

Dec. 9, 1941.

A. LANGDON

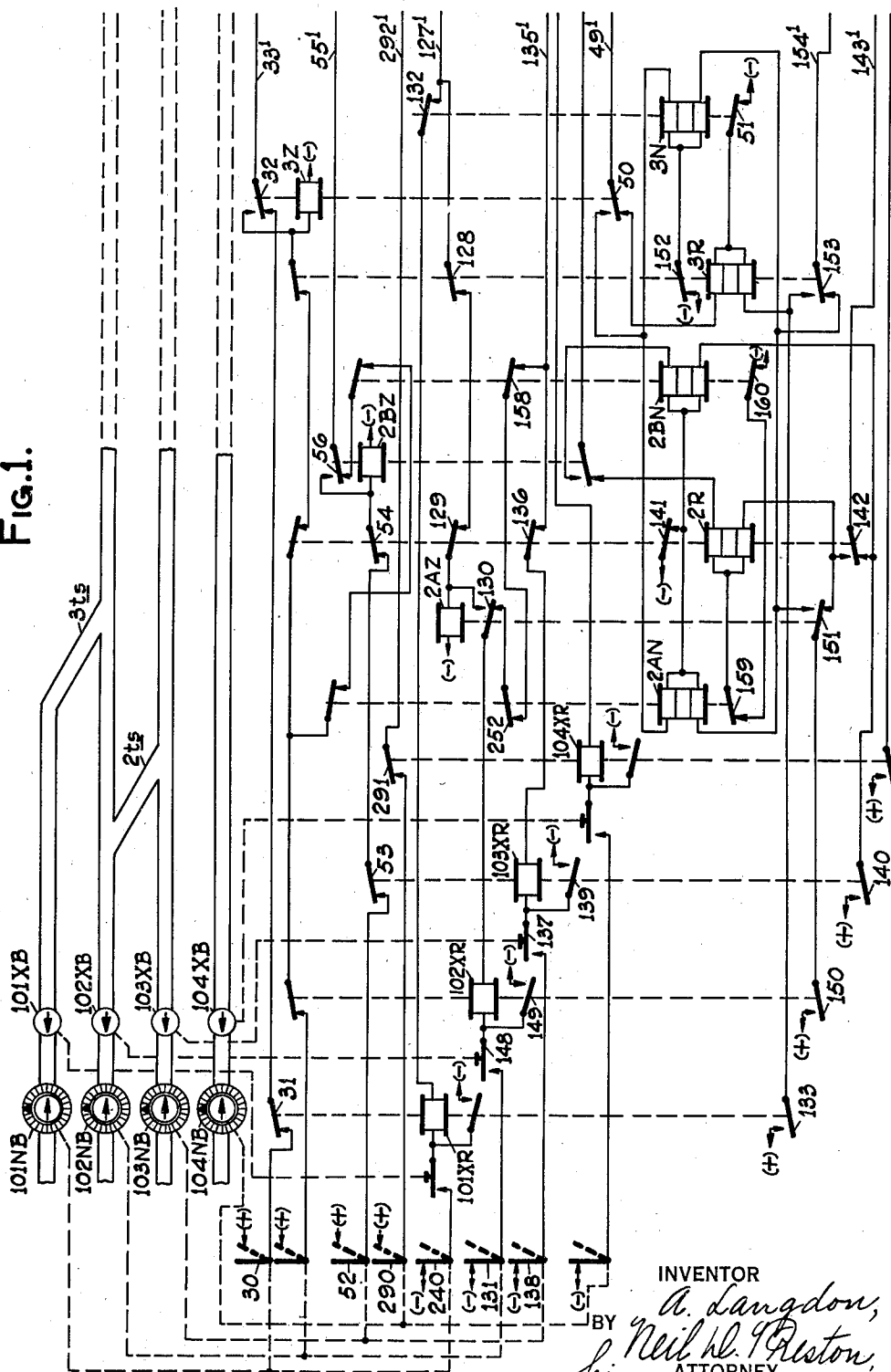
2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 1

FIG. 1.



INVENTOR
A. Langdon,
BY Neil W. Preston,
ATTORNEY

Dec. 9, 1941.

A. LANGDON

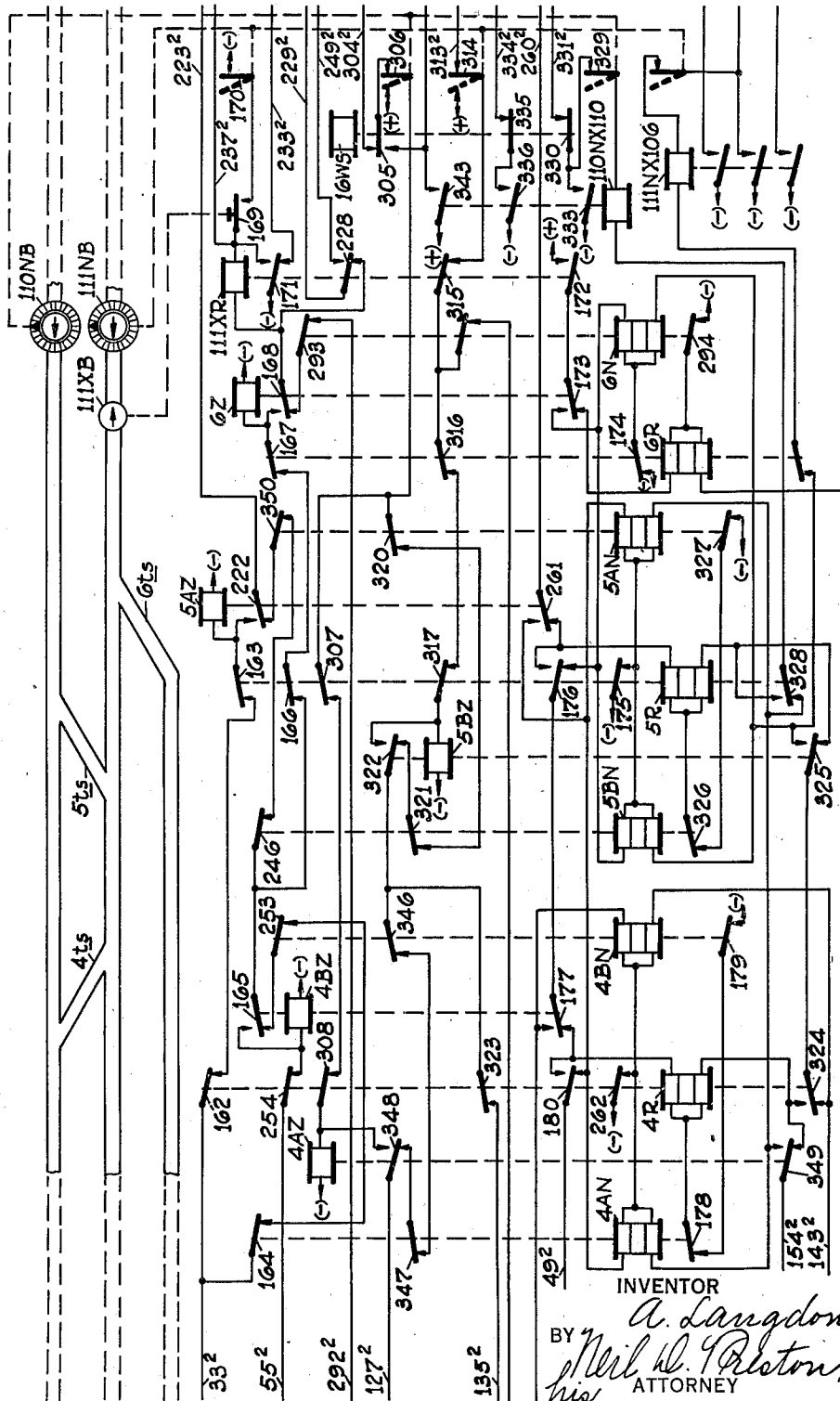
2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 2

2. 5.



Dec. 9, 1941.

A. LANGDON

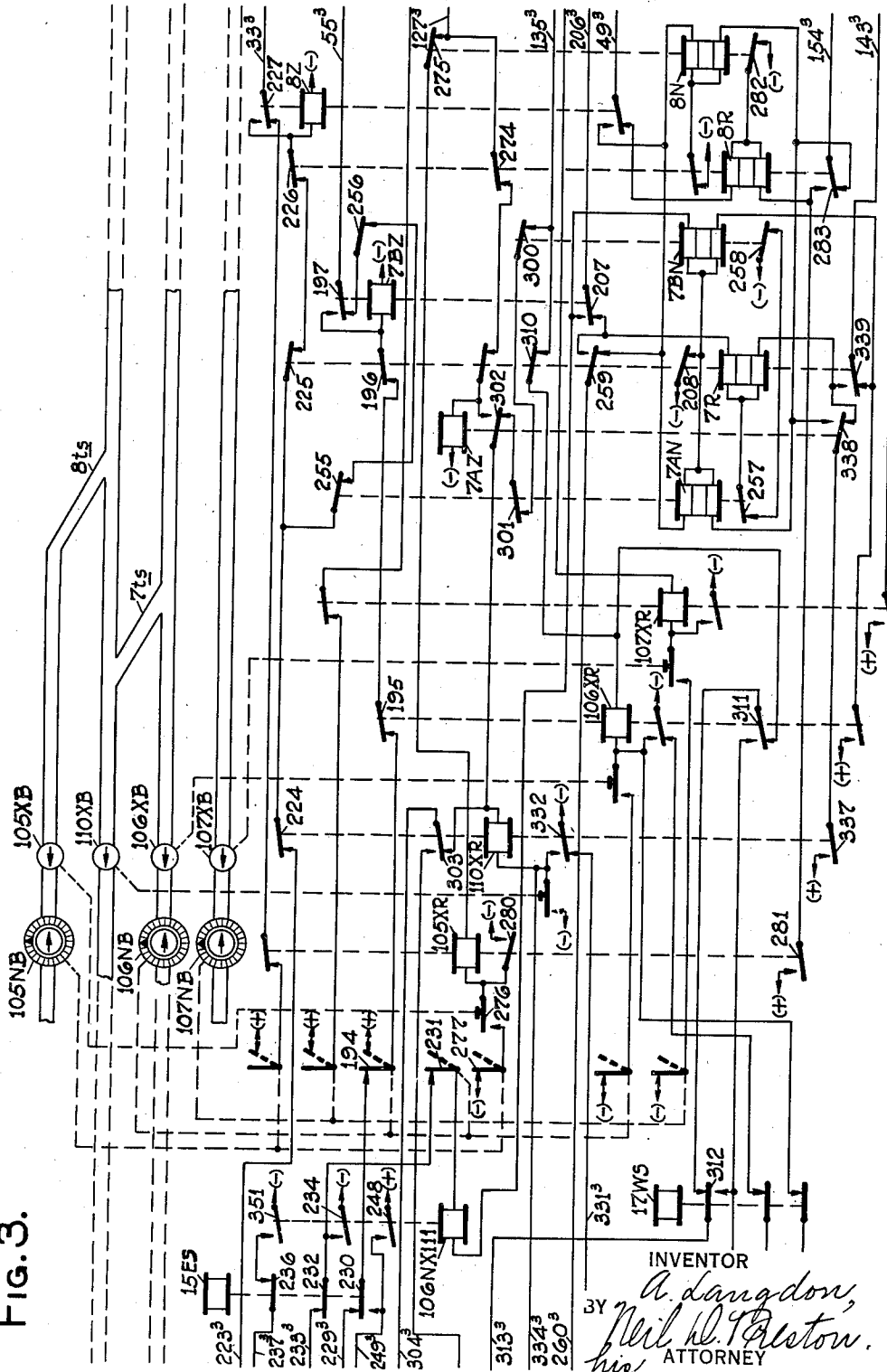
2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 3

FIG. 3.



INVENTOR

BY

A. Langdon,
Neil W. Weston,
ATTORNEY

Dec. 9, 1941.

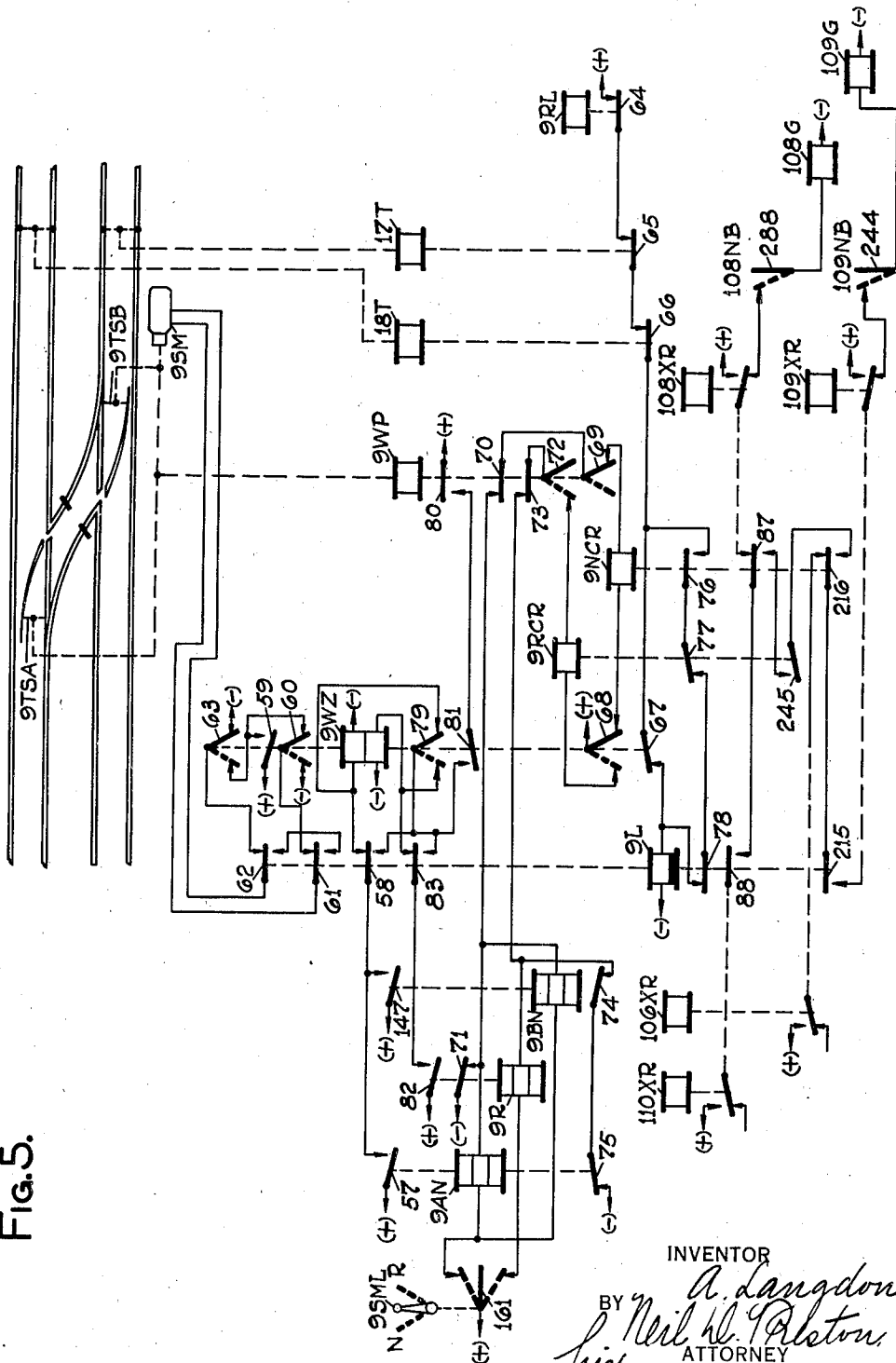
A. LANGDON

2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 5



Dec. 9, 1941.

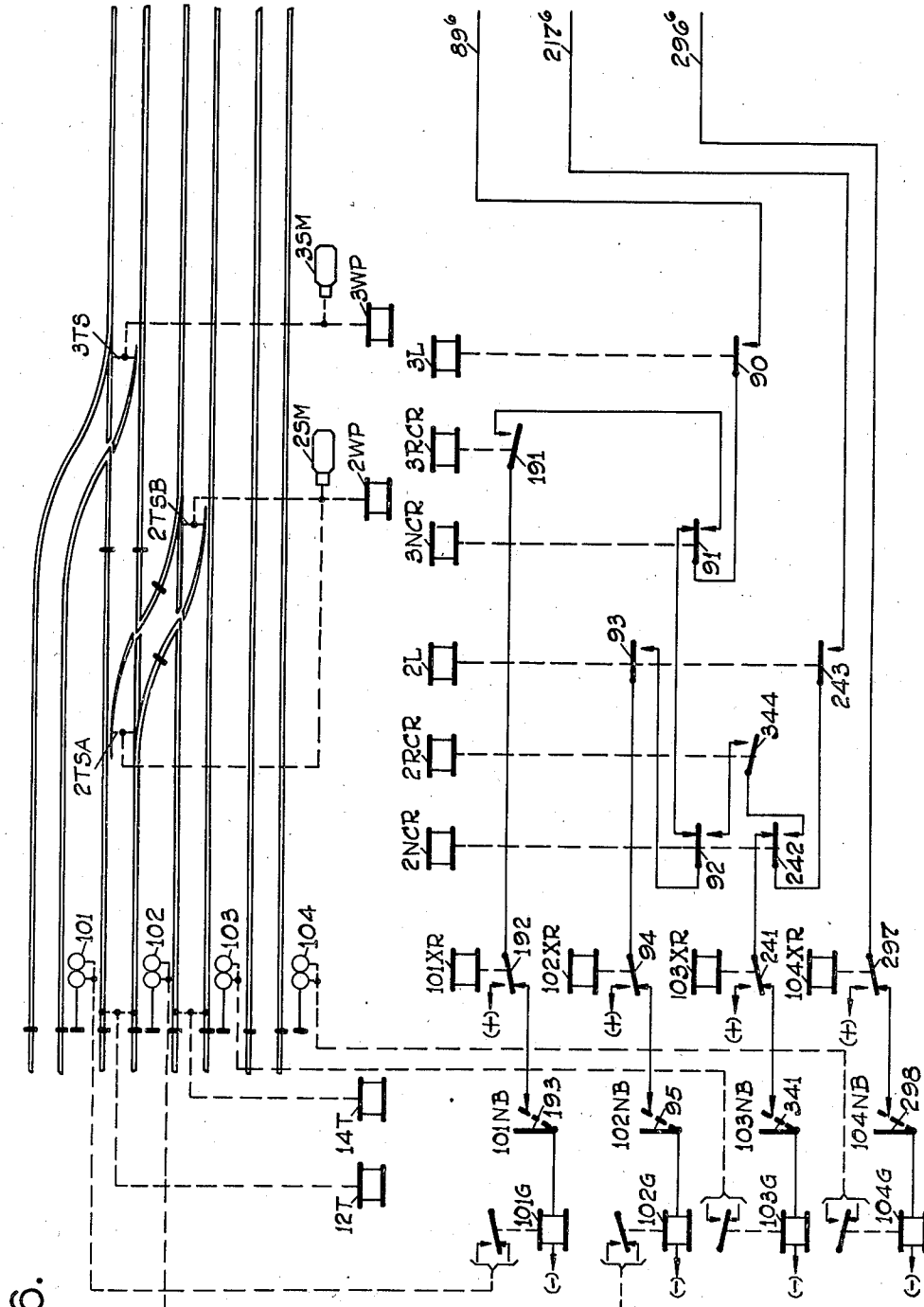
A. LANGDON

2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 6



INVENTOR

INVENTOR
BY *A. Langdon,*
Neil H. Preston,
his ATTORNEY

Dec. 9, 1941.

