode of operation. When that time basis system of control is provided for the entrance and exit relays, it is possible, when the circuits shown in Figs. 1E and 1F are used in combination with the circuits shown in Figs. 4A, 4B, 4C and 4D, to set up simultaneously parallel routes, such for example, as from signal 10 to signal 20 and from signal 11 to signal 21.

Another feature with respect to the system shown in Figs. 4A, 4B, 4C and 4D is that rectifiers are used in the initiating network circuits for the exit relays to allow the picking up of an exit relay only when a route is available between a designated entrance point and the exit point included in the route being set up, one network being provided for each direction of traffic. Such circuits provide that an exit relay cannot even be momentarily picked up when buttons are depressed for defining an impossible or an unavailable route.

It is believed that those features of the system described above, together with other features which will be apparent, can best be understood by considering, as a typical example, the circuits provided and the mode of operation of the system for setting up a route from signal 10 to signal 21. Inasmuch as some of the circuits are similar to those heretofore described, reference will be made more particularly to those features and functions of the modified system which vary from the system as heretofore described.

The depression of button 10B, at a time when the normal conditions of the system exist as illustrated and described, causes the picking up of relay 10NR (see Fig. 4A) by the energization of a circuit closed from (+), through a circuit including front contact 255 of relay 25T, winding of relay 10NR, back contact 256 of relay 10XR, and contact 257 of button 10B closed in a depressed position, to (-). A stick circuit is closed for relay 10NR, upon the picking up of that relay, including front contact 258 of relay 10NR, and contact 257 of button 10B closed in both normal and depressed positions.

The picking up of relay 10NR causes the picking up of entrance repeater relays 14NP, 15NP, 18NP and 19NP by the energization of circuit network selections similar to those heretofore described as illustrated in Figs. 1A, 1B, 1C and 1D.

Each of the relays NP are, however, controlled in a different manner from that heretofore described in that a stick circuit is provided for each relay to maintain it picked up until the exit relay for the next interlocked group toward the entrance point has been picked up in setting up a route by end-to-end control. To consider in detail the circuit for an NP relay as typical of the manner in which the circuits for the other relays NP are provided, assume relay 15NP to

be picked up in setting up a route under the above assumed condition to cause the energization of a circuit for relay 19NP closed from (+), through a circuit including front contact 367 of relay 15NP (see Fig. 4B), back contact 368 of relay 3R, back contact 369 of relay 3BN, wire 370, back contact 371 of relay 5R, back contact 372 of relay 5BN, back contact 373 of relay 6R, back contact 374 of relay 6BN, back contact 375 of relay 17XR, wire 376, back contact 377 of relay 19XR, winding of relay 19NP, back contact 378 of relay 19NR, and back contact 269 of relay 7BN, to (-). A stick circuit is closed at front contact 379 of relay 19NP upon the picking up of that relay to shunt contacts 378 and 269 out of the circuit just described.

The depression of button 21B, following the picking up of the entrance repeater relays NP, causes the picking up of relay 21XR by the energization of a circuit closed from (+), through a circuit including front contact 259 of relay 19NP (see Fig. 4D), back contact 260 of relay 7R, back contact 261 of relay 21NR, winding of relay 21XR, and back contact 262 of button 21B, to (-). Stick energy is applied to that circuit at front contact 263 upon the picking up of relay 21XR. Relay 19NR is picked up prior to the dropping away of relay 19NP to supply energy to the circuit for relay 21XR at front contact 364 (see Fig. 4B).

Although relay 21NR becomes momentarily energized when button 21B is depressed, by the closing of a circuit similar to that described for relay 10NR, the circuit for relay 21NR is opened by the picking up of relay 21XR at back contact 264 because relay 21XR is quick acting with respect to relay 21NR. When relay 21XR is picked up relay 7BN is energized by a circuit similar to that heretofore described, and the picking up of that relay causes the picking up of relay 19NR by the energization of a circuit closed from (+), through a circuit including front contact 265 of relay 32T, winding of relay 19NR, back contact 266 of relay 19XR, contact 267 of button 19B closed in a normal position, front contact 268 of relay 19NP, and front contact 269 of relay 7BN, to (-). The picking up of relay 19NR closes a stick circuit for that relay at front contact 270 to shunt contacts 268 and 269 out of the circuit for that relay. Instead of the picking up of relay 19NR causing the dropping away of relay 19NP, as in the system illustrated in Figs. 1A, 1B, 1C and 1D, relay 19NP is maintained picked up by its stick circuit until the circuit for that relay is opened upon the picking up of the exit relay 17XR.

The exit relay 17XR is picked up, when its circuit is closed upon the picking up of relay 19NR, from (+), through a circuit including front contact 271 of relay 15NP (see Fig. 4B), back contact 272 of relay 3R, wire 273, back contact 274 of relay 5R, back contact 275 of relay 6R, back contact 276 of relay 17NP, back contact 277 of relay 17NR, winding of relay 17XR, wire 278, front contact 279 of relay 19NR, and front contact 280 of relay 19NP, to (-). Stick energy is applied to that circuit at front contact 365 of relay 16XR. Relay 19NP is dropped away upon the picking up of relay 17XR by the opening of its circuit at back contact 375 (see Fig. 4C).

Upon the picking up of relay 17XR, if the completion network circuits for that interlocked group are provided as illustrated in Figs. 1E and 1F, relays 6BN, 5BN and 3BN are successively picked up. The picking up of relay 3BN effects the picking up of relay 15NR in a similar manner

to that described for the picking up of relay 19NR, and a circuit is closed for relay 13XR similar to the circuit described as being closed for relay 17XR, that circuit being closed upon the picking up of relay 15NR from (+), through a circuit including front contact 281 of relay 10NR (see Fig. 4A), back contact 282 of relay 2AN, rectifier 289, back contact 283 of relay 2BN, back contact 284 of relay 13NP, back contact 285 of relay 13NR, winding of relay 13XR, wire 286, front contact 287 of relay 15NR, and front contact 288 of relay 15NP, to (-). Relay 15NP is dropped away upon the picking up of relay 13XR by the opening of its circuit at back contact 366 (see Fig. 4A).

The picking up of relay 13XR causes the picking up of relay 2R to complete the selection of the route from signal 10 to signal 21 via crossover 2ts.

Network without end-to-end control.—If end-to-end control is not required for a particular condition encountered in practice, the system can be simplified from the forms heretofore described, because it is no longer necessary that the completion network relays be energized successively, starting with the AN, BN, N or R relay nearest the exit relay picked up in the completion network for setting up that particular route. Such mode of operation is used in accordance with the system for end-to-end control because it is necessary for the completion network to select between a plurality of entrance relays for possible entrance points. Thus, if end-to-end control is not required, the same completion network circuits can be used for both directions of traffic in a manner similar to that shown in Figs. 6A and 6B which illustrate an entrance-exit type system provided in accordance with the present invention for a track layout corresponding with the track layout for the center interlocked group illustrated in Figs. 3A and 3B.

In setting up a route, in accordance with the system as shown in Figs. 6A and 6B, an entrance relay is picked up upon designation of the entrance point for the route, and, upon designation of the exit point for a route, a route end relay for each end of the route thus defined is picked up, the route end relay for the entrance and exit ends of that route being energized in series. The picking up of those route end relays effects the picking up of the completion network relays successively in the same manner, and employing the same principles as heretofore described for one particular direction of traffic. Inasmuch as the picking up of the route end relays for the entrance and exit ends of each route is effected in series, irrespective of the direction of traffic, the completion network responds in the same manner, and using the same circuits for both directions of traffic over each particular route.

An optional route lever OPL (see Fig. 6B) is provided for determining which of the two optional routes extending between signal 14 and signal 17 is given preference. If the preferred route is not available, the inferior route is set up without positioning the lever OPL. If the lever OPL is in a right hand position as illustrated, a route set up between signal 14 and signal 17 is set up via crossover 6ts in preference to a route via crossover 3ts; and if the lever OPL is in a left hand position a route set up between signal 14 and signal 17 is set up via crossover 3ts in preference to a route via crossover 6ts.