A. LANGDON

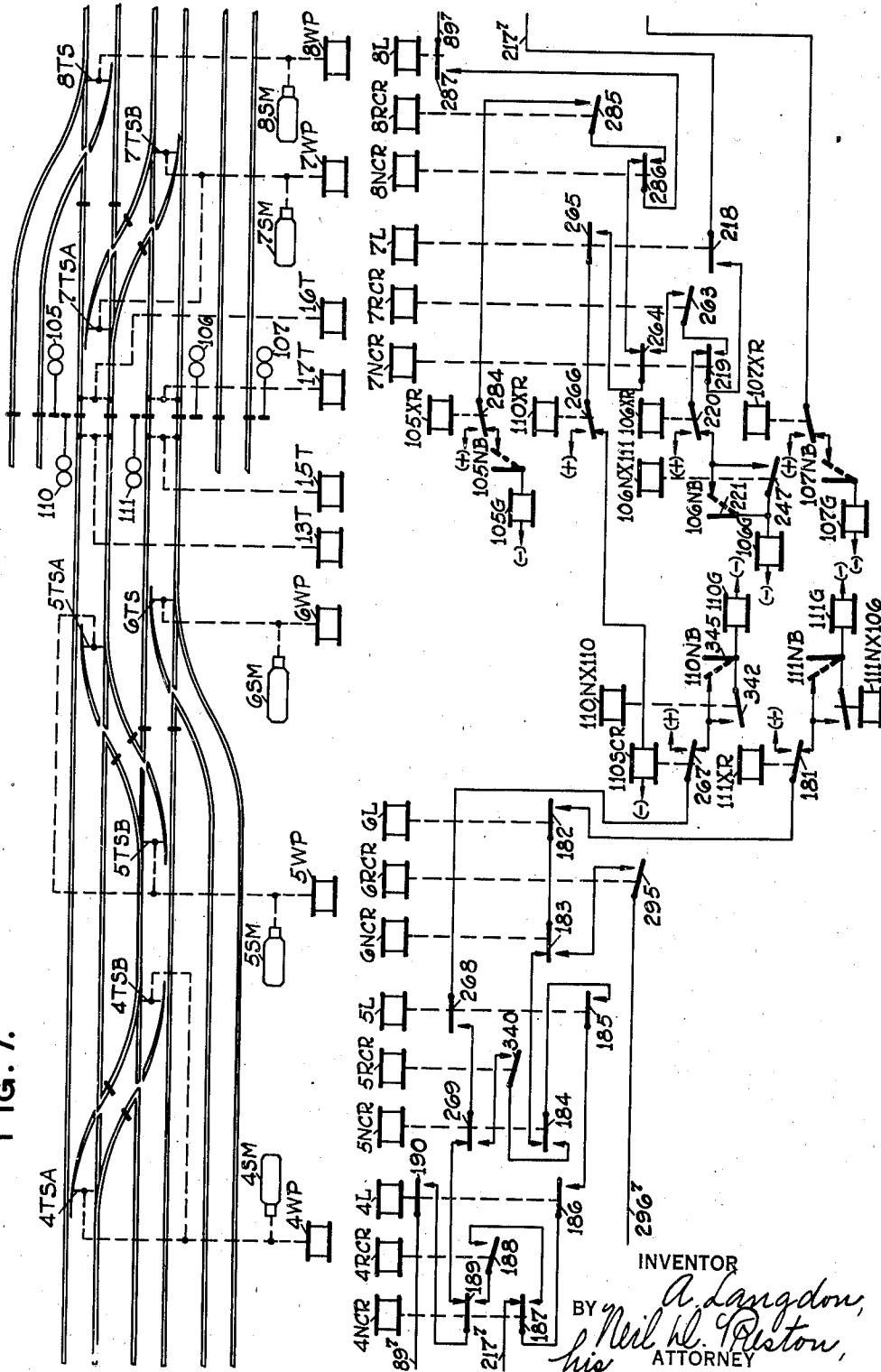
2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 7

FIG. 7.



Dec. 9, 1941.

A. LANGDON

2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Filed Jan. 8, 1937

8 Sheets-Sheet 8

FIG. 8.

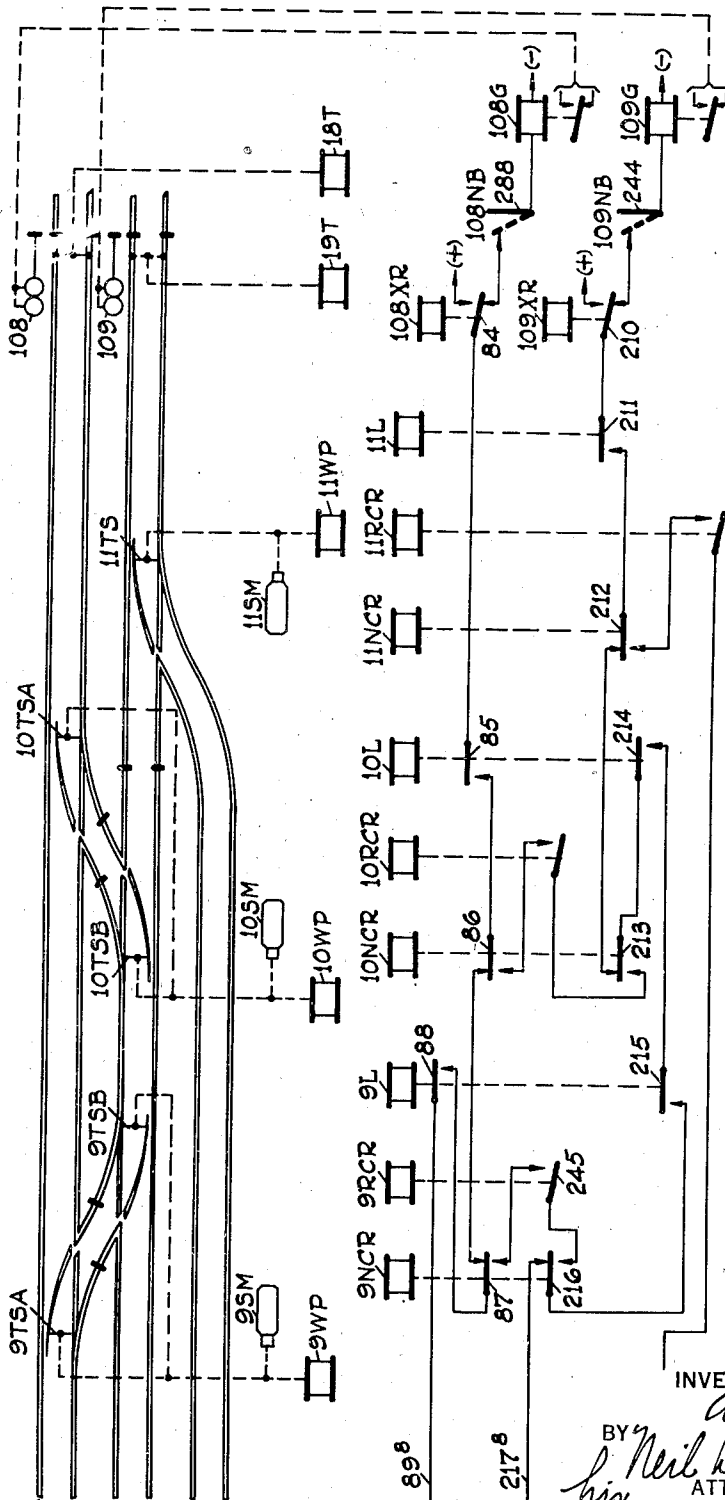


FIG. 9.

INVENTOR
A. Langdon,
BY Neil W. Preston,
ATTORNEY

NX-Control for End-to-End Operation of Plurality of Groups Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 6. Fig. 7. Fig. 8.	NX-Control for Single Group Fig. 1. Fig. 4. Fig. 6. Fig. 8.	Switch and Signal Control Typical of all Track Switches and Signals Fig. 5.
--	---	---

UNITED STATES PATENT OFFICE

2,265,240

INTERLOCKING SYSTEM FOR RAILROADS

Andrew Langdon, Brighton, N. Y., assignor to
General Railway Signal Company, Rochester,
N. Y.

Application January 8, 1937, Serial No. 119,641

67 Claims. (Cl. 246—134)

This invention relates to switch and signal control systems for railroads, and more particularly to systems of the so-called entrance-exit type in which the track switches in any given route are collectively operated to the appropriate positions to establish that route and a signal is cleared for governing train movement over that route by manipulation of manual control devices to designate merely the entrance and exit ends of that route.

In such an entrance-exit type of switch and signal control system, freely movable manual control devices in a form of small buttons or the like, are provided for each signal location of the track layout constituting an entrance and/or exit end of some route or routes afforded by the track layout. In the present embodiment, an entrance signal location may be designated by turning a small knob or button conveniently termed an entrance button; while an exit signal location may be designated by pressing a small push button, conveniently termed an exit button. However, any other suitable arrangement of movable elements may be employed to operate electric contacts for performing distinctive entrance and exit functions in accordance with the operator's manipulation. These manual control devices are mounted on a control panel within convenient reach of an operator, and are suitably identified with their respective signal locations by reason of their location on the control panel adjacent points on a miniature track diagram of the track layout corresponding with their respective signals.

Generally speaking, any one of the various forms of track layouts used on railroads may be considered as made up of one or more groups of switch points in the form of single switches, cross-overs, or the like, which interconnect various stretches of track, each of such groups providing a plurality of routes extending from an entrance signal location, which signal must be cleared to permit a train to enter the route, over one or more track switches of the group in certain normal or reverse positions, to a point on the track constituting the exit end of such route, which exit point may be the entrance end of some other route or routes in an adjoining group, or in some cases may be the end of the territory under the control of the operator. Some of the routes afforded by such a group of associated switches may be conflicting routes, namely, routes which cannot be used for train movement at the same time; while some of these routes may be non-conflicting routes, that is, routes that can be set

up and used at the same time. Since the operation of track switches which may be involved in conflicting and non-conflicting routes is subject to some suitable form of interlocking control, so as to prevent setting up conflicting routes, a group of switches associated with stretches of track to provide these various conflicting and non-conflicting routes may be said to constitute an "interlocked group."

Each of the various routes afforded by an interlocked group may be used for train movement in one direction or in both directions, as may be required for the desired movement of traffic. For train movement over a route in one direction, an entrance signal is provided and located adjacent the entrance end; and for train movement in both directions over a route, there is an entrance signal for each end of that route. If the track layout includes two or more interlocked groups located end-to-end, the signal locations at the adjoining ends of any two interlocked groups are each in effect an entrance signal location for one interlocked group and an exit signal location for the other interlocked group. These signal locations may for convenience be termed intermediate signal locations with respect to through routes that may be provided through such adjoining interlocked groups.

More specifically, when a track layout includes two or more interlocked groups, there may be certain routes of these interlocked groups which may be set up at the same time in an end-to-end relation, so to speak, and provide what is conveniently termed a "through route" over two or more successive interlocked groups and past one or more intermediate entrance signal locations.

Although such a through route can be established by entrance-exit manipulation for each interlocked group in turn, one object of the present invention is to provide that the system will set up a through route in response to the operator's manipulation of the manual control devices to designate the extreme entrance and exit signal locations of the desired through route. The system automatically acts in response to such manipulation to establish the proper route over each of the interlocked groups as required to provide the through route, and cause the intermediate entrance signals for such through route to be automatically cleared. Obviously, such operation of the system greatly simplifies and facilitates the operator's manipulation for the control of traffic through the interlocking plant.

In some track layouts, the arrangement of switches and stretches of track for any given in-

terlocked group may be such that there are two or more alternative or optional routes between the same common entrance and exit signal locations of that interlocked group. Under some conditions, either one of these alternative routes may be used for train movement, but under other conditions a route may be set up in conflict with one of the alternative routes so that the other alternative route is the only one available for use. Thus, another object of the invention is to provide a system that acts when the operator manipulates the buttons for common entrance and exit signal locations for these alternative routes to automatically select the alternative routes one at a time in some predetermined order of preference and dependent upon whether or not the respective routes can be established.

A similar problem of alternative routes is also presented in connection with the establishment of through routes, that is, when a plurality of interlocked groups are located end-to-end, the track layout usually affords two or more alternative routes between the same entrance and exit signal locations of different interlocked groups, thus providing what may be termed "alternative through routes." While the number of alternative through routes depends upon the number of optional or alternative routes in the respective interlocked groups, there may be alternative through routes even though there are no alternative or optional routes in any of the interlocked groups involved.

Under some conditions all of the alternative through routes between entrance and exit signal locations of different interlocked groups may be available for use without any conflict with other established routes; and under other conditions some one or more of the alternative through routes may be in conflict with some route established in some one of the interlocked groups involved. Also, some of the alternative through routes that may be afforded by the track layout are not desirable for use, as for example, a run-around movement from one track over a crossover in the reverse position to another track and then back to the first track over another crossover in the reverse position, when train movement straight along the first track is possible.

Where the track layout affords alternative through routes, the present invention provides that only one of the various alternative through routes will be selected and established upon actuation of manual control devices to designate the extreme entrance and exit ends thereof; and since one or more of these alternative routes may not be available or desirable for use at different times, this selection of a particular through route to be established is in accordance with some order of preference and is also dependent upon conditions of conflict with some other through route or route over some one of the same individual interlocked groups.

In accordance with this invention, the operation of the system to establish routes and clear signals under these various conditions is initiated or controlled by actuation of freely movable manual control devices to designate first an entrance signal location of the track layout where the train to be moved is approaching or standing, and then an exit signal location of the track layout to which it is desired to move the train. Since these manual control devices are freely movable and may be actuated by the operator at any time, safe operation of the sys-

tem requires that the power operation of all track switches should be subject at all times to the control of track circuits and associated relay means for detector or route locking, so that the operation of each of the switches in a route is prevented while a train is passing over or approaching said switches in traversing the route, in spite of any control that may be imposed by the operator carelessly or by mistake to change the position of such switch point.

Also, the signal to be cleared should be the one at the entrance signal location designated by the operator's manipulation, and this signal should not clear unless all of the switches in the route have been properly operated to the required position. The same signal, perhaps with distinctive route or speed indications, is ordinarily used to govern train movement into a plurality of different routes; and since this signal should not assume its clear condition unless the switches have been operated to the position required for a particular one of these routes than designated by the operator, according to this invention, each signal is cleared by closing a clearing circuit which is closed only if all of the switches in some route originating at the corresponding entrance signal location are in the normal or reverse positions corresponding with the control then being exercised by the operator. It is also considered preferable to arrange the signal clearing circuits so that a signal may not clear for a route until all of the switches in that route are effectively locked against power operation.

In connection with the control of signals by track circuits, it is contemplated that the practice suitable for the particular layout and kind of traffic will be adopted. In the case of some signals, such as those governing high speed train movement, the signal clearing circuit would ordinarily be controlled by track circuits of a portion of track extending to the next succeeding signal governing train movement in the same direction, in accordance with the principles of automatic block signalling, so that such a signal may not assume its clear condition unless the block ahead is not occupied by some other car or train. Under other conditions, particularly where it is desirable to move a locomotive or train into an occupied section of track for coupling or uncoupling of cars, or for switching moves, the signal may be allowed to clear independently of the track circuits, provided the switch points are in their full normal or reverse positions and safe for train movement. Such variations in the kind of signal control in accordance with recognized practice are not material to the invention; and while various arrangements of high speed signals, shunt or dwarf signals, or "call-on" signals may be employed, in the interests of simplicity it has been assumed in connection with the particular embodiment of the invention illustrated that the entrance signals for the various routes will be of the low speed type without automatic track circuit control.

In its broad aspect, this invention involves a rather complex combination or organization of electrical relays, circuits, and contacts, which are adapted and arranged for each installation to conform with the location and arrangement of switches, signals and the like. Generally speaking, in addition to suitable means for safeguarding the power operation of switches and the clearing of signals under the supervisory manual control of the operator, the system com-

prises an organization of relays, circuits, and contacts, constituting what may be conveniently termed a route selecting or establishing means, which is conditioned and operated by the actuation of manual control devices to designate the entrance and exit signal locations of a track layout, and which acts automatically to control the power operation of the appropriate switch points to the proper positions to provide a route, or a through route, between any entrance and exit signal locations designated, and to control the clearing of the signal or signals of such a route or through route, regardless of the number of alternative routes or alternative through routes that may be afforded by the track layout, and with the due regard to conflict with other routes then established by the route establishing means.

One characteristic feature of this route establishing means is that the power operation of each of the switches to the normal or reverse position is governed by the energization of associated normal and reverse switch control relays; and an assemblage of circuit paths and contacts each relating to and controlling the energization of the switch control relays for one of the several individual switches are organized in such a way that actuation of manual control devices to designate the entrance and exit ends of any given route will cause energization of a selected switch control relay for each of certain selected switches, as may be required to operate the appropriate switches to the proper positions to provide such a route, these circuits having their interconnections and continuity governed by contacts of these switch control relays so as to provide the necessary interlock between conflicting routes. In this arrangement characterizing this invention, the routes are established and the interlocking between conflicting routes is effective by reason of operations relating to the switches individually, rather than by reason of operations relating to the respective routes as a whole.

Another important aspect of this invention is that the desired and appropriate route is provided or built up by what may be termed pre-selection and completion operations of the route establishing means, for the purpose of enabling one appropriate route through an interlocked group, or a through route over a plurality of interlocked groups, to be automatically selected and established effectively upon actuation of manual control devices to designate the entrance and exit ends of such route or through route.

Considering the principles underlying this scheme for establishing routes by pre-selection and completion, any one of the various routes of a railway track layout may be analyzed as including one or more single switches, ends of crossovers, or the like, over which a train moves in turn in traversing the route, each of these switches having its points disposed with respect to the entrance end of the route, either in a facing point relation and capable of diverting train movement from the route in question to some other route, or in a trailing point relation so as to have only one position suitable for continued train movement in a direction away from said entrance signal location. Upon further analysis, it can be seen that switches in a route in a facing point relation to the entrance end are necessarily in a trailing point relation to the exit end. In short, any route may be considered as made up of switches disposed in a trail-

ing relation to one end of the other end of the route. Accordingly, it can be seen that any particular route of an interlocked group when identified by its entrance and exit ends, can be selected from all of the other routes by combining the position of switches in turn, starting at the exit end, in accordance with the position thereof required by reason of their trailing relation to either the entrance or exit end, as the case may be. In other words, when the trailed positions of switches for one direction of train movement from one signal location are combined with the trailed position of switches for the other direction of train movement from another signal location, the result is a route between said signal locations.

With these considerations in mind, pre-selection according to this invention may be said to involve, in response to the actuation of a manual control device to designate any given entrance signal location, the operation of automatically pre-selecting or conditioning each of those switches which is included in any one of the routes originating at said entrance signal location and is disposed in trailing relation thereto, for operation to the position required on account of such trailing relation. In this connection, although a route is not identified until the exit end as well as the entrance end has been designated, once an entrance signal location is designated, there is a determination of the position to which the trailed switches in all of the possible routes from the entrance signal location should be operated, if such operation is required for the particular one of these routes subsequently chosen, inasmuch as the only possible paths for train movement, regardless of which of these routes will be chosen, will be over these trailed switches in certain positions.

During this pre-selection operation, the trailed switches will not be actually operated by energization of their switch control relays, but the route establishing means is conditioned or prepared to cause operation of such of these switches as may be necessary when the particular route to be established is identified by designation of its exit end. This pre-selection operation in effect selects energizing circuits for the switch control relays associated with these trailed switches, so as to provide for the energization of the proper switch control relays when the completion operation occurs.

Further, the system is arranged so that the pre-selection just explained is effective with respect to each of the trailed switches only if a path for train movement from the designated entrance signal location to and over said switch in the pre-selected position is establishable, i. e. is not in conflict with some route then established by the route establishing means. Consequently, if switches have been pre-selected for operation to the normal position, for example, preparatory to a completion operation about to be described, it is assured that a path for train movement over these switches in the normal position and extending to the designated entrance signal location can be established.

Following this pre-selection operation, the completion operation of the route establishing means occurs when a particular one of the routes originating at the designated entrance signal location is identified by the actuation of a manual control device to designate its exit end. During this completion operation, the proper switch control relays of the appropriate switches required

for this route are energized by an operation which may be explained in general terms as involving determination of the position of successive switches in turn, starting with the switch nearest the exit end, dependent upon the trailing relation of these switches to the respective entrance and exit ends, the switches remote from the exit end to have their position thus determined being selected in accordance with the position of the next adjacent switch nearest the exit end. In the case of switches in a trailing relation to the entrance end of the route, the position to which they are operated is in accordance with the pre-selection; and in the case of the other remaining switches in the route the position to which they are operated is in accordance with that required by reason of their trailing relation to the exit end of the route. The completion operation to establish a particular route originating at the designated entrance signal location renders ineffective the pre-selection with respect to all trailed switches involved in all other routes originating at the same entrance signal location; but this does not prevent subsequent preselection of one or more of these same switches upon designation of some other entrance signal location for a non-conflicting route.

Since routes are established by a completion operation following a pre-selection operation, the proper functioning of the system requires that the manual control device be manipulated to designate an entrance signal location first and then an exit signal location; and in order that an accidental or careless manipulation by an operator may not cause unnecessary or abnormal operation of switches, provision is made in accordance with this invention so that the actuation of a manual control device to designate an exit signal location is not effective to exercise any control upon the route establishing means, unless some other manual control device to designate an entrance signal location had been previously actuated to perform the desired pre-selection operation. Under some conditions a route between a designated entrance and exit signal location may be in conflict with some route then established; and provision is also preferably made in accordance with this invention so that the actuation of a manual control device to designate an exit signal location is not effective to control the route establishing means, unless some route to that exit signal location is not in conflict with any established route, in order to avoid unnecessary operation of switches for routes that cannot be established.

In the specific embodiment of the invention illustrated, the pre-selection functions are performed by what is conveniently termed a self-selecting initiating circuit network; and the completion functions are performed by a completion circuit network. The detail features and operation of pre-selection and completion as exemplified by these initiating and completion circuit networks are more conveniently discussed as the circuits and operation are described in detail.

This general scheme of pre-selection and completion is specially adapted to provide the desired control for the automatic selection of optional or alternative routes. When, for example, that end of a crossover, which is in a trailing relation to a designated entrance signal location, is required to be in opposite positions for different alternative routes, the pre-selection is arranged to be normally effective for a preferred

one of these positions only, as for example, the normal position. Consequently, if the common exit signal location of alternative routes should be designated, this crossover is positioned during the completion operation to provide a predetermined one of the alternative routes. Also, this pre-selection operation for the preferred position of such switches involves the energization of circuits having their continuity controlled by contacts of switch control relays in such a way that the pre-selection is not effective with respect to any given one of the switches unless part of a route or path for train movement from the designated entrance signal location to and over said given switch in the pre-selected position is not in conflict with some route then established by the route establishing means. Thus, if the predetermined or preferred position cannot be used on account of conflict with some established route, the other position of such switch is pre-selected, and during the completion operation another alternative route is the one that is established.

The principle of pre-selection and completion is also specially adapted for through route operation. In accordance with this invention, upon actuation of a manual control device to designate any given entrance signal location, the pre-selection is effective for all routes originating at that signal location in all interlocked groups; and when the extreme exit end of a through route has been designated, a particular route is established through the corresponding remote interlocked group in accordance with the preselection to provide a route through that remote interlocked group from a particular intermediate entrance signal location. Upon completion of this route through the remote interlocked group, suitable relay means and circuit connections for through route operation are rendered effective at this particular intermediate signal location to perform entrance and exit functions at that signal location, much the same as if the manual control devices had been actuated for that signal location. This controls the clearing of the signal at the intermediate signal location in question, and also initiates a completion operation for the next adjoining interlocked group, which establishes a particular route through that interlocked group to a particular intermediate entrance signal location of that group; and this same plan of operation is repeated for as many interlocked groups as may be necessary until the complete through route is established and the signals controlled to assume the clear condition.

During such preselection operation in the different interlocked groups, each of the switches in a trailing relation to the designated entrance signal location is pre-selected for operation to a position to conform with some route originating at that entrance signal location, provided routes or parts of routes forming a path for train movement from that signal location to and over said switch in said selected position is not in conflict with some other established route. Consequently, the completion operation is effective to select automatically between alternative through routes that may exist, in accordance with a predetermined preference and dependent upon conflict with other established routes, in a manner which can be understood to better advantage as the detail operation is explained.

A further important attribute of this invention is the economy in the number of relays required to perform the functions of preselection, com-

pletion, and the like in the rather involved organization constituting the invention; and in general the number of relays required is dependent upon the number of switch points in the track layout, and not upon the arrangement of these switch points, or the number of routes afforded by the track layout. In the preferred embodiment of the invention illustrated, there is a pre-selecting relay, a normal and a reverse switch control relay for each single switch; and a pre-selecting relay and normal switch control relay for each end of a crossover, with a reverse switch control relay common to both ends of a crossover.

Another feature of the invention is that the auxiliary or emergency switch levers, which are usually provided in an entrance-exit system for controlling the operation of switch points individually, controls the energization of the switch control relays in such a way that the operation of an auxiliary lever is not effective to interfere with a route established, but may be used to modify the operation of the route establishing means, if occasion should require.

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 letters in the reference characters designate similar functions or relationships with the distinctiveness between such reference characters provided by the use of distinctive preceding numerals; in which like preceding numerals in the reference characters when applied to different letters represent the inclusion of such devices within a particular group; and in which:

Figs. 1, 2, 3 and 4, when placed end to end, show the miniature track diagram and self-selecting networks for a complicated track layout involving the feature of end-to-end entrance-exit control;

Fig. 5 shows typical switch and signal control circuits, which are governed by a self-selecting network, and their relationship to various of the automatic traffic controlling features.

Figs. 6, 7 and 8 show the track layout and signal control employed in connection with the end-to-end feature shown in Figs. 1, 2, 3 and 4;

Figs. 1 and 4, when placed end to end disclose the miniature track diagram and self-selecting network for a single interlocked group; and

Figs. 6 and 8, when placed end to end, show the track layout and signal control for a single interlocked group as shown by Figs. 1 and 4.

Fig. 9 illustrates the relationships of the various figures.

For the purpose of simplifying the illustration and facilitating in the explanation thereof, the conventional parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain conventional illustrations have been employed, the drawings having been made more with the idea of making clear the purposes and principles of the present invention together with its mode of operation, than with the idea of illustrating the specific construction and arrangement of parts that would probably be employed in practice.

The various relays and their contacts are illustrated in a conventional manner and symbols are employed to indicate connections to the terminals of batteries or other suitable sources of electric

current supply instead of showing all of the wiring connectings to such terminals.

The symbols (+) and (−) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of electric energy; and those terminals with which these symbols are used are assumed to have current flowing from the positive terminal designated (+) to the negative terminal designated (−).

The symbols employed with any one circuit are considered to designate the terminals of the same battery or other suitable source, but it is to be understood that as many separate sources may be provided as found necessary, or as many sources may be combined into a single source as found expedient in the practice of the invention.

If alternating current is employed, the symbols should be considered to represent the instantaneous relative polarities of the respective terminals.

Where groups of devices are referred to in a general way, such devices will be designated by the letters or preceding numerals characteristic of such groups instead of mentioning each specific reference character of that group of devices.

Apparatus

In the operation of railways, track switches are employed at junctions, stations, terminals, shunting yards, and the like, for directing train movement from one track to another, in and out of platforms, sidings, and the like, so as to provide efficient and expeditious movement of traffic; and the track layouts for the varying conditions of traffic movement involve widely varying arrangements of tracks and switches. The system of this invention is organized so that, by the appropriate selection and inter-connection of parts, it may be applied to any one of these various track layouts; and the particular track layout illustrated and used as a basis for an illustration of the features, functions, and mode of operation of this invention, is merely typical or representative. Accordingly, the various terms and expressions used herein with reference to this typical track layout are intended to be employed in a sense applicable to the various other arrangements of track switches and signals that may be encountered in practice.

For the purpose of disclosing the invention as applied to two interlocked groups, a track layout is employed as shown by the placing of Figs. 6, 7 and 8 end to end. In order that the invention may also be considered in its simplest form, that is, a form which employs only a single interlocked group, the drawings have been arranged so that the placing of Figs. 6 and 8 end to end provide a track layout for such a single interlocked group.

It is therefore thought expedient to set forth the apparatus used with the track layout of the combined Figs. 6, 7 and 8 as well as the organization of the complete system for such a track layout, although in the consideration of the operation of the system of the present invention it is considered expedient to first describe the operation of the system for a single interlocked group.

Track layout.—With reference to the combined Figs. 6, 7 and 8, the invention has been shown applied to a track layout including a stretch of double track connected by the crossovers including the track switches 2TSA—2TSB, 4TSA—4TSB, 5TSA—5TSB, 7TSA—7TSB, 9TSA—9TSB, 10TSA—10TSB, as well as includ-

ing the track switches 3TS, 6TS, 8TS, and 11TS connecting turnout tracks to the double tracks.

Signals 101, 102, 103 and 104 are provided for governing east bound traffic at the west entrance to the track layout, while signals 108 and 109 are provided for governing west bound traffic at the east entrance to the track layout. Signals 105, 106 and 107 are provided at an intermediate point in the track layout for governing east bound traffic, while signals 110 and 111 are provided at an intermediate point in the track layout for governing west bound traffic.

Inasmuch as the opposite ends of a crossover are usually operated at the same time, each crossover may be considered as operated by a single switch machine SM, although it is to be understood that two such switch machines may be employed for each crossover if so desired, all within the scope of the present invention. Thus, the switch machines 2SM, 3SM, 4SM, 5SM, 6SM, 7SM, 8SM, 9SM, 10SM and 11SM have been shown for the crossovers and track switches, which switch machines may be of any suitable type, such, for example, as disclosed in the patent to W. K. Howe, Pat. No. 1,466,903, dated September 4, 1923, having their motors controlled in any suitable way such as shown, for example, in the patent to W. H. Hoppe et al. Pat. No. 1,877,876 dated September 20, 1932. If the control of the Hoppe et al. patent is used, relay WZ of this disclosure is assumed to control the application of one polarity or the other to the control relay CR of such patent.

The various signals are assumed to be color light signals giving the usual indications of green for clear and red for danger or stop, and yellow, if an added indication is desired for caution, when track circuit control is employed. However, these signals may be of the search light type, the semaphore type, or any other suitable type instead of the particular type chosen for the embodiment of the present invention.

The track layout has been shown divided into track circuits separated by suitable insulated joints. These track circuits are provided with the usual track batteries and track relays, of which track relays 12T, 13T, 14T, 15T, 16T, 17T, 18T and 19T have been shown. The number of track circuits has been determined in accordance with the usual principles by providing at least one track circuit for each parallel or non-conflicting route in a particular interlocked group. These normally energized track circuits are wired in the usual manner to provide for fouling protection and to provide for the insulation of the track switches, such details of wiring having been omitted for the sake of simplicity in the disclosure.

Each track switch and crossover is provided with the usual switch position repeating relay WP of the usual polar-neutral type. Each relay WP is energized with one polarity or the other in accordance with the normal or reverse locked positions of its track switch in correspondence with its switch machine SM, and is deenergized whenever its track switch or crossover is unlocked or is in operation. The polarized circuit for controlling such a switch position relay is governed through the medium of a point detector contact mechanism for each track switch such as shown for example in the patent to S. S. Bushnell, Patent No. 1,517,236, dated November 25, 1924, it being understood, of course, that there would be two such mechanisms if two switch machines SM were employed for a cross-

over, which mechanisms would jointly control the polarized circuit for the single switch position repeating relay WP for such crossover.

Control machine.—A suitable control machine is located in the central office and is provided with a control panel on which a track diagram is constructed in a manner to be representative of the actual track layout in the field (see Figs. 1, 2, 3 and 4). The construction of this track diagram may be of any suitable type, such for example, as described in the prior application of S. N. Wight, Ser. No. 69,905, filed March 30, 1936, or as shown in the prior application of F. B. Hitchcock, Ser. No. 74,709, filed April 16, 1936. The features of the control panel for indicating the routes set up, track occupancy conditions and the clear or stop condition of the signals, may be provided in any suitable manner, the present invention being more particularly concerned with the setting up of the routes and the interlocking between such routes.

At points on the miniature track layout representative of the route ends on the actual track layout in the field, are located suitable entrance and exit buttons which control the setting up of routes and the clearing of signals for such routes. More specifically, an entrance button NB is provided for each of the signal locations, such as entrance buttons 101NB, 102NB, 103NB, 104NB, 105NB, 106NB, 107NB, 108NB, 109NB, 110NB and 111NB for the respective signals indicated by their preceding numerals. Also, an exit button XB is provided for the exit end of each route, such as exit buttons 101XB, 102XB, 103XB, 104XB, 105XB, 106XB, 107XB, 108XB, 109XB, 110XB and 111XB for the routes ending at the signals indicated by the preceding numerals. It is to be understood, however, that the ends of the routes may or may not correspond to the locations of signals represented on the miniature track diagram, since a route is usually considered as extending from one particular signal to the next signal governing traffic in the same direction, but may extend to some arbitrarily chosen point where there is no signal, as at the end of territory under the control of the operator.

For the purpose of the disclosure of the present invention, each entrance button NB is considered to be in the form of a knob which is rotated 90° from a normal position to an operated position in which operated position it remains until manually restored. Each knob is provided with contacts which are closed when it is in the normal position and other contacts which are closed when it is in an operated position, such contacts being associated with their respective knobs in the disclosure by dotted lines. However, it is to be understood that various other types of manual control means may be employed, as will be mentioned more specifically hereinafter.

Each of the exit buttons XB is of the self-restoring push button type, and has been indicated as associated with its contacts by a suitable dotted line. It is to be understood that the entrance and exit buttons may be associated on the control panel in accordance with any desired plan and still be within the scope of the present invention while accomplishing the novel control of routes by the distinctive actuation of buttons for each of the opposite ends of any route, without operating the individual elements or functions of the routes, through the medium of self-selecting

networks organized according to the principles set forth herein.

The control machine also includes auxiliary switch control levers SML, which are associated with their respective switch machines SM as indicated by their preceding numerals, and of which only the lever 9SML has been shown (see Fig. 5). These emergency switch control levers may be suitably located on the control panel, or may be suitably located on the back of the control machine, as desired, inasmuch as these control levers are merely auxiliary levers for individually operating the levers under certain abnormal conditions hereinafter described in detail.

System devices.—The entrance buttons NB and exit buttons XB are respectively indicated as connected to the contacts which they operate by suitable dotted lines so as to make their relationships readily apparent. Each exit button XB has associated therewith an exit relay XR. Although the entrance buttons NB are shown as operating contacts directly included in the self-selecting networks of the system, it is to be understood that such control may be repeated through entrance relays, if it is so desired.