Having thus considered the system in a gen-

eral manner, to illustrate the mode of operation, assume, for example, that an operator sets up a route from signal 14 to signal 17 when the normal conditions of the system exist as shown and described. The depression of the button for the entrance end to that route causes the picking up of the entrance relay 14NR by the energization of a circuit closed from (+), through a circuit including back contact 55 of relay NPU, bus PU, back contact 290 of relay 14RR, contact 291 of button 14B closed in a depressed position, and winding of relay 14NR, to (-). Upon the picking up of that relay a stick circuit is closed from (+), through a circuit including front contact 292 of relay 27T, front contact 293 of relay 14NR, contact 291 of button 14B closed in a normal and a depressed position, and winding of relay 14NR, to (-). Upon depression of button 17B, relays 14RR and 17RR are picked up by the energization of a circuit closed from (+), through a circuit including contact 294 of button 17B (see Fig. 6B) closed in a depressed position, back contact 295 of relay 17NR, winding of relay 17RR, back contact 296 of relay 6BN, back contact 297 of relay 6AN, back contact 298 of relay 5R, wire 299, back contact 300 of relay 4R, back contact 301 of relay 3R, winding of relay 14RR, and front contact 302 of relay 14NR, to (-).

Upon the picking up of relay 14RR, relay 3AN is picked up by the energization of a circuit closed from (+), through a circuit including front contact 303 of relay 14RR, winding of relay 3AN, and back contact 304 of relay 3R, to (-). The picking up of relay 3AN causes the picking up of relay 4N by the energization of a circuit closed from (+), through a circuit including front contact 303 of relay 14RR, front contact 305 of relay 3AN, upper winding of relay 4N, and back contact 306 of relay 4R, to (-). When relay 4N is picked up, relay 5AN is picked up by the energization of a circuit closed from (+), through a circuit including front contact 303 of relay 14RR, front contact 305 of relay 3AN, front contact 307 of relay 4N, back contact 308 of relay 4R, wire 309, upper winding of relay 5AN, and back contact 310 of relay 5R, to (-). After relay 5AN is picked up, relay 6R is energized by a circuit closed from (+), through a circuit including front contact 303 of relay 14RR (see Fig. 6A), front contact 305 of relay 3AN, front contact 307 of relay 4N, back contact 308 of relay 4R, wire 309, front contact 311 of relay 5AN, back contact 312 of relay 5R, back contact 313 of relay 6AN, upper winding of relay 6R, and back contact 314 of relay 6BN, to (-).

The track switches are operated to positions corresponding with the switch control relays 3AN, 4N, 5AN and 6R in a manner similar to that typically illustrated in Fig. 2. After the track switches have completed their operation and the relay LS associated therewith has been dropped away, a circuit is closed to cause the picking up of relay 14G for the clearing of signal 14 from (+), through a circuit including back contact 315 of relay 17NR (see Fig. 6B), front contact 316 of relay 17RR, back contact 317 of relay 6LS, back contact 318 of relay 6NCR, front contact 319 of relay 6RCR, back contact 320 of relay 6NCR, back contact 321 of relay 6LS, back contact 322 of relay 5LS, front contact 323 of relay 5NCR, wire 324, back contact 325 of relay 4RCR, front contact 326 of relay 4NCR, back contact 327 of relay 4LS, front contact 328 of

relay 3NCR, back contact 329 of relay 3LS, front contact 330 of relay 14RR, front contact 331 of relay 14NR, and winding of relay 14G, to (—). The picking up of relay 14G causes the clearing of signal 14.

If there is a route set up between signal 22 and signal 16 to cause the picking up of relay 6AN, or if relay 6AN is picked up by the lever SML for that track switch, a route is set up from signal 14 to signal 17 when the buttons for the ends of that route are properly actuated, via crossover 3ts in preference to via crossover 6ts irrespective of the position of the lever OPL. Such mode of operation is accomplished by the energization of relay 3R in multiple with relay 3AN to cause the picking up of relay 3R to effect the deenergization of relay 3AN, on account of a difference in the operating characteristics of the two relays. Thus, in setting up a route from signal 14 to signal 17 at a time when relay 6AN is picked up, relay 14NR is picked up by the energization of the circuits described above, and the depression of button 17B for defining the exit point in that route causes the picking up of relays 14RR and 17RR by the energizing of a circuit closed from (+), through a circuit including back contact 294 of button 17B (see Fig. 6B), closed in a depressed position, back contact 295 of relay 17NR, winding of relay 17RR, back contact 332 of relay 6R, back contact 333 of relay 5R, wire 334, back contact 335 of relay 3BN, back contact 336 of relay 3AN, winding of relay 14RR, and front contact 302 of relay 14NR, to (—).

The picking up of relay 14RR, under such conditions, causes the energization of relay 3AN by the closing of a circuit heretofore described, and at the same time closes a circuit for the energization of relay 3R from (+), through a circuit including front contact 303 of relay 14RR, back contact 337 of relay 3AN, upper winding of relay 3R, back contact 338 of relay 3BN, wire 339, front contact 340 of relay 6AN, and front contact 341 of relay 17RR, to (—). Upon considering that circuit, it is obvious that relay 3R could as well be energized when lever OPL is operated to a left hand position to close contact 342 of that lever connected in multiple with front contact 340 of relay 6AN. The relay 3R picks up in preference to relay 3AN because it is a quick acting relay with respect to relay 3AN, and when picked up it opens the circuit for relay 3AN at back contact 304.

Upon the picking up of relay 3R, relay 5BN is picked up by the energization of a circuit closed from (+), through a circuit including front contact 303 of relay 14RR, front contact 343 of relay 3R, back contact 344 of relay 3BN, wire 345, back contact 346 of relay 5R, upper winding of relay 5BN, and front contact 347 of relay 17RR, to (—). Relay 5R is energized at the same time the energization of relay 5BN is effected, but is not picked up, due to the opening of its circuit by the picking up of relay 5BN which is a quicker acting relay. The picking up of relay 5BN causes the picking up of relay 6BN by the energization of a circuit closed from (+), through a circuit including front contact 303 of relay 14RR, front contact 343 of relay 3R, back contact 344 of relay 3BN, wire 345, front contact 348 of relay 5BN, back contact 349 of relay 6R, and upper winding of relay 5BN, to (—).

The picking up of those switch control relays causes the positioning of the track switches with

which they are associated, and the ultimate clearing of signal 14 by the energization of a signal control circuit selected in the same general manner to that described above.

The relays AN, BN, N and R in the completion network illustrated in Figs. 6A and 6B are maintained picked up upon passage of a train, dependent upon the route locking for energizing stick circuits for the lower windings of those relays as is typically shown in Fig. 2 for the energization of the center windings of relays for similar purposes.

Summary

Having considered various detailed features of the system during the above description and having pointed out typical modes of operation, certain general principles will now be pointed out which will show how the system of the present invention may be readily applied to all types of track layouts.

The system provides a single button for each signal location, and that button can be used for designating either an entrance or an exit point at that signal location. As a means for distinguishing between the actuation of the button for designating entrance and exit points a bus system of control is provided as shown in Figs. 1A, 1B, 1C and 1D, whereby the designation of an entrance point in setting up a route prevents the designation of any other entrance points until the route initiated has been completely set up and the signals cleared or the entrance relay for that entrance point restored to normal. If it is desirable in practice to provide that two or more routes can be set up contemporaneously, the system shown in Figs. 4A, 4B, 4C and 4D can be used in which a time basis is used as a means for distinguishing between the designation of entrance and exit points. That is, the depression of a button for an entrance point causes the picking up of an entrance relay in preference to an exit relay, because each exit relay must receive energy from an entrance relay associated with an entrance point in an available route including that point as exit. When a button is depressed for designating an exit point both the entrance and exit relays for that point are energized, but the entrance relay is deenergized by the picking up of the exit relay, because the exit relay is quicker in picking up than the entrance relay.