The contacts of the entrance button NB for one end of a route and the contacts of the exit relay XR for the opposite end of that route jointly control the positioning of the proper switch control relays for the switches and crossovers in that route.

For each crossover, switch control relays AN, R and BN is employed, while for each single switch, control relays N and R are employed. These relays are of the neutral type and govern the operation of their respective switch machines through the medium of polar-neutral relays WZ as hereinafter described. These switch control relays AN, R, BN, N and R are selected through the self-selecting network of the system by certain auxiliary relays AZ and BZ and Z in a manner specifically described hereinafter.

With reference to Figs. 4 and 5, the relationships of these switch control and selecting relays may be more readily appreciated. The crossover including the track switches 9TSA and 9TSB are controlled by the switch machine 9SM, which switch machine is in turn controlled by the switch controlling relay 9WZ, while the switch control relays 9AN, 9R and 9BN control the relay 9WZ. It will be readily apparent that the relays 9AN and 9BN are respectively associated with the switches 9TSA and 9TSB, as the reference characters 9A and 9B are common to both sets of devices. Similarly, the selecting relays 9AZ and 9BZ are respectively associated with the switches 9TSA and 9TSB, as designated in their reference characters having their common characteristics 9A and 9B. However, relay 9R is associated directly with both track switches 9TSA and 9TSB.

Each track switch or crossover has associated therewith a lock relay L which prevents the operation of such track switch when it is unsafe for it to be operated. Such a lock relay has been typically shown in Fig. 5 of the drawings by the relay 9L, and associated with each such lock relay is the route locking for that switch which has been designated by the single relay 9RL. This route locking may include any suitable route locking features such as shown for example in the above mentioned application of S. N. Wight, Ser. No. 69,905, filed March 20, 1936, or as shown in the patent of C. F. Stoltz, Patent

No. 2,115,511 granted April 26, 1938, but it is believed unnecessary for an understanding of the use of route locking in the present invention to disclose the details of such locking.

Relays NCR and RCR are provided for each track switch or crossover to indicate when such track switch is in correspondence with its control relays, as will be pointed out in detail hereinafter.

A signal control relay G is provided for each signal for causing that signal to indicate clear or stop. These signal control relays have been specifically shown for each of the signals in the track layout and the selecting circuits for such relays have been shown in detail. However, the dotted lines connecting such relays with their respective signals have been omitted in all figures of the disclosure except where the association is made readily apparent in the usual conventional manner without adding complexity to the drawings, as in Fig. 8.

It is believed that the remaining features of the present invention will be best understood by considering the detailed operation of the system.

Operation

It is believed expedient to first consider the invention with regard to its simplest form, that is, the embodiment of the invention which includes only a single interlocked group. The placing of Figs. 1 and 4 end to end shows the track diagram and self-selecting network for such a single interlocked group; while the placing of Figs. 6 and 3 end to end shows the actual track layout in the field together with the signal circuit selections for such layout.

Fig. 5 is used with this arrangement of drawings which shows a single interlocked group, and is also used with the arrangement of drawings which shows a plurality of groups combined for end-to-end operation, to show in detail a typical switch control carried from switch control relays of the self-selecting network to their switch machine. This control is typical of every track switch in the layout irrespective of whether there is but a single switch or whether there is a crossover involved.

Inasmuch as one form of the invention employs Figs. 1 and 4, for example, placed end to end, while another form of the invention employs these two Figs. 1 and 4 separated by Figs. 2 and 3, it becomes necessary to employ a special system of numbering of the wires which cross the sheets of drawings so as to readily identify the circuits as they are pointed out in detail. To accomplish this purpose, each wire mentioned as extending from Fig. 1, for example, will be given a separate reference character such as wire 33¹, while this wire in extending to Fig. 2 will be given the reference character 33², but when mentioned in Fig. 4, it will be given the reference character 33⁴. In other words, when a circuit is traced with Figs. 1, 2, 3 and 4 used together, the reference characters will point out in which figures such wires may be found, although the base number will readily identify which wires fall opposite each other when Figs. 1 and 2 are placed end to end.

With this general organization in mind, we may now consider the operation of the system in establishing a route through the track layout for the single interlocked group.

Normal conditions.—Although the track switches TS are usually left in their last operated positions under normal operating conditions,

they have been shown in the disclosure in positions for the passage of main line traffic. The signals are considered to be normally "at stop" with the lower or red indicator of each signal normally illuminated, unless approach lighting features are employed in accordance with well known practices.

The track circuits are all unoccupied so that their respective track relays T are normally picked up.

All of the lock relays L are normally energized as will be readily apparent upon the consideration of the lock relay 9L of Fig. 5, which will be considered in detail hereinafter.

All of the switch control relays N, R and WZ are normally deenergized. It is preferable that all of the indicators on the control panel be normally deenergized to provide what has been conveniently termed "a normally dark board," although any arrangement of indications may be employed with the present invention without departing from the use of the principles involved in the present invention.

Preselection operation by a self-selecting initiating circuit network.—As previously explained, the operation of the system of this invention to select or establish a route involves what is conveniently termed a conditioning or preselection operation initiated by the operation of an entrance button alone, followed by a completion operation in response to the actuation of an exit button.

In the specific embodiment of the invention illustrated, the position of trailed single switches and ends of crossovers is preselected by the energized or non-energized condition of an associated pre-selecting relay Z, the energized condition of this relay corresponding to operation to the normal position, and the deenergized condition to the reverse position. Upon actuation of an entrance button, the appropriate pre-selecting relays Z for the switches, which are included in the various routes originating at the corresponding entrance signal location and which are disposed in a trailed relation to said entrance signal location, are energized by circuit paths arranged in the form of a network. Since these switches of an interlocked group that are trailed for one direction of train movement, are in a facing point position for the opposite direction, there are separate initiating circuit networks for opposite directions of train movement over an interlocked group.

Considering a typical example of this preselection operation, let us consider that the operator desires to establish a route from the entrance signal 101 to the signal 103. To do this, he turns the entrance button 101NB clockwise to an operated position to close contacts 30 and apply electrical energy to a feed point of the initiating circuit network. This causes energization of a preselecting relay Z for each of the trailed switches required to be normal in all of the routes originating at the entrance signal 101. In other words, the pre-selecting relays Z of all of the switches, which are included in all the routes originating at signal 101, receive energy over the circuit paths of the initiating circuit network, providing such switches are in a trailing relation to this entrance signal 101, and also providing these switches are trailed in the normal position.

Applying these principles in the case of the assumed actuation of entrance button 101NB, it will be evident upon reference to the track layout illustrated that there is one route from the

signal 101 to signal 103, and another route from signal 101 to signal 109. A train moving from signal 101 over either of these routes passes over the switch 3 in a trailing direction; but since this switch 3 is trailed in the reverse positions, its pre-selecting relay 3Z of Fig. 1 is not energized. Each of these routes originating at the signal 101 also includes the switch 9TSA for the upper end of the crossover 9; but since this switch is in the facing point relation to the signal 101, its pre-selecting relay 9AZ does not have its energization controlled. The switch 9TSB for the lower end of the crossover 9 is included in a trailing relation to the entrance signal 101 in the route to signal 109; but since this switch is trailed in the reverse position, its associated relay 9BZ is left deenergized. The switch 10TSA for the upper end of the crossover 10 is in a trailing relation to the entrance signal 101 and is included in the route to signal 103; and since this switch is trailed in the normal position, its associated relay 10AZ is energized over a circuit path of the initiating circuit network, which will be presently traced in detail. The switch 10TSB for the lower end of the crossover 10 is included in the route to signal 109 but is in a facing point relation to the entrance signal 101, so that its relay 10BZ does not have its energization controlled. The switch 11TS is included in the route to signal 109, and is also trailed in the normal position, so that its pre-selecting relay 11Z is energized by a circuit path which will be presently traced in detail.

The circuits for energizing the pre-selecting relays 10AZ and 11Z in the example under consideration may be traced from (+), through the contact 30 of the entrance button 101NB, back contact 31 of the exit relay 101XR for the same signal location, back contact 32 of relay 3Z, wire 33¹ of Fig. 1 to wire 33⁴ of Fig. 4, where the circuit divides into two branches for the energization of relays 10AZ and 11Z respectively. For the energization of relay 10AZ the circuit continues through back contact 34 of relay 9R, back contact 35 of relay 10R, winding of relay 10AZ to (—), the energization of this relay 10AZ closing its front contact 40 and continuing the circuit to the exit relay 103XR. The branch circuit for energizing the relay 11Z continues from wire 33⁴ through the back contact 35 of relay 9AN, back contact 250 of relay 9BN, back contact 37 of relay 9BZ, back contact 38 of relay 10R, back contact 39 of relay 11R, winding of relay 11Z to (—), the energization of this relay 11Z closing its front contact 198 to continue the circuit to the exit relay 109XR.

These initiating circuit paths just traced exemplify certain characteristics or features of the initiating circuit network which may be discussed at this time. From one standpoint, the initiating circuit network may be said to comprise wires or circuit portions arranged and interconnected through front and back contacts of the pre-selecting relays Z to conform with the track layout, in such a way that there is a complete initiating circuit for each route, usually comprising a plurality of such interconnected circuit portions, which are energized by the actuation of an entrance button for that route and which supply current for the energization of the exit relay of that route, when the exit button is operated. Each of these circuit portions, which may be considered as relating to either the normal or the reverse position of the associated single switch or end of a crossover, includes a

back contact of the switch control relay for the other position of its switch, so that current may flow over the initiating circuit for a route only so far as there is a path available for train movement along that route not in conflict with some other route then established by the route establishing means, with the result that no current is supplied to energize an exit relay, unless some route can be established to the corresponding exit signal location from the entrance signal location designated. In other words, the initiating circuit network, in addition to providing for the energization of appropriate pre-selecting relays, serves to supply operating current to exit relays for rendering effective the manual actuation of exit buttons for routes not in conflict with established routes.

For example, in the case of the route from the signal 101 to signal 109, the circuit path above traced for energizing the pre-selecting relay 11Z to close its contact 198 and supplying an operating potential to the relay 109XR, includes the back contact 39 of the reverse switch control relay 11R, so that if there should be a route established over the switch 11 in its reverse position, the pre-selecting relay 11Z cannot be energized to position this switch for operation to the normal position, and the exit relay 109XR cannot be energized for any route over this switch in the normal position. Similarly, the energizing circuit for pre-selecting relay 11Z includes a back contact 38 of the reverse switch control relay 10R for the crossover 10, so that if this crossover is included in its reverse position in any established route, the pre-selecting relay 11Z cannot be energized, nor current supplied to the exit relay 109XR. In this connection, it will be evident that if either switch 11 or crossover 10 is included in the reverse position in some established route, no route can be established to the exit signal location 109.

In the case of the crossover 9, the route from signal 101 to signal 109 is over this crossover in the reverse position, and under these conditions, the circuit for energizing the pre-selecting relay 11Z includes the back contacts 250 and 36 respectively of the normal switch control relays 9BN and 9AN for this crossover, so that if there is a route established over either end of this crossover in the normal position, the relay 11Z and the exit relay 109XR cannot be energized from entrance contact 30. In the case of the remaining switch 3, required to be in the reverse position for the route from signal 101 this signal 109 under consideration, and although the circuit for supplying current to the pre-selecting relay 11Z may include a back contact of the relay 3N in the same way as in the case of the single switch 17, as illustrated in this particular instance, the back contact 32 of the relay 3Z is used to open said energizing circuit if the switch 3 is included in some route in its normal position, since the relay 3Z is energized when the switch 3 is controlled to its normal position for a conflicting route originating at the signal 102.

In a similar way and in accordance with the same principles, back contacts of the switch control relays are included in the various circuit paths for the energization of the pre-selecting relays Z of the initiating circuit network; and as will appear as initiating circuits for various routes are traced later. Upon operation of an entrance button to supply potential to a feed point of the initiating circuit network, no operating potential is supplied to an exit relay un-

less some route can be established to the corresponding exit signal location from the entrance signal location designated, and each pre-selecting relay is energized only if a path for train movement is available from the designated entrance signal location to and over the corresponding switch in its normal position.

In connection with such a network arrangement of initiating circuit paths, the contacts of the pre-selecting relays Z act to isolate circuit portions of the network and avoid the flow of current over circuit paths that would otherwise cause improper energization of pre-selecting relays for impossible routes and also supply current to exit relays when a possible route could not be established. For example, the front and back contact 32 of the pre-selecting relay 3Z isolates the connections which supply current from the entrance buttons 101NB and 102NB respectively to the wire or circuit portion 33. In other words, the circuit portion for the reverse position of switch 3 is disconnected from the circuit portion for the normal position of this switch, so that upon actuation of the button 101NB, for example, current may not flow in a reverse direction, so to speak, over a circuit path corresponding to the crossover 2 in the reverse position and energize the pre-selecting relay 9BZ improperly, there being no possible route from the entrance signal 101 over the crossover 2 in the reverse position and the crossover 9 in the normal position. In short, the contacts of the pre-selecting relays Z may be said to limit the flow of current to initiating circuits for possible routes.

Completion operation by a completion circuit network.—After the energization of the initiating circuit network in response to the actuation of an entrance button just described, resulting in preselecting the position of the trailed switches in all of the routes originating at the corresponding entrance signal location, operation of the exit button for a particular one of these routes energizes the corresponding exit relay.

In the particular route under consideration, only the relay 10AZ is picked up although there may be other pre-selecting relays picked up for the other routes emanating from signal 101, such as relay 11Z. Upon the actuation of the exit button 108XB, a circuit is completed for energizing the relay 108XR from (+), through a circuit including lever contacts 30 in an operated position, back contact 31 of relay 101XR, back contact 32 of relay 3Z, wire 33¹, wire 33⁴, back contact 34 of relay 9R, back contact 35 of relay 10R, front contact 40 of relay 10AZ, windings of relay 108XR, back contact 41 of exit button 108XB, lever contact 42 of entrance button 108NB in a normal position, to (—). The current, which flows in this pick-up circuit, causes the contacts of the relay 108XR to be picked up. The closure of contact 43 of relay 108XR applies (—) to the right hand terminal of relay 108XR to shunt out the self-restoring contact 41 of the exit button 108XB to thereby cause relay 108XR to be stuck up dependent upon the entrance button 101NB, although the operator releases the exit button 108XB.

It will be noted that there is an auxiliary pick-up circuit for the exit relay 108XR from (+), through a circuit including lever contact 30 of entrance button 101NB in an operated position, back contact 31 of relay 101XR, back contact 32 of relay 3Z, wire 33¹, wire 33⁴, back contact 36 of relay 9AN, back contact 250 of relay

9BN, back contact 37 of relay 9BZ, back contact 235 of relay 10BN, back contact 239 of relay 10AN, back contact 40 of relay 10AZ, windings of relay 108XR, back contact 41 of exit button 108XB, lever contact 42 of entrance button 101NB in a normal position, to (—).

This circuit is not closed under the usual operating conditions because the relay 10AZ is immediately picked up upon the closure of the lever contact 30, and also because a short interval of time occurs between the operation of the entrance button 101NB and the operation of the exit button 108XB, so that the relay 10AZ has time to pick up and open this auxiliary pick-up circuit at back contact 40. However, if the relay 10AZ fails to pick up either because of a fault in its pick-up circuit or because its pick-up circuit has been manually opened (as hereinafter pointed out), a so-called "run-around route" will be established over the crossovers 9 and 10 in reverse positions. This "run-around route" will be discussed in detail following the consideration of the completion of the main route governed by the operation of the entrance button 101NB and the exit button 108XB.

This energization of the exit relay 108XR closes its contact 44 and supplies an operating potential to a completion circuit network which may be said to be analogous to the initiating circuit network in the sense that it comprises wires or circuit portions, corresponding to the normal or reverse position of each single switch or end of a crossover, which are inter-connected in accordance with the arrangement of the switches in the track layout, by front or back contacts of the pre-selecting relays Z, or by front contacts of reverse switch control relays, or by direct connections, as the case may be. Each of these circuit portions, corresponding respectively to the normal or reverse position of one of the track switches, has its associated normal or reverse switch control relay connected to it, so that the application of an operating potential to such circuit portion effects the energization of the normal or reverse switch control relay to cause operation of the track switch to a corresponding position. Upon energization of the initiating circuit network in response to the manual actuation of any given entrance contact, the resultant energized or non-energized condition of the pre-selecting relays serves in effect to connect the various circuit portions for the energization of switch control relays in such a way that upon application of a potential to a feed point of the completion circuit network corresponding to the exit end of a route, the proper normal or reverse switch control relays for the switches or ends of crossovers to establish that route are energized.

In the arrangement illustrated, there is a completion circuit network for each direction of train movement through an interlocked group, and separate windings of the switch control relays are energized by these completion circuit networks.

The completion circuit network for a given direction may be explained as acting to govern the position of successive switches in turn, starting with the switch nearest the exit end, dependent upon the energized or non-energized condition of the associated pre-selecting relay Z in the case of a switch in a trailing relation to the entrance end; or in accordance with the circuit connections of the network in the case of the remaining switches in the route disposed in a trailing

relation to the exit end. In other words, the circuit connections of the completion circuit network existing after the pre-selection operation may be considered as acting to energize the switch control relays of successive switches, starting with those nearest the exit end, to build up a route by the action of current passing along circuit portions of the completion circuit network in much the same way as a train would do in following a path backward from the exit signal location toward the entrance signal location over switches in their pre-selected position.

Considering a typical example of this completion operation for the route from the signal 101 and signal 108, when the exit relay 108XR is energized and closes its contact 44, an operating potential is applied to a feed point of the completion circuit network corresponding to this exit signal location. The switch 10TSA for the upper end of the crossover 10 is the switch nearest this exit end; and since it is in trailing relation to the entrance signal 101, its position is determined by the condition of the pre-selecting relay 10AZ. As previously explained, this relay 10AZ is energized by the initiating circuit, and hence the wire or circuit portion to which current is applied through the front contact 44 of the exit relay 108XR is connected through the front contact 45 of the relay 10AZ to the circuit portion of the network which corresponds with the normal position of this switch 10TSA, and to which is connected the normal switch control relay 10AN, so that the relay 10AN is energized by a circuit which may be traced from (+), through front contact 44 of relay 108XR, front contact 45 of relay 10AZ, winding of relay 10AN, through back contact of relay 10AZ, winding of relay 10AN, through back contact 46 of relay 10R, to (—).