Separate through route indicating circuit networks are provided for the entrance repeater relays NP for intermediate signals included in routes that can be set up by end-to-end control, one network being provided for each direction of traffic. Such networks include so-called positive and inverse selections on the switch control relays in the circuit for each relay NP, the positive selection being provided by relays corresponding to the position of the track switches included in setting up each route extending to that intermediate signal, and the inverse selections being provided by relays corresponding to the conflicting position of the track switches included in setting up each route extending to that intermediate signal. Such selections together with rectifiers provide that an entrance repeater relay NP can be energized only when a route is available from the designated entrance point to that intermediate signal and no part of such route is already set up or occupied by a train.

The completion network relays as illustrated in Figs. 1E and 1F are energized by completion

circuit networks, one network being provided for each direction of traffic. Upon comparing the completion network relay circuits for the various track switches, it is readily apparent that the circuits are very similar. That is, the circuits for the relays used in governing each track switch that faces a designated exit point are similar, each relay circuit being closed when a route is selected up to that track switch from a designated exit point; and the circuits for the relays used in governing each track switch that is trailed from a designated exit point are similar, each relay circuit being closed when a route is selected up to that track switch from a designated exit point. It should be therefore readily apparent how the system can be expanded to include other track switch or how the network can be provided for any track layout encountered in practice. Thus, the following rules or principles characteristic of the completion network can be applied when the system is provided for any particular track layout.

The reverse switch control relay for a track switch facing a designated exit point receives energy, when a route is selected up to that track switch, upon the picking up of a switch control relay for the next track switch toward the designated exit point in each route being set up, such energy being fed from the exit relay for the designated exit point.

The normal switch control relay for each track switch facing a designated exit point receives energy, when a route is selected up to that track switch, upon the picking up of a switch control relay for the next track switch toward the designated exit point in each route being set up, the energization of that relay being rendered effective only when there is an available route including that track switch in a normal position in a route extending between designated entrance and exit points.

In considering jointly the above rules for the energization of the normal and the reverse switch control relays, it is apparent that both the normal and the reverse switch control relays for each track switch facing a designated exit point receive energy, when a route is selected up to that track switch, upon the picking up of a switch control relay for the next track switch toward the designated exit point in each route being set up, if a route is available between designated entrance and exit points over that track switch in a normal position. Under such conditions preference is given the normal switch control relay by making the reverse switch control relay comparatively slow acting and providing a circuit interlock between the two relays. Such preference provides that, of optional routes available, the route diverging nearest the designated entrance point is set up.

In order to provide the circuits for the normal switch control relay for each of the track switches facing a designated exit point in such a manner as to allow the energization of that relay only when a route is available between designated entrance and exit points over that track switch in a normal position, various circuit selections are required which are dependent upon the nature of the track layout. A general rule that can be applied to any track layout is that the circuit for each of the normal switch control relays must include enough inverse selections of the normal and reverse switch control relays, for track switches between that track switch and each of the entrance points in possible routes in-

cluding that track switch facing the exit point, to allow the energization of that relay only when it is desired to set up a route over that track switch in a normal position. It is believed that, from the following examples, it will be apparent to those familiar with the art when such selections are required. With reference to the circuit for the upper winding of relay 4N (see Fig. 1E), back contact 244 of relay 3R is included in the circuit to prevent the feeding of energy through the completion network to relay 4N when relay 14NR is picked up for a route set up from signal 14 to signal 19. The circuit for the upper winding of relay 5AN, however, does not require any inverse selections in the branch of the circuit extending to front contacts of relay 14NP, 14NR and 22NR, because any route that can be set up having either of those points as an entrance point would require that track switch to be normal.

Another condition where only certain ones of the inverse selections is required is shown in the circuit for the upper winding of relay 6BN which provides that, if relay 3BN is picked up to open back contact 358, energy cannot feed through the completion network from front contact 356 of relay 14NP or front contact 358 of relay 14NR to the upper winding of relay 6BN, thus providing that a route can be set up from signal 14 to signal 19 via crossover 6ts if that route is available, and the route via crossover 3ts is not available because of the presence of a westbound train in track section 28.

Having described the present invention as used in governing a particular track layout, it is desired to be understood that the invention is not limited to the specific forms shown, and that additions, changes, and modifications can be made to adapt the system provided by this invention to various requirements of practice, without in any manner departing from the spirit or scope of the present invention, except as limited by the scope of the following claims.

What I claim is:

1. In a switch and signal control system for governing the power operation of a track switch included in each of a plurality of conflicting routes through a track layout in a given direction between a plurality of entrance points and an exit point, said track switch having its points facing said exit point; manually operable contact means for each of said entrance points and for said exit point; normal and reverse switch control relays for governing the power operation of said track switch to corresponding normal and reverse positions; circuit means for energizing the winding of said reverse switch control relay whenever said contact means for said exit point is actuated following the actuation of said contact means for any one of said entrance points only if a route is available for use between such entrance and exit points regardless of the position of said switch required for the designated route; circuit means for energizing the winding of said normal switch control relay when said contact means for said exit point is actuated following the actuation of said contact means for a particular one of said entrance points only if a route is available for use between such entrance and exit points and the designated route requires said track switch in a normal position; and means for giving preference to said normal switch control relay so that its contacts alone become actuated for governing the operation of said track switch when both said

normal and said reverse switch control relays have their windings energized simultaneously.

2. In an interlocking system for railroads, a track layout having a power-operated track switch operable to normal and reverse positions so as to be included in a plurality of conflicting routes between a plurality of entrance points and a single exit point, said track switch having its points facing said exit point, manually operable control buttons for said entrance and exit points, a normal and a reverse switch control relay for respectively governing the normal and reverse power operation of said track switch, said reverse switch control relay being relatively slower to pick up in response to energization than said normal switch control relay, circuit means for said reverse switch control relay energized in response to the joint operation of a control button for any given entrance point and the operation of the control button for said exit point regardless of the position of said switch required for the designated route, circuit means for said normal switch control relay energized upon the joint operation of the control button for said exit point and a control button for the entrance points of only those of said routes which require said track switch to be in a normal position, and contact means included in said energizing circuits for said normal and reverse switch control relays effective to open the energizing circuit for said normal switch control relay when said reverse switch control relay is picked up and effective to open the energizing circuit for said reverse switch control relay when said normal switch control relay is picked up, whereby the operation of the control buttons for the opposite ends of a route including said switch in a normal position causes the picking up of the normal switch control relay to govern said track switch to a normal position and open the energizing circuit of said reverse switch control relay before said reverse switch control relay can pick up, and whereby the operation of the control buttons for the opposite ends of a route including said track switch in a reverse position fails to energize and pick up said normal switch control relay which allows said reverse switch control relay to pick up and govern said track switch to a reverse position.

3. In a switch and signal control system of the entrance-exit type for governing the power operation of a track switch included in each of a plurality of conflicting routes through a track layout between a plurality of entrance points and an exit point, such track switch having its points facing said exit point; manually operable contact means for said entrance and exit points; a normal and a reverse switch control relay for respectively positioning said track switch to a corresponding position when picked up; circuit means for energizing a winding of a certain one of said switch control relays whenever said contact means for said exit point is actuated, following the actuation of said contact means for any one of said entrance points, if only some route is available between such points and regardless of the position of said switch required for the designated route; circuit means for energizing a winding of the other of said switch control relays when said contact means for said exit point is actuated, following the actuation of said contact means for a particular one of said entrance points, only if the route between such designated entrance and exit points requires that track switch in a position corresponding

to that position to which such other switch control relay can operate the track switch; and circuit means for giving a preference to said other switch control relay so that its contacts alone become picked up when the windings of both said switch control relays become energized at the same time.

4. In a switch and signal control system for governing the power operation of track switches in a track layout to set up routes between signal locations at entrance and exit points through the track layout, manually operable control buttons for each of said signal locations, normal and reverse switch control relays for each of said track switches for governing the power operation of that track switch to corresponding normal or reverse positions, and the normal and reverse switch control relays for each of the track switches having a back contact included in the energizing circuit of the other switch control relay for that track switch, and each of the reverse switch control relays being slow acting with respect to the normal switch control relays, whereby a normal switch control relay is picked up in preference to a reverse switch control relay for any given track switch whenever the normal and reverse switch control relays for that track switch have their windings energized at the same time, and route establishing means for selectively energizing said normal and reverse switch control relays to set up any given route in response to the actuation of the control buttons for the opposite ends of that route, said route establishing means comprising circuit means for energizing the winding of the reverse switch control relay for each track switch having its points facing a designated exit point when a switch control relay for the preceding track switch from the exit end of such route has been picked up, circuit means for the normal switch control relay of each track switch facing a designated exit point energized when a switch control relay for the preceding track switch from said exit point is picked up only providing such track switch is required to be in a normal position for the route having its entrance and exit points designated and such normal position of that track switch is available for use, and circuit means for energizing only the normal or reverse switch control relay as required to properly position each track switch facing the designated entrance point upon the picking up of a switch control relay for the preceding track switch from said exit point.

5. In a switch and signal control system of the character described for governing the power operation of track switches in setting up routes through a track layout having a plurality of conflicting routes extending between entrance and exit points defined by the location of signals provided for governing traffic through that track layout; manually operable contact means for each of said entrance and exit points for, when actuated, designating the entrance and exit points for each route to be set up; normal and reverse switch control relays for each track switch for governing the operation of that track switch to corresponding positions, each of the reverse switch control relays being slow-acting with respect to the normal switch control relays and interlocked with the normal switch control relays to provide that a normal switch control relay is always picked up in preference to a reverse switch control relay for any particular track switch whenever the normal and reverse switch

control relays for that track switch have their windings energized at the same time; a completion circuit network for energizing said normal and reverse switch control relays in succession for the switches of a route beginning at the designated exit end of that route, comprising circuit selections which provide that a reverse switch control relay has its windings energized for each track switch having its points facing a designated exit point when a route being set up is selected up to that track switch from the exit point designated, and comprising circuit selections which provide that a normal switch control relay has its windings energized for each track switch having its points facing a designated exit point when a route being set up is selected up to that track switch from the exit point designated, if a route is available between the designated entrance and exit points over that track switch in a normal position; and switch operating means responsive to the picking up of either the normal or reverse switch control relay for each track switch for operating that track switch to a corresponding position.

6. In a switch and signal control system for railroads; a track layout including one or more track switches for providing a plurality of routes between signal locations; manually operable contact means for each of said signal locations; an exit relay for each of said signal locations; normal and reverse switch control relays for each of said track switches for governing its power operation; an initiating circuit network arranged in conformity with the track layout and supplied with energizing potential upon the operation of a manually operable contact means for the entrance to a route for energizing the exit relay for the exit end of the route upon the operation of the manually operable contact means for such exit end, only providing there is an available route between such entrance point and the exit point; and a completion circuit network rendered effective upon the energization of an exit relay for energizing the normal and reverse switch control relays as required to set up the route for which said exit relay is then energized, a predetermined one of said switch control relays for each track switch that has its points facing a designated exit point and having its winding energized dependent upon the exit relay picked up, irrespective of the entrance point, and the other of said switch control relays for each track switch having its winding energized dependent upon an available route over such track switch in that position between the entrance and exit points for that route, such other relays being comparatively quick acting in comparison to said predetermined relays to provide that such other relays pick up and govern their particular track switches in preference to said predetermined relays when both normal and reverse relays for each of such switches have their windings energized at the same time.

7. In a switch control system for a railroad track layout including one or more track switches to set up different routes between entrance and exit points; manually operable contact means for said entrance and exit points; an entrance relay for each of said entrance points and an exit relay for each of said exit points; circuit means for energizing an entrance relay upon the operation of its associated manually operable contact means; stick circuit means for maintaining an entrance relay energized dependent upon traffic conditions in the route with which it is

then associated; circuit means for initially energizing any given exit relay upon the operation of said manually operable contact means for that exit point, providing an entrance relay is picked up for an entrance point to a route leading from such entrance point to said exit point, and providing such route is available for train movement; stick circuit means for each of said exit relays effective, when an exit relay is once picked up, to maintain it energized dependent upon the energized condition of the entrance relay which effected its initial energization; normal and reverse switch control relays for each of said track switches for respectively governing their normal and reverse operation; a completion circuit network for controlling the energization of the normal and reverse switch control relays to set up any given route through the track layout, the picking up of an exit relay for any given exit point being effective to apply energizing potential to the corresponding point of the completion circuit network to cause the successive energization of the normal and reverse switch control relays of the switches included in said given route, starting with a relay for the switch nearest the exit end of the route, the selection of the switches to have their switch control relays energized over the completion network being determined by the picked up condition of the normal or reverse relay of the next preceding switch nearer the exit point, the selection of the normal or reverse switch control relay of those switches thus selected and in a trailing relation to the designated exit point being in accordance with the position which such switches must have to direct a train from said exit point toward the designated entrance point, and the selection of the normal or reverse switch control relay for each of the remaining track switches in a facing relation to the designated exit point being effected by applying energy to a slow-acting reverse relay of each switch regardless of the entrance point designated and energizing a quick-acting normal relay for that switch when the designated entrance point requires that switch in the normal position.

8. In a switch and signal control system, a track layout including a plurality of interlocked groups each of such groups having track switches to set up different routes between signal locations, said interlocked groups being located end-to-end so that there are a plurality of through routes each including intermediate signal locations, manually operable control buttons for each of said signal locations located on a track diagram control panel; an entrance repeater relay for each of the intermediate signal locations, initiating circuit means responsive to the operation of a control button for any given signal location for energizing the entrance repeater relays for all of the signal locations included in all of the routes emanating from that signal location designated as an entrance point, route establishing means for each interlocked group responsive to the designation of a signal location of that interlocked group as an entrance point and the designation of another signal location in the same interlocked group as an exit point by the operation of the control buttons for such signal locations to cause the operation of the track switches in that interlocked group for setting up a route between such points and clearing a signal at the entrance point to such route, said route establishing means for each interlocked group also being responsive to the picking up of an entrance

repeater relay for a signal location of its interlocked group and the actuation of an exit button for another signal location of its interlocked group to establish a route between such signal locations by operating the track switches and clearing the signal at the entrance of the route, circuit means associated with each of said intermediate signal locations rendered effective upon the completion of a route including that signal location in response to the energized condition of an entrance repeating relay for acting the same as if a control button had been operated to designate that signal location as an exit point, to thereby cause the route establishing means for the interlocked group preceding such signal location to respond to set up a route through that interlocked group to a signal location of that interlocked group designated as the entrance point of the through route by actuation of a control button or constituting an intermediate signal location in the through route and having its entrance repeater relay energized, whereby routes may be established in any given interlocked group by the designation of two signal locations of that group as entrance and exit points and whereby through routes may be established by the actuation of control buttons for the opposite ends of such through routes.

9. In a switch and signal control system of the entrance-exit type in which all possible routes through a track layout having a plurality of interlocked groups adjoining end-to-end can be set up by the designation of entrance and exit points for each interlocked group, and can also be set up by the designation of an entrance and an exit point between which intermediate entrance points are included; manually operable contact means for each of said entrance and exit points for, when actuated, designating entrance and exit points for routes to be set up; an entrance repeater relay for each intermediate entrance point included between extreme ends of said track layout; an initiating circuit network for each direction of traffic for energizing said entrance repeater relays for traffic in that direction, each of said circuit networks comprising circuit selections which provide that, upon designation of an entrance point in setting up a route for that direction of traffic, an entrance repeater relay is energized for each intermediate entrance point that is included in a possible route available emanating from that designated entrance point; route establishing means for each interlocked group responsive to the designation of entrance and exit points for each available route within its interlocked group for causing the operation of the track switch to set up a route between those designated points; through route establishing means responsive to the designation of an entrance and an exit point only for each route, between which points one or more intermediate entrance points is included, for acting upon said route establishing means individual to the interlocked groups between those designated entrance and exit points, provided that the entrance repeater relay is energized for each of those intermediate points; and circuit means for deenergizing all of said entrance repeater relays for routes emanating from a designated entrance point when a through route is completely set up including that designated point as entrance.