It having thus been determined that the route to be built up is over the upper end of the crossover 10 in its normal position and along the upper track, it can be seen upon referring to the track layout that, if this upper end of the crossover is to be in the normal position for a route, the switch 9TSA for the upper end of the crossover 9 must also be in the normal position; and hence the circuit portions for the relays 9AN and 10AN may be directly connected. In other words, the position of the switch 9TSA, which is disposed in a trailing relation to the exit end, is determined when the positioning of the switch 10TSA is determined; and there is only one position which the switch 9TSA may have to provide a path for train movement, so that relay 9AN may be energized in multiple with relay 10AN by a circuit readily traced through the upper winding of relay 9AN and back contact 47 of relay 9R, to (—).

The positioning of the switch 10TSA for the upper end of the crossover 10 in accordance with its preselection also determines that the route to be established is along the upper track, and accordingly current is passed on from the wire energizing relay 10AN through back contact 48 of relay 9R to wire 49⁴ of Fig. 4 connected to wire 49¹ of Fig. 1 and to the contact 50 of the preselecting relay 3Z for the next succeeding switch 3. Switch 3 is in a trailing relation to the entrance signal 101, but is trailed in the reverse position, and hence its pre-selecting relay 3Z is not energized. Current is thus supplied through the back contact 50 of this relay 3Z to the circuit portion for the reverse position of this switch, to which is connected the reverse switch control relay 3R, so that its upper winding is energized by

a circuit readily traced from (+), through front contact 44 of relay 108XR, front contact 45 of relay 10AZ, back contact 48 of relay 9R, wires 49⁴ and 49¹, back contact 50 of relay 3Z, upper winding of relay 3R, back contact 51 of relay 3N, to (-).

In connection with the completion circuit network, it may be pointed out here that certain circuit portions thereof are connected upon energization of reverse switch control relays, and other connections normally existing are broken upon such energization. For example, in the case of the route from signal 101 to 108 just described, the circuit portions for the energization of relays 9AN is normally connected through the back contact 48 of the reverse switch control relay 9R to the wire 49⁴ leading to the contact 50 of the pre-selecting relay 3Z, while the circuit path for the energization of the reverse switch control relay 9R is connected to the wire 49⁴ through its front contact 48. This arrangement of interconnecting circuit portions of the completion circuit network through front and back contacts of reverse switch control relays is employed for the purpose of isolating the circuit portions for the energization of normal and reverse switch control relays, so that current supplied to a reverse switch control relay of a switch cannot also flow to a normal switch control relay of that switch and any associated switch, or vice versa, and thereby cause the undesired operation of switch control relays.

Considering another characteristic of the completion circuit network, the operation of an entrance button energizes pre-selecting relays for all of the establishable routes originating at the corresponding entrance signal location; and when a particular one of these routes is established by the operation of the completion circuit network, the pre-selection is rendered ineffective with respect to all of the other routes originating at the same entrance signal location. For example, at the time the exit relay 108XR is energized and the route of signal 101 to signal 108 is established as just described, other initiating circuit paths are energized to energize pre-selecting relay 11Z for a route from signal 101 to signal 109; and when the route from signal 101 to signal 108 is established, these other initiating circuit paths for the other routes are broken so as to prevent energization of relay 11Z so far as its energization from the entrance button 101NB is concerned, but at the same time leave available initiating circuit paths for the energization of the pre-selecting relay 11Z upon actuation of some other entrance button for a non-conflicting route, such as the entrance button 103NB. This effect is produced by opening the back contact 36 of switch control relay 9AN, when the upper end of the crossover 9 is operated to the normal position, to interrupt the supply of current to the relay 11Z from the button 101NB, this being the point of conflict between the established route from signal 101 to signal 108 and the route from signal 101 to signal 109. It can be seen that the opening of this back contact 36 of the switch control relay 9AN does not prevent the energization of relay 11Z upon the operation of some other entrance button, such as entrance button 103NB, for some route not in conflict with the established route, such as over the lower end of the crossover 9 in the normal position. The same plan of control applies to the other routes; and it may be said that upon establishing a given route, the initiating circuit paths for all other

routes originating at the same entrance signal location are interrupted at the points of conflict.

Further, the energization of switch control relays to establish a route controls the circuits in such a way that the operation of an entrance and/or exit button for any conflicting route will not effect any change in the circuits of the initiating and completion circuit network so far as the established route is concerned. This interlock between conflicting routes will be considered later in detail, and it is considered expedient to discuss now the manner in which the switch control relays govern the operation of their associated track switches.

From the above description, it will be seen that the operation of an entrance button NB closes a contact which applies positive potential (+) to what are conveniently termed "initiating circuit paths" which correspond to the available routes emanating from the entrance point corresponding to the operated entrance button. The operation of the exit button XB employs the energy of a particular one of the initiating circuit paths to pick up and stick the exit relay for the corresponding exit point, which exit relay applies energy to a completion circuit path corresponding to the initiating circuit path supplying energy to such exit relay. It will, of course, be apparent that only one completion circuit path can be energized by the picking up of an exit relay because the preselecting relays Z allow energy to be applied only to the completion circuit path corresponding to the employed initiating circuit path, and the response of the N and R relays to the energization of the completion circuit paths completely isolates the initiating and completion circuit paths so that they can not be interrupted by the operation of an entrance and exit button for a conflicting route.

In general, it may be stated that there is a group of initiating circuit paths for each direction and a group of completion circuit paths for each direction with the circuits of each group arranged according to the several routes through the track layout, and the initiating and completion circuit paths for each route cooperate to establish that route to which they correspond. These principles apply both to the simplified track layout arrangement of Figs. 1 and 4 and also to the more complex track layout arrangement of Figs. 1, 2, 3 and 4. In other words, the principles of the self-selecting network of the present invention are applicable both within a single interlocked group and also to a number of related interlocked groups, all of which will be more clearly apparent as the system of the present invention is further discussed.

Switch control.—Each of the track switches included in the route respond to their respective switch control relays N and R, but only the operation with respect to the control of the crossover 9 will be described in detail with reference to Fig. 5, as control is typical of the operation of all of the track switches.

More specifically, the switch control relay 9AN has been picked up by the operation of the self-selecting network. This closes an energizing circuit for the switch control relay 9WZ from (+), through a circuit including front contact 57 of relay 9AN, front contact 58 of relay 9L, upper winding of relay 9WZ, to (-). The energy which flows in this circuit actuates the polar contacts of the relay 9WZ to right-hand positions and causes the neutral contacts to be picked up.

The response of the relay 9WZ closes the normal operating circuit for the switch machine 9SM from (+), through a circuit including front contact 59 of relay 9WZ, polar contact 60 of relay 9WZ in a right-hand position, front contact 61 of lock relay 9L, through the switch machine 9SM, front contact 62 of lock relay 9L, polar contact 63 of relay 9WZ in a right hand position, to (-). The current which flows in this normal operating circuit causes the switch machine 9SM to operate the track switches 9TSA and 9TSB to normal positions, if they are not already in such position.

It will be noted that the normal energizing circuit for the relay 9WZ and also the operating circuit for the switch machine 9SM include front contacts 58 and 61 respectively of the lock relay 9L. This lock relay 9L is normally energized by a circuit closed at (+), through a circuit including front contact 64 of route locking relay 9RL, front contact 65 of relay 17T, front contact 66 of relay 18T, back contact 67 of relay 9WZ, windings of relay 9L, to (-).

The energization of the relay 9WZ opens this pick-up circuit for the lock relay 9L at back contact 67, so that, when the switch machine 9SM is already in a normal position, as in the case under consideration, the correspondence relay 9NCR is already energized, which allows the lock relay 9L to immediately drop away.

The energizing circuit for the normal correspondence relay 9NCR is closed from (+), through a circuit including polar contact 68 of relay 9WZ in a right-hand position, windings of relay 9NCR, polar contact 69 of relay 9WP in a right-hand position, front contact 70 of relay 9WP, back contact 71 of relay 9R, to (-).

On the other hand, if the track switches 9TSA and 9TSB were in reverse positions before the switch control relay 9AN is picked up, then the reverse correspondence relay would be energized. Such energizing circuit for the relay 9RCR would be closed from (+), through a circuit including polar contact 68 in a left-hand position, windings of relay 9RCR, polar contact 72 of relay 9WP in a left-hand position, front contact 73 of relay 9WP, back contact 74 of relay 9BN, back contact 75 of relay 9AN, to (-).

Under such circumstances, the picking up of the relay 9AN opens back contact 75 deenergizing the relay 9RCR. The actuation of the polar contact 68 of relay 9WZ to a right-hand position continues to cause the deenergization of the relay 9RCR, and the normal correspondence relay 9NCR is not picked up until the track switches 9TSA and 9TSB are completely operated to normal positions. Thus, upon the opening of back contact 67 of relay 9WZ, a stick circuit is closed for the lock relay from (+), through a circuit including front contact 64 of route locking relay 9RL, front contact 65 of relay 17T, front contact 66 of relay 18T, back contact 76 of relay 9NCR, back contact 77 of relay 9RCR, front contact 78 of relay 9L, windings of relay 9L, to (-).

This stick circuit maintains the relay 9L energized until the track switches 9TSA and 9TSB are operated into correspondence with the switch control relays 9WZ, 9AN, 9R and 9NB at which time the relay 9NCR is picked up opening back contact 76 and deenergizing relay 9L, preventing further control of switch control relay 9WZ. It is noted that the lock relay 9L is made slightly slow acting so as to bridge any time period between the opening of back contact 67 of relay

9WZ and the closing of either of the contacts 76 of relay 9NCR or 77 of relay 9RCR depending upon which operation of the switch machine is to occur.

The dropping away of the lock relay 9L causes the switch control 9WZ to be maintained energized through a stick circuit closed from (+), through a circuit including front contact 57 of relay 9AN, back contact 58 of lock relay 9L, polar contact 79 of relay 9WZ in a right hand position, upper winding of relay 9WZ, to (-). It is to be understood that the relay 9WZ is sufficiently slow acting to bridge the gap of energization between the opening of front contact 58 of relay 9L and the closing of back contact 58 so as to be continuously picked up during the drop away of the lock relay 9L.

If the switch control relay 9AN is deenergized for some reason before the switch machine 9SM completes the operation of the track switches 9TSA and 9TSB to proper positions, a stick circuit is closed for the relay 9WZ to maintain it energized for the completion of the switch machine stroke. This circuit is closed from (+), through a circuit including back contact 80 of relay 9WP, front contact 81 of relay 9WZ, polar contact 79 of relay 9WZ in a right hand position to energize the upper winding of relay 9WZ when it has been actuated to a normal controlling position, and in a left hand position to energize the lower winding of the relay 9WZ when it has been actuated to a reverse controlling position, to (-). It is of course understood that the relay 9WP is deenergized whenever the track switches 9TSA and 9TSB are being operated from one position to another, and also that the correspondence relays 9RCR and 9NCR are deenergized by reason of open front contacts 70 and 73 thereby causing the lock relay 9L to be maintained energized.

Before continuing with the completion of the route under consideration at this time, let us observe the manner in which the reverse operation of the track switches 9TSA and 9TSB is prevented while the route is locked either by the presence of a train on the track circuit 18T or upon the deenergization of the route locking relay RL. While the route is locked in advance of a train or is occupied by a train, the lock relay 9L is maintained deenergized. Under such conditions, the operator might, through operations later to be considered, cause the picking up of the reverse switch controlling relay 9R which would deenergize the normal correspondence relay 9NCR at open back contact 71, but the lock relay 9L is dropped away so that energy is merely applied to the stick circuit for the relay 9WZ from (+), through a circuit including front contact 82 of relay 9R, back contact 83 of relay 9L, polar contact 79 of relay 9WZ in a right hand position, upper winding of relay 9WZ, to (-). Such energization of the relay 9WZ merely maintains its polar contacts in their former right hand positions and maintains its neutral contacts picked up.

If a momentary loss of shunt should occur causing the pick-up circuit of the lock relay 9L to be closed at front contact 66 of relay 18T, the pick-up circuit of the lock relay 9L would not be energized because of opened back contact 67 of relay 9WZ which is maintained energized by its stick circuit.

In order for the reverse operation of the track switches to be accomplished (or any operation to an opposite position), all of the switch control-

ling relays 9AN, 9R, and 9BN must be deenergized allowing the relay 9WZ to be dropped away while the lock relay can be picked up. In other words, the switch control of the present invention as typically shown in Fig. 5 provides what has been conveniently termed "electric lever lock equivalent" in such a manner that the switch control relays 9AN, 9R and 9BN, for example, are required to be deenergized by restoration of the governing entrance buttons in order to accomplish the restoration of the system to normal conditions so that upon the release of the locking of a track switch a new controlling condition can be immediately effective.

Signal selections.—The signal selections for the single interlocked group under consideration with Figs. 1 and 4 combined, are found in Figs. 6 and 8 placed end to end as pointed out in the illustration of Fig. 9.

With the correspondence relays for all of the track switches in the route in proper energized positions because of the proper response of the respective switches to their respective switch controlling relays, then all of the lock relays L for such switches are deenergized, at which time an energizing circuit is closed for the signal governing that route. For example, the route under consideration requires the track switches 9TSA and 10TSA to be in normal positions and locked and track switch 3TS in a reverse position and locked in order to allow the energization of the signal clearing relay 10IG, which has a circuit closed from (+), through a circuit including front contact 84 of exit relay 108XR, back contact 85 of lock relay 10L, front contact 86 of correspondence relay 10NCR, front contact 87 of correspondence relay 9NCR, back contact 88 of lock relay 9L, wire 89^a, wire 89^b, back contact 90 of lock relay 3L, back contact 91 of correspondence relay 3NCR front contact 191 of correspondence relay 3RCR, back contact 192 of exit relay 101XR, lever contact 193 of entrance button 101NB in an operated position, winding of relay 10IG, to (—). The energization of the signal relay 10IG causes the signal 101 to indicate clear instead of stop, while control has been indicated by a dotted line in Fig. 6, and it is to be understood that each of the signal controlling relays G control their respective signals in a similar manner.

The route from signal 101 to the signal 108 is now established and cleared so that a train may pass thereover.

Train passage and route locking.—It will be evident from the previous consideration of Fig. 5 that the passage of a train past the signal 101 causes the continued locking of the track switch 9TSA by reason of the further opening of the energizing circuit for lock relay 9L at front contact 66 of track relay 10T. It is to also be understood that the lock relays L for each of the remaining track switches are similarly controlled by their detector track circuits. Also, the route locking relay 9RL represents any suitable type approach locking and/or route locking employed in practice, and may be of the type above mentioned in connection with the route locking as shown in the patent to C. F. Stoltz, Patent No. 2,115,511, dated April 26, 1938, where the clearing of a signal for a route causes each of the track switches in that route to be locked and to remain locked so long as a train is in such route and the locking for each switch is released in the rear of such train as it passes through the route providing the control for that route has been

returned to stop. The route locking relay 9RL is considered to embody the various necessary selections for suitable approach and route locking for the track switches 9TSA and 9TSB, but it is to be understood that each of the track switches in the track layout under consideration may be provided with such a route locking relay or suitable circuit selections.

It is also to be understood that this route locking relay 9RL may have embodied in its selections suitable time release means for the approach locking as shown in the above mentioned prior application, so organized that, if a train is approaching the signal when it is cleared, the route locking is not released immediately upon the restoration of the entrance button 101NB to a normal position, but only after a predetermined time has elapsed following such restoration.

Although the relay 9RL (see Fig. 5) is considered to be representative of a complex circuit selection and numerous relays to provide route locking, approach locking, and suitable time release for such locking, it is believed sufficient for an understanding of the present invention to merely know how such locking affects the energization of the circuit for the lock relay 9L. It is, of course, understood that the lock relay L for each of the remaining track switches of the track layout are similarly affected by their associated locking (not shown).

This summarized effect on the lock relay 9L may be considered in terms of energization and deenergization of the relay 9RL, which are briefly stated as follows:

(a) The relay 9RL is deenergized whenever its associated track switches are included in a route governed by a cleared signal and remains deenergized so long as such signal is cleared.

(b) The relay 9RL remains deenergized for a predetermined time after a cleared signal, which governs a route in which the associated track switches are included, is returned to stop in the face of an oncoming train, and picks up then only if the train has not entered the route during such predetermined time.

(c) The relay 9RL remains deenergized when its associated switches are included in a route which has a train entering such route in acceptance of a cleared governing signal, although the governing signal returns to stop upon the entrance of the train into the route and although the train has not yet reached the associated detector track circuit for its track switches.

(d) The relay 9RL is picked up immediately upon the passage of a train beyond the detector track sections associated with its switches providing that the governing signal has been returned to stop.

Restoration to normal.—Any time after the operator has established a route, as when a train has passed the entrance signal and entered the route, or when a route has been set up prematurely or by mistake, the relays and circuits for this route may be restored to normal by turning the corresponding entrance button back to the normal position. In the case of the route from signal 101 to signal 108 for example, it is readily apparent that the relay 10IG controlling the signal 101 to the clear condition is deenergized immediately upon the restoration of the button 101B to normal by reason of the opening of the contact 193 in Fig. 6.

Also, such restoration of the entrance button 101NB causes the opening of contact 30 (see Fig.

1) which deenergizes each of the pre-selecting relays Z dependent upon it for energy as well as the exit relay 108XR (see Fig. 4). The opening of the contact 44 of relay 108XR deenergizes all of the switch controlling relays N and R involved in the route (it being understood that suitable preceding numerals for the various track switches are applied to N and R as well as A and B to designate their use with cross-overs, as required). Such deenergization of the switch controlling relays N and R of course causes the deenergization of their respective switch controlling relay WZ, so that upon the unlocking of the route by the picking up of the route relays RL, all of the lock relays pick up through their respective pick-up circuits.

Thus, the self-selecting network and the various switch controls and signal selections associated with this route are all returned to normal conditions and the operator may again establish the same route or any other route non-conflicting or conflicting with the route just described because of the restoration of such route to its normal-at-stop conditions.

Conflicting route protection.—The operator may establish a particular route, and unintentionally endeavor to establish a route conflicting with such route. Such conflicting route is prevented from being established by reason of the organization of the self-selecting network provided in accordance with the present invention.