10. In a switch and signal control system of the character described in which the setting up of routes through a track layout between entrance and exit points of a plurality of inter-

locked groups adjoining end-to-end can be effected by end-to-end control; manually operable contact means for each entrance and exit point; an entrance relay for each entrance point; an exit relay for each exit point; circuit means for energizing each of said entrance relays when said contact means for that entrance point is actuated; circuit means for maintaining each of said entrance relays energized dependent upon the passage of a train past that entrance point; an initiating circuit network comprising circuit selections for the energization of each exit relay within an interlocked group if the corresponding exit point is included in a route being set up, comprising circuit selections for the energization of each of said entrance relays for each intermediate entrance point in a route being set up by end-to-end control, such energization being rendered effective after a route is completely selected including that entrance point through that interlocked group, and comprising stick circuit means for maintaining the entrance relay for each intermediate entrance point energized in series with the exit relay for the portion of the route extending through that interlocked group, such stick circuit means being deenergized upon the passage of a train past that entrance point; route establishing means responsive to the energization of an entrance relay and an exit relay for any one interlocked group for operating the track switches to set up a route between those entrance and exit points; electro-responsive means for each intermediate entrance and exit point included in a through route being set up by end-to-end control through a plurality of interlocked groups, for rendering effective the establishing of that route as if the portion of the route extending through each interlocked group had been designated by the actuation of contact means for the entrance and exit points within that group; and circuit means for maintaining the route set up through each interlocked group as long as the entrance relay for the entrance point to that route is maintained energized.

11. In a switch and signal control system of the character described for governing the power operation of switches and the clearing of signals constituting entrance and exit points through a plurality of interlocked groups adjoining end-to-end; manually operable contact means for each entrance and exit point; an entrance relay and an exit relay for each respective entrance and exit point; circuit means for energizing each of said entrance relays when said contact means for that entrance point is actuated; circuit means for maintaining each of said entrance relays energized, dependent for deenergization upon the passage of a train past that entrance point; an initiating circuit network comprising circuit selections providing for the energization of each exit relay for each of said exit points within an interlocked group, if that exit point is included in a route being set up, and comprising circuit selections providing for the energization of each of said entrance relays for each intermediate entrance point in a route being set up by end-to-end control, such energization being rendered effective after a route is completely selected through that interlocked group including that entrance point; route establishing means responsive to the energization of an entrance relay and an exit relay for the respective entrance and exit points to each route within an interlocked group for operating the track switches to set up a route

between those points; electro-responsive means for each intermediate entrance and exit point included in a composite route being set up by end-to-end control through a plurality of interlocked groups and energized by the actuation of the manually operable contact means alone designating the entrance point of said composite route for rendering effective the establishing of that route the same as if the portion of the route extending through each interlocked group had been designated by the actuation of contact means for the entrance and exit ends of that group; and circuit means for maintaining the route set up through each interlocked group as long as the entrance relay for the entrance point to the portion of the route extending through that interlocked group is maintained energized.

12. In a switch and signal control system of the entrance-exit type in which the power operation of track switches and the clearing of signals in a track layout between entrance and exit points of a plurality of interlocked groups adjoining end-to-end can be effected by end-to-end control; manually operable contact means for each entrance and exit points; an entrance relay and an exit relay for each respective entrance and exit point; circuit means for energizing each of said entrance relays when said contact means for that entrance point is actuated; circuit means for maintaining each of said entrance relays energized dependent for deenergization upon passage of a train past that entrance point; circuit means for energizing each of said exit relays when said contact means for that exit point is actuated, if there is a possible route available between that exit point and an entrance point designated by an entrance relay energized; route establishing means responsive to the energization of an entrance relay and an exit relay for the respective entrance and exit points to each route within an interlocked group for causing the power operation of track switches to set up a route between those points, such route being maintained set up as long as the entrance relay for the entrance point to that route within that interlocked group is maintained energized; electro-responsive means for each intermediate entrance and exit point included in a composite route being set up by end-to-end control through a plurality of interlocked groups, for rendering effective the establishing of that route as if the portion of the route extending through each interlocked group had been designated by the actuation of contact means for the entrance and exit ends of that group, and circuit means for energizing the entrance relay for each intermediate entrance point, included in a route being set up by end-to-end control, in series with the exit relay for the exit point included in that route within that interlocked group, such energization being rendered effective only if the portion of the route extending through that interlocked group has been completely set up.

13. In a switch and signal control system of the character described in which routes through a track layout having a plurality of interlocked groups adjoining end-to-end can be set up by the designation of entrance and exit points through each interlocked group or by designation of the entrance and exit ends only of routes extending through a plurality of interlocked groups; manually operable contact means for the entrance and exit points to each interlocked group for designating the entrance and exit points for each route to be set up; an entrance repeater relay

for each intermediate entrance point included between extreme ends of said track layout; an initiating circuit network for each direction of traffic for energizing said entrance repeater relays for traffic in that direction, each of said circuit networks comprising circuit selections which provide that, upon designation of an entrance point in setting up a route for that direction of traffic, an entrance repeater relay is energized for each intermediate entrance point that is included in a possible route available emanating from that designated entrance point; and route establishing means for power operating the track switches to set up a route through each interlocked group, rendered effective upon the actuation of said contact means for designating an exit point within that interlocked group only if an entrance point for a possible route available having that point as exit is designated, either by the actuation of said contact means for that entrance point, or by energization of the entrance repeater relay for that point; whereby the designation of an exit point in setting up a route within that interlocked group, or by end-to-end control extending through that interlocked group, is ineffective for setting up a route through that group unless an entire route is available for use between the entrance and exit points designated by actuation of said contact means.

14. In a switch control system of the character described, a track layout having power-operated track switches for setting up different routes between said signal locations constituting the entrance and exit points, said track layout being so arranged as to provide a plurality of optional routes between common entrance and exit points, manually operable control buttons for each of said signal locations, a normal and a reverse switch control relay for each of said track switches for governing the power operation of that track switch to corresponding normal or reverse positions, and the normal and reverse switch control relays for each of the track switches having a back contact included in the energizing circuit of the other switch control relay for that track switch, and each of the reverse switch control relays being slow acting with respect to the normal switch control relays, whereby a normal switch control relay is picked up in preference to a reverse switch control relay for any given track switch whenever the windings of the normal and reverse switch control relays for that track switch are energized at the same time, and route establishing means for picking up said normal and reverse switch control relays as required to set up any given route in response to the actuation of the control buttons for the opposite ends of that route, said route establishing means comprising circuit means for energizing the reverse switch control relay for each track switch having its points facing a designated exit point when the button for said exit point is actuated or a switch control relay for the preceding track switch from the exit end has been picked up regardless of the designated entrance point, circuit means energizing for the normal switch control relay of each track switch facing a designated exit point when the button for said exit point is actuated or a switch control relay for the preceding track switch from said exit point is picked up only providing such track switch is required to be in a normal position for the route having its entrance and exit points designated, and circuit means for picking up only the normal or reverse switch control relay as required for

each track switch facing the designated entrance point upon actuation of an exit button or the picking up of a switch control relay for the preceding track switch from said exit point, and switch control circuit means responsive to the picking up of the normal or reverse switch control relay for each track switch for operating that track switch to a corresponding position, whereby the designation of an entrance point and an exit point between which there are two optional routes available results in the setting up of that particular one of such routes diverging nearest the designated entrance point.