More specifically, we will assume that the route from signal 101 to signal 108 (see Figs. 6 and 8) is established, as above described, and that the operator endeavors to establish a conflicting route from signal 109 to signal 101 by actuating the entrance button 109NB (see Fig. 4) in a counterclockwise direction 90° to an operated position and depressing the exit button 101XB (see Fig. 1).

The route from signal 101 to signal 108 causes the energization of relays 10AZ, 108XR, 10AN, 9AN and 3R (see Figs. 1 and 4).

The actuation of the entrance button 109NB closes contact 120 which applies energy to a circuit from (+) for preselecting relay 10BZ, through a circuit including contact 120 in an operated position, back contact 121 of exit relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, windings of relay 10BZ, to (—). The picking up of the relay 10BZ, when there is no conflicting route, would ordinarily continue the circuit from the heel of contact 123 through front contact 124 of relay 10BZ, back contact 125 of relay 9BN, back contact 251 of relay 9AN, back contact 126 of relay 9AZ, wire 127⁴, wire 127¹, back contact 132 of relay 3N, to the right hand terminal of relay 101XR, but this circuit can not be closed because the back contact 251 of relay 9AN is open under the conditions assumed. Thus, the exit relay 101XR cannot be picked up to apply energy to a completion circuit network. In a similar manner, whenever a route is established, initiating circuits for all conflicting routes are broken at a back contact of some switch control relay energized to provide the established route, so that no conflicting route can be established by operation of entrance and exit buttons.

Inasmuch as the entrance button 101NB is operated to set up the route from signal 101 to signal 108, its normal contact 240 is open, so that the exit relay 101XR can not be picked up, which is a necessary element of the conflicting route under consideration. Thus, conflicting

routes are effectively prevented from being established.

However, it will be readily apparent that parallel or non-conflicting routes can be established in the usual manner, such as from the signal 109 to the signal 103, for example (see Figs. 6 and 8).

Let us consider that the entrance button 109NB (see Fig. 4) is operated followed by the actuation of the exit button 103XB (see Fig. 1) to establish a parallel route. The closure of contact 120 (see Fig. 4) energizes the relay 10BZ, as above pointed out, which passes energy from the heel of contact 123 through front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135⁴, wire 135¹, back contact 136 of relay 2R, windings of relay 103XR, back contact 137 of exit button 103XB, contact 138 of entrance button 103NB in a normal non-operated position, to (—).

As soon as the exit relay 102XR (see Fig. 1) picks up, its front contact 139 applies negative potential (—) to its left-hand terminal so that the exit button 103XB may be immediately released and the relay 103XR will thereby be maintained energized.

The picking up of the exit relay 103XR closes an energizing circuit for the relay 2BN from (+), through a circuit including front contact 140 of relay 103XR, lower winding of relay 2BN, back contact 141 of relay 2R, to (—).

A circuit is also closed for energizing the relay 9BN, from (+), through a circuit including front contact 140 of relay 103XR, back contact 142 of relay 2R, wire 143¹, wire 143⁴, lower winding of relay 9BN, back contact 47 of relay 9R, to (—).

A circuit for relay 10BN extends from wire 143⁴, through back contact 144 of relay 9R, front contact 145 of relay 10BZ, lower winding of relay 10BN, back contact 46 of relay 10R, to (—).

A similar circuit is closed for the relay 11N from front contact 145 of relay 10BZ, lower winding of relay 11N, back contact 146 of relay 11R, to (—).

It will of course be apparent from a consideration of Fig. 5 that when the relays 9AN and 9BN are both energized for parallel routes, that no added control is accomplished so far as the relay 9WZ is concerned, as the front contact 147 of relay 9BN is in multiple with the front contact 57 of the relay 9AN, and the back contact 74 can accomplish nothing upon opening in addition to what has already been accomplished by opened contact 75. This is true for each of the track switches for the parallel route. However, if the route from the signal 101 to the signal 108 were not established, it is readily apparent that the relays BN would accomplish the proper switch controls to establish the parallel route between signals 109 and 103.

It should also be mentioned in this connection that the control for a single track switch is the same as the control for a cross-over with the omission of the second normal relay N, inasmuch as the relays AN and BN are in multiple so far as the control of the relay WZ is concerned. Thus, the energization of the relay 11N will cause the setting up of the normal route over the track switch 11TS, while the energization of the relay 11R will cause the setting up of the reverse route over the track switch 11TS.

Upon the proper response of all the track switches between signals 101 and 109, the signal 109 will be cleared by a circuit closed from

(+), through a circuit including front contact 241 (see Fig. 6) of exit relay 103XR, front contact 242 of relay 2NCR, back contact 243 of relay 2L, wire 217⁶, wire 217⁸, front contact 216 of relay 9NCR, back contact 215 of relay 9L, back contact 214 of relay 19L, front contact 213 of relay 10NCR, front contact 212 of relay 11NCR, back contact 211 of relay 11L, back contact 210 of relay 109XR, contact 244 of entrance button 109NB in an operated position, windings of relay 109G, to (-). The picking up of the relay 109G changes the indication of the signal 109 from stop to clear, so that a train may proceed over the route from the signal 109 to the signal 103.

It will be apparent from the description in connection with the restoration of the route between signals 101 and 108 that the route between signals 109 and 103 may be similarly restored to normal merely by the return of the entrance button 109NB, of course considering that the release of the track switches in the route is subject to the usual route locking conditions above considered in detail.

Optional route selection.—Upon the consideration of Figs. 6 and 8, it will be readily apparent that three are two routes between the signals 102 and 109 either one of which may be taken providing there are no conflicting routes established. One route is over the track switches 9TSA and 9TSB in reverse positions with the track switches 2TSA and 2TSB in normal positions, while the other route is over the track switches 2TSA and 2TSB in reverse positions with the track switches 9TSA and 9TSB in normal positions.

It is obvious that only one of these optional or alternative routes can be established or used at any one time; and the system of this invention is organized so that, upon actuation of the entrance button for the common entrance end of such optional routes, the route establishing means is conditioned or prepared so that only one of these optional routes will be established without race or conflict in the energization of the relays, when the exit button for the common exit end of these optional routes is operated. Stated more specifically, the actuation of the entrance button for the common entrance end of optional routes energizes pre-selecting relays Z over initiating circuit paths in such a way as to condition the completion circuit network to set up only one of the optional routes upon operation of the exit button for the common exit end of these routes.

Considering the features of this invention accomplishing this result, the energized or non-energized condition of the pre-selecting relay Z associated with each of the switches in a trailing relation to the common entrance end of optional routes, determines whether that switch shall be operated to the normal or reverse position respectively; and if a trailed switch or end of a crossover is required to be in different positions for the different alternative routes, it is pre-selected for operation to one position only, i. e. its pre-selecting relay Z is either energized or left deenergized, so that the completion circuit network acts to establish only one of the alternative routes. Under ordinary conditions, the switch or end of a crossover required to be in different positions for different alternative routes can be trailed in the normal position and its pre-selecting relay Z is energized to provide a preferred or superior one of the optional

routes; but if there should be some route in conflict with this superior option, the ether inferior option is automatically selected and established, because the switch in question cannot be trailed in the normal position and its pre-selecting relay Z is deenergized. In this connection, as previously explained, a pre-selecting relay Z can be energized by the initiating circuit network only if a path for train movement from the entrance signal location to and over the corresponding switch in its normal position is not in conflict with some established route. Consequently, when the conflict with the superior optional route exists, some pre-selecting relay acting when energized to provide that superior optional route cannot be energized on account of the conflict, and the completion circuit network acts to build up another optional route over a corresponding switch or crossover in the reverse position. In other words, the automatic selection between optional routes in a predetermined order of preference and dependent upon the availability of these respective optional routes, is accomplished by the way in which the pre-selecting relays are controlled over the initiating circuit network.

It may be noted here that this scheme of optional route selection gives different superior optional routes for opposite directions of train movement. For example, the route over the track switches 9TSA and 9TSB in reverse positions will be automatically established upon the actuation of the entrance button 109NB followed by the actuation of the exit button 102XB, while the actuation of the entrance button 102NB followed by the actuation of the exit button 109XB causes the second optional route to be set up over the switches 2TSA and 2TSB in reverse positions.

Considering this operation in detail for the optional routes for train movement from right to left from signal 109 to signal 102, upon the operation of the entrance button 109NB, the preselecting relay 10BZ is picked up, as above described, which transfers energy to pick up the relay 2AZ from the heel of contact 123, through front contact 124 of relay 10BZ, back contact 125 of relay 9BN, back contact 251 of relay 9AN, back contact 126 of relay 9AZ, wire 127⁴, wire 127¹, back contact 128 of relay 3R, back contact 129 of relay 2R, windings of relay 2AZ, to (-). Upon the actuation of the exit button 102XB, energy is applied to the pick-up circuit for relay 102XR from the heel of contact 129, through front contact 130 of relay 2AZ, windings of relay 102XR, back contact 148 of exit button 102XB, contact 131 of entrance button 102NB in a non-operated position, to (-). Upon the picking up of the relay 102XR, negative potential (-) is applied through front contact 149 to the left-hand terminal of the relay 102XR, so that the exit button 102XB may be immediately released and relay 102XR will remain energized.

The picking up of the relay 102XR causes the energization of the switch control relay 2AN by a circuit closed from (+), through a circuit including front contact 150 of relay 102XR, front contact 151 of relay 2AZ, lower winding of relay 2AN, back contact 141 of relay 2R, to (-).

A circuit is also closed for energizing the relay 3N from (+), through a circuit including front contact 150 of relay 102XR, front contact 151 of relay 2AZ, lower winding of relay 3N, back contact 152 of relay 3R, to (-).

The relay 9R has a circuit closed from (+), through a circuit including front contact 150 of relay 102XR, front contact 151 of relay 2AZ, back contact 153 of relay 3R, wire 154¹, wire 154², back contact 155 of the relay 9AZ, lower winding of the relay 9R, back contact 156 of relay 9AN, back contact 157 of relay 9BN, to (-).

Upon the picking up of the relay 9R a circuit is closed for the relay 10BN from back contact 155 of relay 9AZ through front contact 144 of relay 9R, front contact 145 of relay 10BZ, lower winding of relay 10BN, back contact 46 of relay 10R, to (-).

The relay 11N is also energized in multiple with the relay 10BN from the front contact 145 of relay 10BZ, lower winding of relay 11N, back contact 146 of relay 11R, to (-). It will thus be seen that the self-selecting network causes the relays 2AN and 9R to be picked up, so that the superior optional route is determined as the router over the track switches 9TSA and 9TSB in reverse positions.

The relays 2AN, 3N, 9R, 10BN, and 11N cause the proper energization of their respective relays WZ so as to position the track switches for the establishment of the route. After the response of the track switches and the energization of the proper correspondence relays, the respective lock relays L drop away causing the clearing of the signal 109 by the energization of the signal control relay 109G.

This circuit for energizing relay 109G is closed from (+), through a circuit including front contact 94 (see Fig. 6) of relay 102XR, back contact 93 of relay 2L, front contact 92 of relay 2NCR, front contact 91 of relay 3NCR, back contact 90 of relay 3L, wire 89⁶, wire 89⁸, back contact 88 of relay 9L, back contact 87 of relay 9NCR, front contact 245 of relay 9RCR, back contact 216 of relay 9NCR, back contact 215 of relay 9L, back contact 214 of relay 10L, front contact 213 of relay 10NCR, front contact 212 of relay 11NCR, back contact 211 of relay 11L, back contact 210 of relay 109XR, contact 244 of entrance button 109NB in an operated position, windings of relay 109G, to (-).

The energization of the relay 109G causes the signal 109 to be cleared. It is of course understood that this route may be restored to normal in a similar manner pointed out for the other routes, that is, merely by the restoration of the entrance button 109NB to its normal position.

It may be well to point out the reason for the establishment of the route over the track switches 9TSA and 9TSB in reverse positions as determined by the selective energization of the preselecting relays Z. It was previously pointed out that the operation of an entrance button supplies energy to the initiating circuits for a particular direction for energizing the preselecting relays Z for all the trailed track switches required to be in normal positions for all of the routes emanating from the signal for which the entrance button is operated. Applying this rule or plan of energization of pre-selecting relays Z to the optional route situation under consideration, operation of the entrance button 109NB closes its contact 120 in Fig. 4 and supplies an operating potential to a feed point of the initiating circuit network for train movement from right to left, and causes energization of the pre-selecting relays 10BZ and 2AZ, since the lower end of the crossover 10 and the upper end of the crossover 2 are the only switches trailed in

the normal position from the entrance signal 109 in the various routes originating at that signal location. In this connection, it will be noted that the switch 11, switch 9TSB for the lower end of the crossover 9, switch 3, and switch 2TSB for the lower end of the crossover 2 are all disposed in a facing point relation to the signal 109 in the various routes originating at that signal location, and hence the pre-selecting relays Z for these switches are not controlled. The switch 9TSA for the upper end of the crossover 9 is in a trailing relation to the signal 109, but is trailed in a reverse position, so that its preselecting relay 9AZ is not energized.

Thus, upon the actuation of the exit button 102XB, the completion circuit network thus energized for positioning the switch control relays finds the relay 2AZ picked up which determines that the relay 2AN shall be energized. Also, the relay 9R is energized because of the dropped away condition of relay 9AZ. In other words, the application of the rule for the conditioning of the pre-selecting relays Z provides, that, in the case of optional routes emanating from a particular entrance point the first diverging route shall be the superior route having the preference.

It will be noted that both of the optional routes include the track switch 2TSA. One trails the switch reverse, and the other trails it normal. As the latter route requires energization of its relay 2AZ, it is obvious that such route will be the superior route. Thus, positively acting conditions inherently give the desired predetermined selection of the optional routes.

However, the superior route at times gives way to the inferior route when such superior route is in conflict with a route already set up, which condition will now be discussed in detail.

In the event that a route is established between the signals 101 and 108 at the time of the operation of the entrance button 109NB and the exit button 102XB, the inferior route will be automatically established over the cross-over including track switches 2TSA and 2TSB in reverse positions, as the track switch 9TSA is already included in an established route.

Assuming that the route between the signals 101 and 108 is set up, as above described, then the relays 10AZ, 10AN, 9AN and 3R of the self-selecting network are picked up. Then upon the actuation of the entrance button 109NB (see Fig. 4) to an operated position, the relay 10BZ is picked up over a circuit previously pointed out, which in turn endeavors to pick up the relay 2AZ, but this is prevented at back contact 251 of relay 9AN which is picked up for the route between signals 101 and 108.

The actuation of the exit button 102XB (see Fig. 1) then causes the exit relay 102XR to be picked up over a circuit closed from (+), through a circuit including lever contact 120 of entrance button 109NB in an operated position, back contact 121 of relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135¹, wire 135², back contact 158 of relay 2BN, back contact 252 of relay 2AN, back contact 130 of relay 2AZ, windings of relay 102XR, back contact 148 of exit button 102XB, lever contact 131 of entrance button 102NB in a non-operated position, to (-). As soon as the contacts of relay 102XR pick up, front contact 149 connects negative potential

(-) to the left-hand terminal of the relay so that the exit button 102XB may be immediately released and relay 102XR will remain energized.

The picking up of the exit relay 102XR, closes a circuit for energizing the reverse switch control relay 2R from (+), through a circuit including front contact 150 of relay 102XR, back contact 151 of relay 2AZ, lower winding of relay 2R, back contact 159 of relay 2AN, back contact 160 of relay 2BN, to (-).

When the relay 2R responds, a pick-up circuit is closed for the switch control relay 9BN from (+), through a circuit including front contact 150 of exit relay 102XR, back contact 151 of relay 2AZ, front contact 142 of relay 2R, wire 143¹, wire 143⁴, lower winding of relay 9BN, back contact 47 of relay 9R, to (-).

A circuit is also closed for the switch control relay 10BN from (+), through a circuit including front contact 150 of relay 102XR, back contact 151 of relay 2AZ, front contact 142 of relay 2R, wire 143¹, wire 143⁴, back contact 144 of relay 9R, front contact 145 of relay 10BZ, lower winding of relay 10BN, back contact 46 of relay 10R, to (-).

The relay 11N is energized in multiple with the relay 10BN from front contact 145 of relay 10BZ, through the lower winding of relay 11N, back contact 146 of relay 11R, to (-).

Thus, it will be seen that the prevention of the picking up of the relay 2AZ by the energized condition of the switch control relay 9AN, causes the relay 2R to be picked up together with the picking up of the relay 9BN so as to establish the inferior optional route. The remaining features of the establishment of this route are similar to those pointed out in connection with other routes, and will therefore not be considered in detail in order to simplify the disclosure.

Manual selection of optional routes

It may happen under some circumstances that it will be desirable to set up the inferior optional route although a route is not established between the signals 101 and 108, as in the situation where the operator desires to set up the inferior optional route in anticipation of the setting up a route between the signals 101 and 108.

This may be accomplished by either of two manual acts on the part of the operator, that is, either the operation of the auxiliary switch machine control lever 2SML (not shown) to a reverse controlling position, or the operation of the auxiliary switch machine control lever 9SML to a normal controlling position. The manner in which an emergency switch machine control lever SML energizes either the normal switch control relays N or the reverse switch control relay R has been specifically shown in Fig. 5 with respect to the emergency switch machine control lever 9SML for the crossover including the track switches 9TSA and 9TSB. It is to be understood that each of the track switches is similarly provided with an auxiliary control lever.

More specifically, this may be seen with reference to Fig. 5 where the actuation of the lever 9SML to a reverse position energizes the relay 9R by a circuit closed from (+), through lever contact 161 in a reverse position, center winding of relay 9R, back contact 74 of relay 9BN, back contact 75 of relay 9AN, to (-).

On the other hand, the operation of the lever

9SML to a normal position closes a circuit for energizing the relays 9AN and 9BN in multiple from (+), through a circuit including lever contact 161 in a normal operated position, central windings of relays 9AN and 9BN in multiple, back contact 71 of relay 9R, to (-).

In a similar manner, the operation of the lever 2SML (not shown) controls the energization of its associated relays 2AN, 2R and 2BN. For the manual selection of the inferior optional route under consideration, we may first assume that the lever 2SML (not shown) has been operated to its reverse position in which the relay 2R (see Fig. 1) is picked up in the same manner as pointed out for the relay 9R in connection with the discussion of Fig. 5.