15. In a switch and signal control system, a track layout having stretches of track interconnected by cross-overs and having turn-out track switches with signal locations at the extreme ends of such stretches and also at intermediate points whereby the track layout is divided into a plurality of interlocked groups within which different routes may be set up, and whereby there are a plurality of through routes along said stretches of track each including one or more intermediate signal locations and one or more of said through routes including one or more of the stretches of track or parts thereof, manually operable control buttons for each of the signal locations for designating such locations as entrance or exit points, route establishing means for each of said interlocked groups effective to cause power operation of the crossovers to set up any given route in response to the designation of a signal location at one end of that route as an entrance point and the designation of the signal location at the other end of that route as an exit point for causing the operation of the track switches in such interlocked group to set up such route and to clear the signal at the entrance end to such route, said route establishing means including means for causing the particular route to be set up between two signal locations which diverges nearest the entrance point when two optional routes between the designated entrance and exit points are available, circuit means responsive to the operation of a control button for the designation of a signal location as an entrance point for causing the operation of an entrance repeater relay for all of the intermediate signal locations in the available through routes emanating from such entrance point, said entrance repeater relays acting on the route establishing means for the associated interlocked group the same as the designation of its signal location as an entrance point by the operation of its control button, and circuit means at each intermediate signal location rendered effective by the establishment of a route extending from that signal location in response to the picked up condition of its associated entrance repeating relay for acting on the route establishing means for the adjacent interlocked group the same as if that signal location had been designated as an exit point by the operation of its control button, said route establishing means acting in response to the actuation of a control button to designate the exit end of a through route to establish through each interlocked group in turn a particular route extending from only one intermediate signal location of that interlocked group having its entrance repeater relay energized and to release the energized entrance repeater relay for other intermediate signal locations, said particular route established through an interlocked group when more than one of its entrance repeater relays are energized being over switches

in the normal position in preference to the reverse position, whereby through routes may be established by the designation of signal locations at the opposite ends of such through routes as entrance and exit points causing the establishment of routes in the intermediate interlocked groups and the clearing of signals therefor the same as if control buttons for all of the intermediate signal locations had been operated.

16. In a switch and signal control system for governing the power operation of track switches in setting up routes through a track layout which provides a plurality of optional routes between common entrance and exit points, each of said routes including at least one intermediate signal; manually operable contact means for each of said points for rendering effective the setting up of a route between those entrance and exit points when the contact means is actuated for both of those points; a through route relay for each of said intermediate signals energized in response to the actuation of the contact means for said entrance point if a route is available between said entrance point and that intermediate signal; and route establishing means rendered effective upon actuation of said contact means for said exit point, following the actuation of said contact means for said entrance point, for governing the power operation of the track switches to set up the optional route if available for use between said entrance and exit points diverging nearest said entrance point, and clearing the signals for governing traffic over that route, such route establishing means and the clearing of each intermediate signal in that route being rendered effective only if the through route relay for each intermediate signal in that route is energized.

17. In a switch and signal control system of the character described for governing the power operation of switches and the clearing of signals in a track layout providing a plurality of optional routes between common entrance and exit points for traffic in a given direction; manually operable contact means for said entrance and exit points for, when actuated by an operator, designating entrance and exit points for each route to be set up; normal and reverse switch control relays for each track switch for governing the operation of that track switch to corresponding positions, the reverse switch control relay for a particular track switch having its points facing said exit point in one of said optional routes being quick acting with respect to the normal switch control relay for that track switch, while the normal switch control relays for the remainder of the track switches are quick acting with respect to the reverse switch control relays for those track switches, the normal and reverse switch control relays for each of the track switches having their energizing circuits interlocked in such a manner as to provide that the reverse switch control relay for said particular track switch is picked up in preference to the normal switch control relay for that track switch whenever both normal and reverse switch control relays have their windings energized at the same time, and that the normal switch control relay for each of the other track switches is picked up in preference to the reverse switch control relay for that track switch whenever both normal and reverse switch control relays for that track switch have their windings energized at the same time; a completion circuit network for energizing said normal and reverse switch control relays which provides that the reverse switch

control relay for said particular track switch has its winding energized when a route being set up is selected up to that track switch from the exit point designated, if a route is available between designated entrance and exit points over that track switch in a reverse position, that a normal switch control relay has its winding energized for said particular track switch when a route being set up is selected up to that track switch from the exit point designated regardless of the designated entrance point, that a reverse switch control relay has its winding energized for each of the other track switches facing said exit point when a route being set up is selected up to that track switch from the exit point designated, if a route is available between said entrance and exit points over that track switch in a normal position, and that a normal or reverse switch control relay, depending upon the required position of that track switch, is energized for each track switch that would be trailed from said exit point when a route being set up is selected up to that track switch from the exit point designated; and switch operating means responsive to the normal or reverse switch control relay picked up for each track switch for operating that track switch to a corresponding position; whereby a route is set up between said entrance and exit points, when such route is designated by an operator by actuation of said contact means for said entrance and exit points, via said particular track switch reverse in preference to a route via either of the other track switches reverse whenever that route is available, irrespective of whether or not that route diverges nearest the designated entrance or exit point.

18. In a switch and signal control system of the entrance-exit type for a track layout having a plurality of conflicting routes extending between entrance and exit points defined by the location of wayside signals for governing traffic over that track layout; manually operable contact means for each of said entrance and exit points; an entrance relay for each of said entrance points; circuit means for energizing each of said entrance relays when said contact means for its associated entrance point is actuated, means responsive to the energization of any given entrance relay for rendering said circuit means ineffective to energize any other entrance relay until the signal corresponding with said given energized entrance relay indicates clear; and route establishing means responsive to the actuation of said contact means for an exit point of a route, following the picking up of an entrance relay for an entrance point to that route, for operating the switches to set up a route between the entrance and exit points thus designated and for clearing the signal governing entrance to that route.

19. In a switch and signal control system of the entrance-exit type for governing traffic through routes of a track layout having a plurality of track switches for setting up such routes extending between entrance and exit points defined by the location of signals; a single self-restoring control button for each of said signal locations; an entrance relay for each of said entrance points; circuit means for energizing

each of said entrance relays when the button for its associated signal location is actuated, such energization being rendered effective only if the signal is clear that is associated with each of the other entrance relays which are then energized; means for maintaining each entrance relay energized until restored manually or automatically by the movement of a train past the corresponding signal, and route establishing means responsive to the actuation of the button for a signal location designating an exit point for an available route, following the energization of an entrance relay for an entrance point to that route, for causing the power operation of the switches to set up a route between the entrance and exit points thus designated and for clearing the signal governing traffic through that route corresponding with the entrance relay energized by the first button actuated, and thereby render other control buttons effective to energize their respective entrance relays.

20. In a switch and signal control system for governing the power operation of track switches to set up any desired one of a plurality of conflicting routes through a track layout in accordance with the designation of entrance and exit ends of such routes by an operator, manually operable contact means for said entrance and exit ends for designating the ends of each route to be set up, a route end relay for each of the route ends, circuit means for energizing simultaneously the route end relays for both ends of each route when the entrance and exit ends of that route have both been respectively designated and a possible route is available between those route ends, normal and reverse switch control relays for each track switch effective, when picked up, to cause the power operation of that track switch to a corresponding position, a completion circuit network for energizing said normal and reverse switch control relays comprising circuit selections which provide that all of the track switches included in each route being set up have their relays energized in succession, starting with the track switch nearest a predetermined end of said track layout, such energization being rendered effective if the route end relays are energized for the ends of that route, irrespective of the direction of traffic for the route being set up.