The energization of the relay 2R, opens the pick-up circuit of the relay 2AZ at back contact 129 (see Fig. 1) which accomplishes the same result as the opening of back contacts 128 and 251 of relays 3R and 9AN respectively when a conflicting route is set up, so that upon the actuation of the entrance button 109NB and the exit button 102XB, for example, the inferior optional route is set up in a similar manner as above pointed out. Or, in the case where the switch machine control lever 9SML is operated to a normal position, the relays 9AN and 9BN are both picked up. The opening of back contact 125 of relay 9BN similarly prevents the relay 2AZ from being picked up under the conditions of the optional route control, so that the inferior optional route is selected in a similar manner as pointed out in connection with the establishment of the inferior route because of the presence of a route conflicting with the superior optional route.

Thus, it will be evident from the above description that the optional route control is primarily automatic, but may be made subject to manual intervention when desired by the operator.

The same principles and mode of operation for automatic selection between optional routes may be applied to any track layout, regardless of the number of alternative routes between this same entrance and exit signal location, in a manner readily appreciated upon analysis of the method of selecting optional routes by the energization of pre-selecting relays dependent upon availability of a path for train movement to and over the corresponding switch in the normal positions.

Operation of plurality of interlocked groups.—The above description points out the operation for a single interlocked group, which operation for any single interlocked group among a plurality of interlocked groups remains the same, but it is necessary to consider the manner in which a plurality of interlocked groups are related with each other.

In order to do this, Figs. 6, 7 and 8 are placed end to end to show the actual track layout in the field for such a plurality of interlocked groups together with the signal selecting circuits, while Figs. 1, 2, 3 and 4 are placed end to end to show the corresponding miniature track diagram together with the circuits of the self-selecting network. As pointed out above, Fig. 5 shows a switch control typical of all track switches and cross overs irrespective of whether they are included in a layout for a single interlocked group or for a plurality of interlocked groups.

As above mentioned, this system of interlocking is contemplated as having any suitable type of route locking employed therewith but has more

particularly contemplated the use of approach locking, route locking and rear release locking as shown in the prior patent to C. F. Stoltz, Patent No. 2,115,511, dated April 26, 1938. The details of this type of locking has not been shown in connection with the various track switch controls and signals in order to simplify the disclosure of the present invention.

However, in associating two interlocked groups with each other, it becomes desirable to employ certain features of this contemplated type of route locking in order to provide certain features of automatic control in connection with the end-to-end operation of the present invention. Therefore, the directional stick relays 15ES and 16WS and 17WS have been shown in block form, it being believed that a brief description of the operation of these relays will be sufficient for an understanding of their relation to the present invention, the detail control of which may be had by reference to the above mentioned prior application.

Each track circuit is provided with two relays one for each direction, such as a relay ES for east-bound directional control and a relay WS for west-bound directional control. When a route is established in an east-bound direction, the directional control relays ES for all the track circuits in such route are sequentially dropped beginning at the entrance end, each dependent upon the preceding relay and cannot be picked up when a train enters that route even though the route is restored to stop until after the train passes beyond each such track circuit with which each such relay is associated. During such an establishment of an east-bound route, the west-bound relays WS remain picked up.

Each of these directional stick relays includes in its pick-up circuit a front contact of the track relay for the track circuit with which it is associated and a front contact of the directional stick relay for the same direction associated with the preceding track circuit for the route in which it is then associated, or a front contact, in the case of the first track circuit in the route, of the route locking stick relay for the associated governing signal. A front stick contact on each of these relays WS and ES shunts the front contact of its associated track relay included in its pick-up circuit.

Establishing routes individually in end-to-end relation.—Although the self-selecting networks for each of the plurality of groups operate the same as above described for the single interlocked group, it is thought expedient to point out the manner in which individual groups may be individually operated before pointing out how the same result may be accomplished by the end-to-end, or through route, operating feature of the present invention.

Let us consider that the operator desires to establish a route from the signal 101 to the signal 106 (see Figs. 6, 7 and 8). To do this, he turns the entrance button 101NB (see Fig. 1) in a clockwise direction to an operated position after which he operates the exit button 111XB (see Fig. 2).

The operation of the entrance button 101NB closes an energizing circuit for the pre-selecting relay 5AZ from (+), through a circuit including lever contact 30 in an operated position, back contact 31 of relay 101XR, back contact 32 of relay 3Z, wire 33¹, wire 33², back contact 162 of relay 4R, back contact 163 of relay 5R, windings of relay 5AZ, to (—).

A circuit is closed for energizing the pre-selecting relays 6Z from (+), through a circuit including lever contact 30 in an operated position, back contact 31 of relay 101XR, back contact 32 of relay 3Z, wire 33¹, wire 33², back contact 164 of relay 4AN, back contact 253 of relay 4BN, back contact 165 of relay 4BZ, back contact 166 of relay 5R, back contact 167 of relay 6R, windings of relay 6Z, to (—).

As soon as the relay 6Z picks up, a circuit is completed for the exit relay 111XR upon the actuation of the exit button 111XB, from the heel of contact 167, through front contact 168 of relay 6Z, windings of relay 111XR, back contact 169 of exit button 111XB, lever contact 170 of entrance button 111NB in a non-operated position, to (—). Upon the picking up of the contacts of the relay 111XR, front contact 171 applies negative potential (—) to the right-hand terminal of relay 111XR so that the exit button 111XB may be immediately released.

The picking up of the contacts of the relay 111XR closes an energizing circuit for the relay 6N from (+), through a circuit including front contact 172 of relay 111XR, front contact 173 of relay 6Z, upper winding of relay 6N, back contact 174 of relay 6R, to (—).

Relay 5BN is energized in multiple with the relay 6N from front contact 173, through upper winding of relay 5BN, back contact 175 of relay 5R, to (—).

A circuit is closed for energizing the relay 4R from (+), through a circuit including front contact 172 of relay 111XR, front contact 173 of relay 6Z, back contact 176 of relay 5R, back contact 177 of relay 4BZ, upper winding of relay 4R, back contact 178 of relay 4AN, back contact 179 of relay 4BN, to (—).

Upon the picking up of the relay 4R, a circuit is closed for energizing the relay 3R from back contact 177, through front contact 180 of relay 4R, wire 49², wire 49¹, back contact 50 of relay 3Z, upper winding of relay 3R, back contact 51 of relay 3N, to (—).

This completes the operation of the self-selecting network, and the track switches are controlled as previously described. After all of the track switches included in the route have properly responded, the signal 101G is energized by a circuit (see Figs. 6, 7 and 8) closed from (+), through a circuit including front contact 181 of exit relay 111XR, back contact 182 of relay 6L, front contact 183 of relay 6NCR, front contact 184 of relay 5NCR, back contact 185 of relay 5L, back contact 186 of relay 4L, back contact 187 of relay 4NCR, front contact 188 of relay 4RCR, back contact 189 of relay 4NCR, back contact 190 of relay 4L, wire 89⁷, wire 89⁶, back contact 90 of relay 3L, back contact 91 of relay 3NCR, front contact 191 of relay 3RCR, back contact 192 of relay 101XR, lever contact 193 of entrance button 101NB in an operated position, winding of relay 101G, to (—).

The energization of this relay 101G causes the signal 101 to be cleared for the passage of traffic. The route from signal 101 to signal 106 is thus established and is subject to route locking and other conditions pointed out for a route in connection with Figs. 1 and 4.

It may be that the operator desires to continue the passage of a train from the signal 106 (see Fig. 7) to the signal 109 (see Fig. 8) in which event he operates the entrance button 106NB (see Fig. 3) in a clockwise direction to

an operated position and then actuates the exit button 109XB (see Fig. 4).

This causes the energization of the preselecting relay 7BZ by a circuit closed from (+), through a circuit including lever contact 194 in an operated position, back contact 195 of relay 106XR, back contact 196 of relay 7R, windings of relay 7BZ, to (-).

As soon as the relay 7BZ picks up, energy is passed on to energize the relay 9BZ from the heel of contact 196, through front contact 197 of relay 7BZ, wire 55³, wire 55⁴, back contact 56 of relay 9R, windings of relay 9BZ, to (-).

When the relay 9BZ picks up, energy is passed on to pick up the relay 11Z from back contact 56 through front contact 37 of relay 9BZ, back contact 38 of relay 10R, back contact 39 of relay 11R, windings of relay 11Z, to (-).

When the relay 11Z picks up, energy is passed on for the picking up of the exit relay 109XR, upon the actuation of the exit button 109XB. This circuit is closed from the heel of contact 39 through front contact 198, windings of relay 109XR, back contact 199 of exit button 109XB, lever contact 200 of entrance button 109NB in a non-operated position, to (-). As soon as the exit relay picks up its contacts, its front contact 201 applies negative potential (-) to the right-hand terminal of the relay 109XR so that the exit button 109XB may be immediately released.

The picking up of the exit relay 109XR closes an energizing circuit for the relay 11N from (+), through a circuit including front contact 202 of relay 109XR, front contact 203 of relay 11Z, upper winding of relay 11N, back contact 146 of relay 11R, to (-).

The relay 10BN is picked up in multiple with the relay 11N from front contact 203 through upper winding of relay 10BN, back contact 46 of relay 10R, to (-).

Relay 9BN is energized by a circuit closed from (+), through a circuit including front contact 202 of relay 109XR, front contact 203 of relay 11Z, back contact 204 of relay 10R, front contact 205 of relay 9BZ, upper winding of relay 9BN, back contact 47 of relay 9R, to (-).

An energizing circuit is closed for the relay 7BN from (+), through a circuit including front contact 202 of relay 109XR, front contact 203 of relay 11Z, back contact 204 of relay 10R, front contact 205 of relay 9BZ, wire 206⁴, wire 206³, front contact 207 of relay 7BZ, upper winding of relay 7BN, back contact 208 of relay 7R, to (-).

The picking up of these switch control relays causes the aligning of the track switches to proper positions to establish the route in a manner similar to that described for the establishment of other routes. The signal relay 106G is energized by a circuit closed from (+), through a circuit including front contact 210 of relay 109XR (see Fig. 8), back contact 211 of relay 11L, front contact 212 of relay 11NCR, front contact 213 of relay 10NCR, back contact 214 of relay 10L, back contact 215 of relay 9L, front contact 216 of relay 9NCR, wire 217⁸, wire 217⁷, back contact 218 of relay 7L, front contact 219 of relay 1NCR, back contact 220 of relay 106XR, lever contact 221 of entrance button 106NB in an operated position, windings of relay 106G, to (-). The clearing of the signal 106 upon the energization of the relay 106G allows the passage of the train on through such route past the signal 109 up to the next signal in advance for governing east-bound traffic or to some arbitrarily chosen point designating the end of such route.

As pointed out above, the relay 5AZ is picked up upon the operation of the entrance button 101NB for the establishment of the route through the interlocked group of Figs. 1 and 2. This causes the application of energy through front contact 222 to the wire 223² extending to certain of the preselecting relays Z in the succeeding interlocked groups, as will be pointed out in detail below under the consideration of the establishment of a through route by end-to-end operation. It is desired to point out, however, that the establishment of the route upon the actuation of the exit button 111XB causes the deenergization of the relay 5AZ upon the picking up of the relay 4R by reason of open back contact 162, so that any energization of preselecting relays in the next interlocked group effected by flow of current over the through route connection or wire 223 will be cancelled and not interfere with the setting up of any desired route in such next interlocked group.

It will be observed that there is a circuit from the wire 33² through back contact 164 of relay 4AN, back contact 253 of relay 4BN, back contact 165 of relay 4BZ, back contact 246 of relay 5BN, back contact 350 of relay 5AN, back contact 222 of relay 5AZ, to wire 223², but, although the relay 5AZ is dropped away, this connection between the wires 33² and 223² is not closed at this time because of the open back contact 246 of relay 5BN which is energized for the establishment of the route above pointed out. This connection between the wires 33² and 223² is for the purpose of establishing the run-around routes as will be later described in detail. It may be pointed out here that the purpose of this operation described is to open the through connection at the signal 111, so that any energization of pre-selecting relays in the next interlocked group effected by the flow of current through route connecting wire 223 will be cancelled, and cannot interfere with setting up any desired route in this interlocked group by the operation of appropriate entrance and exit buttons.

It may also be pointed out in this connection that the supply of energy to the left hand terminal of the exit relay 111XR is passed on through back contact 228 of relay 111XR over through route connecting wire 229 which causes the energization of certain of the preselecting relays Z of the succeeding interlocked groups, but upon the actuation of the exit button 111XB, the relay 111XR picks up and deenergizes all succeeding preselecting relays, so as not to interfere with the setting up of routes in the succeeding interlocked groups.

In order to return these routes to stop in the two interlocked groups, each route must be returned to stop by the operation of its respective entrance button to the normal non-operated position causing the restoration of the system to normal conditions as shown. This restoration of the route to stop in each interlocked group is wholly independent of the restoration of the other route so that either or both of these routes may be restored to stop as desired by the operator.

End-to-end or through route operation.—Having considered how a train may be passed through a plurality of interlocked groups by setting up routes in end-to-end relation by an entrance-exit control for the individual interlocked groups, consideration will now be given to an important operation of this invention, in which a through route over two or more adjoining interlocked

groups, and comprising in effect routes through these interlocked groups in end-to-end relation, can be automatically established merely by the operation of the entrance and exit buttons for the extreme ends of this through route.

For this through route operation the initiating circuit networks of adjoining interlocked groups at signal locations, which may become an intermediate signal location in some desired through route, are interconnected by what may be termed through route connections, so that upon actuation of an entrance button the pre-selection operation characteristic of this invention is effective for all interlocked groups with respect to all through routes originating at the corresponding entrance signal location. In other words, the operation of an entrance button conditions the route establishing means to provide any route through the same interlocked group and also through routes over one or more succeeding interlocked groups, thereby preparing the system to act automatically to establish any one of these routes or through routes that the operator may happen to choose by operating a corresponding exit button.

To illustrate how the pre-selection operation is extended by through route connections to a plurality of interlocked groups, and referring to Figs. 1, 2, 3 and 4 arranged end-to-end, assume that the operator proposed to establish a through route from signal 101 to the signal 109 and actuates the entrance button 101NB.

The operation of the entrance button 101NB energizes the relay 5AZ over a circuit above pointed out, which relay as soon as it picks up passes such energization on to the relay 9Z by a circuit closed from the heel of contact 163 of relay 5R, front contact 222 of relay 5AZ, wire 223², wire 223³, back contact 224 of relay 110XR, back contact 225 of relay 7R back contact 226 of relay 8R, windings of relay 8Z, to (—).

As soon as the relay 8Z picks up energy is passed on from the heel of contact 225, through front contact 227 of relay 8Z, wire 33³, wire 33⁴, back contact 34 of relay 9R, back contact 35 of relay 10R, windings of relay 10AZ, to (—).

It may be pointed out here that this energization of the relay 10AZ and the closing of its contact 40 supplies an operating potential to the exit relay 108XR, making it possible for the operator to energize this relay if he wishes a through route to the signal 108.

A circuit is also closed for the relay 6Z from (+), through a circuit including lever contact 30 in an operated position, back contact 31 of relay 101XR, back contact 32 of relay 3Z, wire 33¹, wire 33², back contact 164 of relay 4AN, back contact 253 of relay 4BN, back contact 165 of relay 4BZ, back contact 166 of relay 5R, back contact 167 of relay 6R, windings of relays 6Z, to (—).

As soon as the relay 6Z picks up, energy is passed on from the heel of contact 167 through front contact 168 of relay 6Z, back contact 228 of relay 111XR, wire 229², wire 229³, front contact 230 of relay 15ES, lever contact 194 of entrance button 106NB in a non-operated position, back contact 195 of relay 106XR, back contact 196 of relay 7R, windings of relay 7BZ, to (—).

As soon as the relay 7BZ picks up, energy is passed from the heel of contact 196, through front contact 197 of relay 7BZ, wire 55³, wire 55⁴, back contact 56 of relay 9R, windings of relay 9BZ, to (—).

As soon as the relay 9BZ picks up, energy is

passed on from back point of contact 56, through front contact 37 of relay 9BZ, back contact 38 of relay 10R, back contact 39 of relay 11R, windings of relay 11Z, to (—).

As soon as the relay 11Z picks up and closes its front contact 198, an operating potential is supplied to the exit relay 109XR, so that it may be energized when the exit button 109XB is operated by the operator for the through route in question.

In this way, certain pre-selecting relays are energized in both of the interlocked groups for all of the switches or ends of crossovers trailed in the normal position in any route originating at the entrance signal location 101. Upon reference to the track diagram, such switches trailed in the normal position may be readily identified as the upper end of crossover 5, switch 6, lower end of crossover 7, switch 8, lower end of crossover 9, upper end of crossover 10 and switch 11; and the circuits above traced show how the initiating circuit networks for the two adjoining interlocked groups with the through route connecting wires 223 and 229 provide for the energization of the preselecting relays 5AZ, 6Z, 7BZ, 8Z, 9BZ, 10AZ and 11Z corresponding to these switches and ends of crossovers trailed normal.

It can be readily seen that there are a number of alternative paths for train movement from the signal 101 past the intermediate signals 110 or 106 to the signal 109, as well as optional routes in the interlocked group of Figs. 3 and 4 between the location of signal 110 and the signal 109 afforded by the crossovers 7 and 9. In short, the track layout illustrated provides a plurality of alternative through routes between the signals 101 and 109, such as over crossovers 4, 7 and 9, respectively, in the reverse position; and generally speaking, conventional track layouts affording through routes over a plurality of interlocked groups usually have a plurality of alternative or optional through routes between the same common entrance and exit signal locations.

It is evident that only one of these various possible through routes should be established upon actuation of the buttons to designate the common entrance and exit ends of these routes; and an important feature of this invention is that such optional through routes are automatically selected one at a time in a predetermined order or preference, and dependent upon conflict of the respective alternative through routes with established through routes.