21. In a switch and signal control system of the entrance-exit type for governing the power operation of track switches to set up any desired route through a track layout in accordance with the designation of entrance and exit ends of each of such routes by an operator, manually operable contact means for said entrance and exit ends for designating the ends of each route to be set up, a route end relay for each of the route ends, circuit means for energizing simultaneously the route end relays for the entrance and exit ends of each route, if such ends of that route have both been respectively designated by an operator and if a possible route is available between those route ends, normal and reverse switch control relays for each track switch for causing the power operation of that track switch to a corresponding position, a completion circuit network responsive to the energization of both route end relays for a designated route for energizing said normal and reverse switch control relays, comprising circuit selections which provide for the energization of one or both of the switch control relays for each track switch facing a predetermined end of said track layout

when a route being set up is selected up to that track switch from that predetermined end, said circuit selections providing for the energization of a normal switch control relay for each track switch facing said predetermined end when a route being set up is selected up to that track switch from such predetermined end and if the route between the designated entrance and exit points requires that track switch in a normal position, said completion circuit network also comprising circuit selections which provide for the energization of a normal or a reverse switch control relay, depending upon the required position of that track switch for each track switch trailed from said predetermined end when a route being set up is selected up to that track switch from such predetermined end, and switch operating means responsive to the energization of the normal or reverse switch control relay for each track switch for operating that track switch to a corresponding position, the switch control relay for one position of each switch being slower acting than the other so that the switch control relay for the other position is energized in preference to the switch control relay for said one position when energizing current is simultaneously supplied to both the normal and reverse switch control relays of that switch.

22. In a switch and signal control system of the entrance-exit type for the establishment of any desired route through a track layout which provides by the power operation of the track switches of such layout a plurality of conflicting routes extending between entrance and exit points; manually operable contact means for each of the entrance and exit points; normal and reverse switch control relays for each track switch, said reverse switch control relay for each switch being slow acting with respect to said normal switch control relay for that track switch; an exit relay for each of said exit points; circuit means for energizing the exit relay for any given exit point when its manually operable contact means is actuated following the actuation of said manually operable contact means for an entrance point to any possible route extending to that exit point, said circuit means being effective only if said possible route is available for use; circuit means for energizing in succession the switch control relays for the respective switches included in said available route beginning at the exit end of such route, the normal switch control relay for each switch required to be in a normal position for said available route being energized and picked up in its turn, the reverse switch control relay for each switch in said available route being energized in its turn regardless of the designated entrance point and picking up its contacts if its associated normal switch control relay remains deenergized but being deenergized and failing to pick up its contacts if its associated normal switch control relay is also energized, and switch control means for causing the operation of each of said track switches to the normal or reverse position in accordance with the picked up condition of its respective normal or reverse switch control relay.

23. In a switch and signal control system of the character described for governing the power operation of track switches and the clearing of signals in setting up routes for a particular direction of traffic through first and second adjoining track portions, there being a signal provided for the entrance to each portion for said

particular direction of traffic; manually operable contact means for the entrance and exit points of each of said portions; route establishing means responsive to the actuation of said manually operable contact means for the entrance and exit points of each track portion for setting up a route within that portion by causing the power operation of the track switches to proper positions for such route and clearing the entering signal to that route; a through route relay associated with the intermediate signal of said adjoining track portions for said direction of traffic, energized in response to the actuation of the manually operable contact means for the entrance point to said first track portion for that direction of traffic; and through route establishing means responsive to the actuation of said manually operable contact means for the exit point of said second track portion following the actuation of said manually operable contact means for the entrance point to said first track portion and the resulting energization of said through route relay for effecting the response of the respective route establishing means for said first and second track portions to thereby set up a through route extending through both of these track portions and for clearing the signals at the entrances to such track portions.

24. In a switch and signal control system of the entrance-exit type for governing the power operation of track switches included in optional routes extending between common entrance and exit points for traffic in a given direction; manually operable contact means for said entrance and exit points; normal and reverse switch control relays for each of said track switches for governing the operation of that track switch to corresponding normal and reverse positions, said reverse switch control relay for a particular one of said track switches being quick acting with respect to said normal switch control relay for that track switch, and said normal switch control relay for each of the remaining track switches being quick acting with respect to their reverse switch control relays, the normal and reverse switch control relays having their energizing circuits interlocked in such a manner as to provide that the quick acting switch control relay for each track switch is picked up in preference to the other switch control relay for that track switch whenever both the normal and reverse switch control relays for such switch become energized at the same time; circuit means responsive to the actuation of said contact means for said entrance and exit points for energizing the switch control relays for the track switches in succession beginning at the exit end of said optional routes, said circuit means acting to apply energizing current to the slower acting switch control relay of each switch in turn disposed in a facing relation to said exit end and also to the quicker acting switch control relay of that switch if there is an optional route available over that switch in a corresponding normal position, said circuit means acting to apply energizing current to either the normal or the reverse switch control relay alone of each of the remaining switches in turn disposed in a trailing relation to said exit point dependent upon the position of that switch required to continue a route toward the designated entrance point; and switch operating means responsive to the picking up of said normal or reverse switch control relay for each of said track switches for operating that track switch to a corresponding position; whereby

any switch, which may optionally be in either of its two positions to set up an optional route, assumes one position in preference to the other by reason of the relative timing of its switch control relays.

25. In a switch and signal control system for governing the power operation of track switches in setting up routes through a track layout providing a plurality of conflicting routes extending between signal locations constituting entrance and exit points, manually operable contact means for each of said signal locations for, when respectively actuated, designating the corresponding signal location as the entrance or exit point, normal and reverse switch control relays for each track switch, each such relay being effective when picked up for governing the power operation of that track switch to a corresponding normal or reverse position, and a route establishing circuit means for selectively energizing said normal and reverse switch control relays as required to set up any desired route having its entrance and exit ends designated by the actuation of the manually operable contact means for the corresponding signal locations constituting entrance and exit points, said circuit means comprising circuit selections for energizing the switch control relays for each switch in succession beginning at a designated exit point and following along a route toward the designated entrance point only providing that route is available for use, said circuit selections acting with respect to each switch along that route facing said exit point to cause the energization of its reverse switch control relay irrespective of the position required of that switch to continue that route but to cause the energization of its normal switch control relay only if such normal position of that switch be required to continue said route toward the designated entrance point, said circuit selections effecting an interlock between the normal and reverse switch control relays of each switch so that either relay picked up deenergizes the other, and means providing that the simultaneous energization of both the normal and reverse switch control relays for a switch shall effect the picking up of the normal switch control relay in preference to the reverse switch control relay.

26. In a switch and signal control system of the character described for railway track layouts affording through routes past one or more intermediate signals, manually operable buttons for designating the entrance and exit ends of desired routes, route establishing means for operating the switches and controlling the clearing of an entrance signal and each intermediate signal in a through route in response to the actuation of buttons to designate the extreme entrance and exit ends thereof, relay means associated with each intermediate signal for controlling the clearing thereof for through route operation, said route establishing means including initiating circuits energized by the actuation of a button for an entrance signal location for energizing said relay means associated with each intermediate signal included in any through route originating at said entrance signal location, and means effective while the same or any conflicting route connecting with an intermediate signal location is established or occupied by a train for preventing energization of said relay means for that intermediate signal location.

27. In a switch and signal control system of the character described for railway track layouts

including a plurality of interlocked groups of power operated switches affording through routes past one or more intermediate signal locations defining the limits of the various interlocked groups, manually operable buttons for designating the various signal locations as the entrance and exit ends of the various possible routes provided by said track layout, route establishing means for operating the track switches and controlling the clearing of an entrance signal and each intermediate signal in a through route in response to the actuation of control buttons to designate the extreme entrance and exit ends of such through route including relay means associated with each intermediate signal for controlling the clearing thereof for through route operation, initiating circuits energized by the actuation of a button for any given entrance signal location for energizing said relay means associated with each intermediate signal included in any through route originating at said entrance signal location, and traffic controlled contacts included in said initiating circuits effective when any given route connecting with an intermediate signal location is established or occupied by a train, to open the associated initiating circuit for that route for preventing the energization of said relay means for that intermediate signal location.

28. In a switch and signal control system of the character described for railway track layouts having a plurality of interlocked groups of power operated track switches defined by signal locations for governing traffic over routes in the various interlocked groups and at times constituting intermediate signal locations for those through routes including one or more such group defining signal locations, manually operable buttons associated with each signal location for designating that location as the entrance or exit point of desired routes, route establishing means associated with each interlocked group for operating the track switches of that group and controlling the clearing of an entrance signal in response to the actuation of buttons to designate entrance and exit points of any desired route in that interlocked group, and through route establishing means for inter-relating the route establishing means for the adjoining interlocked groups including relay means for each signal location which may become an intermediate signal location in some through route for acting on the route establishing means of its interlocked group the same as if a button had been operated to designate said signal location as an entrance point and for controlling the clearing of such signal and acting upon the route establishing means for the adjoining interlocked group the same as if such signal had been manually designated as an exit point when the control button for the extreme exit end of a through route has been actuated, initiating circuits energized by the actuation of a button or the picking up of said relay means for any given entrance signal location of any interlocked group for energizing said relay means associated with the next intermediate signal location included in any through route originating at said given entrance signal location, whereby said relay means for the several intermediate signal locations in any through route are energized in succession and the actuation of the control button at the extreme exit end of such through route causes the route establishing means for the several interlocked groups included in such through route to be effective.

fective to establish routes in succession beginning at such exit end, and traffic controlled contacts associated with each interlocked group and included in the initiating circuits associated with that interlocked group for preventing the energization of the relay means associated with the signal locations at the ends of any route established or occupied by a train within a given interlocked group, whereby through routes are prevented from being built up under a train.

29. In a switch and signal control system of the character described for railway track layouts having a plurality of interlocked groups of power operated track switches each group defined by signal locations for governing traffic in the various routes of that interlocked group and at times constituting intermediate signal locations for those through routes including one or more such interlocked groups, said track layout including two or more alternative through routes past different intermediate signal locations, manually operable buttons associated with each signal location for designating that location as the entrance or exit point of desired routes, route establishing means associated with each interlocked group for operating the track switches of that route and controlling the clearing of an entrance signal in response to the actuation of buttons to designate entrance and exit points of any desired route in that interlocked group, said route establishing means acting in the case of alternative routes to selectively establish such routes in an order dependent upon their relative degree of directness between the entrance and exit points designated, and through route establishing means for inter-relating the route establishing means for adjoining interlocked groups including relay means for each signal location which may become an intermediate signal location in some through route for acting on the route establishing means of its interlocked group the same as if a button had been actuated to designate said signal location as an entrance point and for controlling the clearing of such signal and acting upon the route establishing means for the adjoining interlocked group the same as if such signal location had been manually designated as an exit point when the control button for the extreme exit end of a through route has been actuated, initiating circuits energized by the actuation of a button or the picking up of said relay means for any given entrance signal location of any interlocked group for energizing said relay means associated with the next intermediate signal location included in any through route originating at said given entrance signal location, whereby said relay means for the several intermediate signal locations in all through routes originating at an entering signal location are energized in succession and the actuation of the control button at the extreme exit end of any one of such through routes causes the route establishing means for the several interlocked groups included in that through route to be effective to establish routes in the several interlocked groups in succession beginning at such extreme exit end, and traffic controlled contacts associated with each interlocked group and included in the initiating circuits associated with that interlocked group for preventing the energization of the relay means associated with the signal locations at the ends of any route established or occupied by a train within that given interlocked group to thereby

permit the energization of said relay means for the different intermediate signal locations of a less direct through route to effect the establishment of such less direct alternative through route upon the actuation of the button at the extreme end of such alternative through routes.

30. In combination, a track layout including track switches operable to form different traffic routes with a signal for each track at each end of the layout, certain of said routes being located end-to-end to form a first and a second portion of a through route having an intermediate signal, a route button and an entrance relay for each signal location, an additional entrance relay for the intermediate signal, means normally effective when any route button is momentarily operated to energize the associated entrance relay, route establishing means for each route effective when energized to operate the track switches as required for such route, means responsive to the operation of the route button for the exit end of a route having the entrance relay for its entrance end energized for energizing the route establishing means for such route, means for clearing the signal associated with the energized entrance relay when such route becomes established, means responsive to the energization of the entrance relay for the first portion of said through route for energizing said additional entrance relay for said second portion, means effective when entrance relays for both portions of said through route are energized for energizing the route establishing means for both portions in response to the momentary operation of the button for the exit end of the second portion, and means effective, if the route button for the exit end of the first portion of said through route is operated, to energize the route establishing means for said first portion only and then release said additional entrance relay for said second portion.

31. In an interlocking control system, a track layout including track switches operable to form different traffic routes, a normal and a reverse route relay for each track switch, a route circuit network including a plurality of normally open circuits including one for each normal or reverse route relay each circuit corresponding to a route, or portion thereof, for which the track switch controlled by such route relay is required to occupy a corresponding normal or reverse position, a route button and an entrance relay for each route end, means responsive to the operation of the button for one end of a selected route, when no other route button has been operated, for energizing the corresponding entrance relay, means controlled by each entrance relay when energized for connecting one terminal of a source of current to one end of the circuits for certain of the route relays for routes having a corresponding entrance end to prepare such circuits for energization, means responsive to the momentary operation of the route button for the exit end of said selected route for connecting the other terminal of said source to the opposite end of the prepared circuit for the route relay for each switch of the selected route, means for subsequently maintaining such route relays energized until such entrance relay is released, and means controlled by each energized route relay for operating the corresponding track switch to normal or reverse as required for the selected route.

32. In an interlocking control system, a track layout including track switches operable to form different traffic routes, a normal and a reverse

route relay for each track switch, a route circuit network including a plurality of normally open circuits including one for each normal or reverse route relay each circuit corresponding to a route, or portion thereof, for which the track switch controlled by such route relay is required to occupy a corresponding normal or reverse position, a route button and an entrance relay for each route end, means responsive to the operation of the button for one end of a selected route, when no other route button has been operated, for energizing the corresponding entrance relay, means controlled by each entrance relay when energized for connecting one terminal of a source of current to one end of the circuits for certain of the route relays for routes having a corresponding entrance end to prepare such circuits for energization, means responsive to the momentary operation of the route button for the exit end of said selected route for connecting the other terminal of said source to the opposite end of the prepared circuit for the route relay for the last track switch in said selected route, a means for maintaining said last named route relay energized until such entrance relay is released, means responsive to the energization of each route relay for a switch in said selected route for energizing the route relay for the next preceding switch in such route, and means controlled by each energized route relay for operating the corresponding track switch to normal or reverse as required for the selected route.

33. In a switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over a plurality of adjoining interlocked groups past one or more intermediate signal locations, said system comprising manually operable buttons for designating the signal locations as the entrance and exit ends of desired routes and through routes, an entrance and an exit relay for each signal location, an entrance repeating relay for each signal location that may become an intermediate signal in some through route, normal and reverse switch control relays for each of the track switches for controlling such track switches to corresponding normal and reverse positions, circuit means responsive to the operation of a button to designate an entrance signal location for energizing the entrance

relay for such signal location and closing a stick circuit therefor, local initiating circuits for each interlocked group including contacts of the normal and reverse relays for the track switches of that group and responsive to the energization of an entrance relay or to the energization of an entrance repeating relay for any given signal location of such interlocked group for conditioning for energization the exit relay for the exit end of each available route in that interlocked group originating at such signal location, said local initiating circuits being effective irrespective of the occupied condition of each available route, through route initiating circuits for each interlocked group responsive to the picking up of an entrance relay for an entrance signal location and to the energization of the entrance repeating relay for that signal location of such interlocked group for energizing the entrance repeating relay at the exit end of each available route in that interlocked group originating at that signal location, said through route initiating circuits for each interlocked group including contacts controlled by traffic to prevent the energization of an entrance repeating relay at the end of a route occupied by a train, whereby the designation of a signal location as an entrance point energizes the local initiating circuits for each of the interlocked groups included in some through route originating at the designated entrance signal location providing such through route is not occupied by a train, circuit means responsive to the operation of a button to designate a signal location as the exit end of some through route for energizing said exit relay for that signal location, route completion means responsive to the picking up of an exit relay for the exit end of an available route of an interlocked group for causing energization of the normal and reverse switch control relays as required to establish that route, and circuit means associated with each intermediate signal location responsive to the completion of a route originating at that signal location when its entrance repeating relay is energized for energizing the entrance relay for that signal and the exit relay for the available route terminating at that signal location.

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