In explaining how this result is accomplished, it may be considered that the preselection operation performed by the energization of initiating circuit paths upon actuation of an entrance button is effective for the adjoining interlocked groups, on account of the through route connections afforded by wires 223 and 229, with respect to the complete track layout of these adjoining interlocked groups, in the same way as if there were no intermediate signal locations, and the two interlocked groups in effect are one interlocked group. As previously explained with respect to one interlocked group, there is an automatic selection of the optional routes afforded by that group; and when the same principles and mode of operation are applied to a plurality of adjoining interlocked groups, there is an automatic selection between the alternative routes in the same way, leaving only one through route establishable by the operation of the completion

circuit network between entrance and exit signal locations of different interlocked groups.

Considering the through route from the signal 101 to signal 109 under consideration from this standpoint, the particular pre-selecting relays energized as above explained cause the completion circuit networks of the adjoining interlocked groups to act to build up one predetermined route between these signal locations. In other words, upon operation of the exit button 109XB, the completion circuit network for the remote interlocked group acts in accordance with the pre-selection to provide a route to a particular one of the intermediate signal locations, and then the completion circuit network of the near interlocked group acts to provide a particular route between that particular entrance signal location and the entrance signal 101; and during this completion operation, the energization of switch control relays opens contacts in the initiating circuit paths then energized at the points of conflict between these particular routes established in the interlocked groups and all other routes through these interlocked groups originating at the same entrance signal 101, in a manner previously discussed.

Considering now the completion operation for the particular route from signal 101 to signal 109 in question, when the relay 109XR picks up, it closes its front contact 201 to apply negative potential (—) to the right hand terminal of its windings so that the exit button 109XB may be immediately released.

The picking up of relay 109XR closes a circuit for energizing the relay 11N through its upper winding as above pointed out. The relay 10BN also receives energy in multiple with the energization of the relay 11N, as above pointed out. Energy is passed on through the back contact 204 of relay 10R and front contact 205 to energize the relay 9BN, as above pointed out in connection with the establishment of the route from signal 106 to signal 109. Energy then passes from front contact 205 over wire 206⁴, wire 206³ and front contact 207 of relay 7BZ to energize the relay 7BN, as above pointed out.

Energy also passes from front contact 207 through windings of relay 106NX111, lever contact 231 of entrance button 106NB in a non-operated position, front contact 232 of relay 15ES, wire 233², wire 233³, back contact 171 of relay 11XR, to (—). The energy which flows in this circuit causes the relay 106NX111 to be picked up closing its front contact 234 to apply negative potential (—) to the right hand terminal of its windings through lever contact 231.

The picking up of the relay 106NX111 causes the automatic picking up of the exit relay 11XR without the operation of exit button 11XB by applying negative potential from (—), through front contact 351, front contact 236 of relay 15ES, wire 237³, wire 237², to the right hand terminal of the windings of the exit relay 11XR. Positive potential (+) is applied to the left hand terminals of this relay 11XR over the self-selecting network with the relay 6Z picked up, as above pointed out so that the relay 11XR picks up and closes its front contact 171 to directly apply negative potential (—) to its left hand terminal. In other words, the picking up of the relay 106NX111 in effect takes the place of the actuation of the exit button 11XB and the closure of back contact 169 acts to pick up the exit relay 11XR.

It may be noted here that the relay 106NX111 is energized for through route operation only, and

cannot pick up when the entrance button 106NB is operated to open its contact 231, otherwise the energization of relay 106NX110 would close its contact 351 and connect the exit relay 11XR of the adjoining interlocked group to (—) independently of the exit button 11XB and interfere with operation of the route establishing means of this adjoining interlocked group.

Concerning this relay 106NX111, it may be pointed out here that, in connection with the operation of establishing through routes over successive interlocked groups a relay conveniently termed a through route relay, is provided for each signal location which may become an intermediate signal location in some through route. The purpose of this through route relay is to close contacts which perform the same functions in the control of the circuit networks as if the corresponding entrance and exit buttons had been actuated. The relay 106NX111 of Fig. 3 is such a through route relay for the signal locations 106 and 111, the designation 106NX111 being given because this relay performs the function of an entrance button for signal location 106 and an exit button for signal location 111, the contacts 351 and 248, respectively, of this relay performing the same functions as the closure of the contact 169 of the exit button 11XB and contact 194 of entrance button 106NB.

The picking up of the exit relay 11XR closes front contact 172 and thereby energizes the relays 6N, 5BN, 4R, 3R and 3N as above pointed out in connection with the establishment of the route from the signal 101 to the signal 106 for the individual group.

The relays WZ for the respective track switches respond to their respective switch control relays N and R as pointed out in connection with Fig. 5. After the response of the track switches to their respective controls, the correspondence relays NCR and RCR assume proper positions in which the lock relays L for the track switches included in the route are dropped, so that the signal circuits for the signals 101 and 106 for their respective interlocked groups are energized.

The relay 101G is energized by the same circuit as previously pointed out in connection with the establishment of the route between signal 101 and 106 by employing the entrance button 101NB and the exit button 11XB, so that this circuit will not be traced in detail. The circuit for the signal relay 106C is closed in a similar manner as pointed out in connection with the establishment of the route for that group by the use of entrance button 106NB and the exit button 109XB with the exception that the entrance button 106NB has not been operated to close the contact 221 (see Fig. 7), but the relay 106NX111 has been picked up, as above described, closing its front contact 247 and shunting the contact 221 so that the circuit for the relay 106G is completed. The picking up of the relays 101G and 106C causes the clearing of their respective signals as above described.

The picking up of the exit relay 11XR closes front contact 172 and thereby energizes the relays 6N, 5BN, 4R, 3N and 2AN as above pointed out in connection with the establishment of the route from the signal 101 to the signal 106 for the individual group.

The relays WZ for the respective track switches respond to their respective switch control relays N and R as pointed out in connection with Fig. 5. After the response of the track switches to their respective controls, the correspondence relays

NCR and RCR assume proper positions dropping the lock relays L for each of the track switches included in the route so that the signal circuits for the signals 101 and 106 for their respective interlocked groups are energized.

The relay 101G is energized by the same circuit as previously pointed out in connection with the establishment of the route between signal 101 and 106 by employing the entrance button 101NB and the exit button 111XB, so that this circuit will not be traced in detail. The circuit for the signal relay 106G is closed in a similar manner as pointed out in connection with the establishment of the route for that group by the use of entrance button 106NB and the exit button 109XB with the exception that the entrance button 106NB has not been operated to close the contact 221 (see Fig. 7), but the relay 106NX111 has been picked up, as above described, closing its front contact 247 and shunting the contact 221 so that the circuit for the relay 106G is completed. The picking up of the relays 101G and 106G causes the clearing of their respective signals as above described.

Restoration to normal of a through route.—It may happen that a through route is set up, prematurely or by mistake, and the operator may wish to restore all or some part of this through route to normal before a train enters.

The restoration of this through route between the signals 101 and 109 may be accomplished either individually or collectively. In other words, this through route may be restored to stop by the restoration of the entrance button 101NB to its non-operated position causing the complete through route to be restored to stop conditions, or this through route may be taken apart, so to speak, by operating the entrance button 106NB (see Fig. 3) to an operated position thereby causing the routes for the individual interlocked groups to be wholly dependent upon their respective entrance buttons.

The restoration of the thorough route by the returning of the entrance button 101NB to its non-operating position will first be considered. The relay 111XR was picked up automatically by the closure of contact 351 of the relay 106NX111, and upon the picking up of the relay 111XR closes its contact 171 to complete its stick circuit which is dependent upon the entrance button 101NB by reason of its stick circuit characteristics as pointed out with the individual interlocked group control, when the pick-up circuit is opened. The pick up circuit provided through front contact 351 of relay 106NX111 is opened at front contact 236 of relay 15ES when this relay 15ES drops away, as pointed out above, which occurs when a route is cleared over the track section with which such relay is associated and remains dropped away until such route is restored to stop and its track section is unoccupied. In other words, as soon as the signal 101 clears, the relay 111XR is rendered dependent upon its stick circuit characteristics.

The picking up of the exit relay 111XR opens the pick up circuit for the relay 7BZ at back contact 228, but inasmuch as the relay 106NX111 is picked up when the relay 111XR picks up, an auxiliary energizing circuit for the relay 7BZ is closed from (+), through a circuit including front contact 248 (see Fig. 3) of relay 106NX111, wire 249², wire 249³, front contact 228 of relay 111XR, wire 229², wire 229³, front contact 230 of relay 15ES, lever contact 194 of entrance button 106NB in a non-operated position, back contact

195 of relay 106XR, back contact 196 of relay 7R, windings of relay 7BZ, to (—). This shift of the energy for the relay 7BZ causes the relay 7BZ to be temporarily dependent upon the continued closure of front contact 228 of relay 111XR. As soon as the signal 101 clears and causes the dropping away of the relay 15ES, its back contact 230 is closed so that energy is supplied from (+) through front contact 248 and back contact 230 for the relay 7BZ instead of through the front contact 228 of the relay 111XR.

Thus, when the operator restores the entrance button 101NB, it removes energy from the relay 111XR, and causes the signal 101 to restore to stop which in turn causes the relay 15ES to be picked up, providing the associated track section 15T is unoccupied, so that the energization of the relay 7BZ is again made dependent upon the relay 111XR. Although back contact 228 is now closed, relay 111XR is not receiving energy, so that the relay 7BZ is deenergized as well as the succeeding preselecting relays Z and the exit relay 109XR. This, of course, causes the signal 106 to be restored to stop because the circuit for the relay 106G requires that the exit relay 109XR be picked up as well as the relay 106NX111 which is dependent upon the relay 109XR in this particular route set up.

It might happen that the operator would desire to maintain the signal 101 cleared to allow a train to pass up to the signal 106 but cause said signal 106 to be restored to stop although it had previously been cleared by the setting up of the through route. As previously mentioned, a through route may be taken apart so to speak, and have any particular element included within it restored to stop conditions.

For example, assuming the through route is set up as above described with the signals 101 and 106 cleared, the signal 106 may be restored to stop by first actuating the entrance button 106NB to an operated position and then restoring it to its non-operated position. Such operation of the entrance button 106NB opens the contact 231 deenergizing the relay 106NX111 which in turn deenergizes relay 7BZ at open front contact 248, but energy is supplied to the relay 7BZ by reason of the closure of contact 194 in an operated position. In other words, the operation of the entrance button 106NB to an operated position causes that part or element of the through route in its associated interlocked group to be made wholly dependent upon the entrance button 106NB, but maintains the signal 106 cleared. The energy received for the relay 106NX111 before movement of 106NB flowed through front contact 234, because back contact 171 is open with the relay 111XR picked up. In other words, the dropping away of the relay 106NX111 opens its stick circuit and prevents such relay from again picking up when the entrance button 106NB is restored to a non-operated position. The return of entrance button 106NB to a stop or non-operated position deenergizes the relay 7BZ by the opening of contact 194 from an operated position, as such contact does not supply energy to relay 7BZ when in a non-operated position with the relay 106NX111 dropped away. Such deenergization of the relay 7BZ causes the signal 106 to be restored to stop by reason of the deenergization of the exit relay 109XR, although signal 101 remains cleared dependent upon the entrance button 101NB.

Train movement over a through route.—As-

suming a through route established from signal 101 to signal 109 as just described, when a train passes the signal 101 and enters this through route, the operator will restore the entrance button 101NB to the normal position, unless he wishes the route to be maintained for some following train. This restores to normal the initiating and completion circuits for the rear interlocked group, and causes the signal 101 to assume its stop condition; but due to the presence of the train, the relay 15ES is maintained deenergized in a manner characteristic of this form of directional stick relay, and as explained more in detail in the specification of Patent No. 477,671 previously mentioned.

Accordingly, the restoration of the entrance button 101NB causes the exit relay 111XR to drop, but the back contact 230 of the relay 15ES is closed, and with the relay 106NXIII energized and its contact 248 closed, said relay 106NXIII is maintained energized to cause closing of its contact 247 in Fig. 7 to energize relay 106G and keep the signal 106 in the clear condition. When the train entirely passes the signal 106 and the relay 15ES picks up, the circuit for energizing the preselecting relay 7BZ and also the through route relay 106NXIII is shifted to the back contact 228 of the exit relay 111XR, which is now dropped away because the entrance button 101NB has been restored. Consequently, the relay 106NXIII is deenergized and the signal 106 automatically caused to assume its stop condition after the train has passed it. In short, when a train enters an established through route, the operator restores the entrance button to normal to put to stop the entrance signal, but the intermediate signal or signals in this through route are automatically put to stop as the train passes this signal or signals.

It was mentioned above, that, when a through route is established as described, the presence of a train between the signal 101 and 106 maintains the relay 15ES deenergized so that the signal 106 is maintained cleared until the train passes such signal although the entrance button 101NB is restored to a non-operated position. This would appear to cause the signal 106 to be automatically held in a cleared condition, but such signal 106 is under manual control even with such conditions and may be restored to stop in the same manner as described above in connection with the operation of the entrance button 106NB to an operated position and then restored to its stop or non-operated position. In other words, such operation of the entrance button 106NB to an operated position causes the dropping of the relay 106NXIII even under such circumstances as it is dependent for its energy upon a stick circuit including back contact 230 of relay 15ES, so that the restoration of the button 106NB to a non-operated position results in the relay 106NXIII remaining deenergized and causes the relay 106G to be deenergized in turn effecting the stop indication of the signal 106.

The present invention contemplates that a large number of interlocked groups may be associated with each other so that a through route may be set up through several interlocked groups, say five or six, for example. The present disclosure, for the sake of simplicity, shows only two such interlocked groups placed end-to-end.

In the event that a large number of interlocked groups are placed end-to-end, a through route is cleared through such groups by the end-to-end feature of operation above typically de-

scribed, and may be taken apart, so to speak, element by element. For example, the operation of the entrance button to the third interlocked group to an operated position and then the restored to its non-operated position will cause the signal governing traffic for the through route at the entrance to that particular interlocked group, as well as the signals at the entrance to each of the successive interlocked groups to be restored to stop, although the signals at the entrance to the first interlocked group and at the entrance to the second interlocked group are maintained clear dependent upon the entrance button for the entrance to the first interlocked group.

If it were desired to place only the signal governing the third interlocked group at stop, all that would be necessary to cause such operation would be to actuate the entrance button for the signal at the entrance to the fourth interlocked group to an operated position before actuating the entrance button for the third interlocked group to an operated position and then restoring it to a non-operated position.

In summary, the present invention contemplates that the principles of the chosen embodiment may be so applied to a complex and expanded track layout that the end-to-end feature of operation of the present invention provides great facility in the setting up of through routes without in any way interfering with the individual control of each of the elements of such through routes.

Selection between optional through routes.—

As previously noted, there are several alternative through routes from the signal 101 to the signal 109, and the predetermined one established in the manner previously described is only one of the possible through routes. This predetermined through route established under ordinary conditions is a superior or preferred route; and the system of this invention is arranged so that other ones of the optional through routes will be established, as may be required on account of conflict with established routes, or by operation of auxiliary switch levers. If a superior route should be in conflict with another route already established, the second of the optional routes is then set up; and similarly, if such second route should be in conflict with a route already established, the third optional route is automatically set up. This is accomplished irrespective of whether the optional routes are within a single interlocked group or whether such optional routes are provided by several interlocked groups associated with each other to give through route end-to-end operation.

For example, let us assume that a route is set up between the signals 103 and 106 to allow a first train to progress up to signal 106 contemporaneously with the passage of a second train from the signal 101 up to the signal 109. This causes the through route from signal 101 to signal 109 to be made up of the track switches 7TSA and 7TSB in reverse positions, which is an inferior route compared to the through route with track switches 4TSA and 4TSB in reverse positions.

It should also be understood that selection from among a plurality of optional through routes may be accomplished manually by the operation of the auxiliary switch control levers as pointed out in connection with the optional route selection for a single interlocked group. It is believed unnecessary to go into detail as to

how this may be done inasmuch as the operation is the same as for a single interlocked group.

With the route between the signal 103 and 106 set up, the relays 2BZ, 2BN, 4BZ, 4BN, 5BN, 6Z and 6N are all picked up.

Now to consider the operations of the preselecting relays Z effected by the actuation of the entrance button 101NB. The relay 5AZ is energized by a circuit above pointed out after which energy is passed on through front contact 222 over wires 223² and 223³ to the relay 8Z.

The relay 6Z can not receive energy from the wire 33² because of the open back contact 253 of relay 4BN, but does receive energy from (+) through a circuit including lever contact 52 of entrance button 103NB in operated position, back contact 53 of relay 103XR, back contact 54 of relay 2R, front contact 56 of relay 2BZ, wire 55¹, wire 55², back contact 254 of relay 4R, front contact 165 of relay 4BZ, back contact 166 of relay 5R, back contact 167 of relay 6R, windings 6Z to (-). But the front contact 168 can not pass energy on to the relay 7BZ because of the open back contact 228 of relay 111XR.

However, the relay 9BZ receives energy which is passed on by the relay 5AZ from the heel of contact 163 of relay 5R, front contact 222 of relay 5AZ, wire 223², wire 223³, back contact 224 of relay 110XR, back contact 255 of relay 7AN, back contact 256 of relay 7BN, back contact 197 of relay 7BZ, wire 55³, wire 55⁴, back contact 56 of relay 9R, windings of relay 9BZ, to (-).

The picking up of relay 9BZ passes energy on from the back point of contact 56 through front contact 37 of relay 9BZ, back contact 38 of relay 10R, back contact 39 of relay 11R, winding of relay 11Z, to (-).

The picking up of the relay 11Z passes energy on from the heel of contact 39 through front contact 198 of relay 11Z to relay 109XR, so that upon the actuation of the exit button 109XB closing back contact 199 the circuit is completed through contact 200 of entrance button 109NB in a non-operated position, to (-). The picking up of the relay 109XR closes front contact 201 applying negative potential (-) to the right hand terminal of the relay 109XR, causing it to be stuck up dependent upon the entrance button 101NB, as above described.

The closure of contact 202 of relay 109XR energizes the relay 11N inasmuch as the relay 11Z is picked up, as above described. The relay 10BN is energized in multiple with the relay 11N as above described. Inasmuch as the relay 9BZ is picked up, the relay 9BN is energized by a circuit also pointed out above. Energy is passed on by the relay 9BZ through its front contact 205, over wire 206⁴, wire 206³, back contact 207 of relay 7BZ, upper winding of relay 7R, back contact 257 of relay 7AN, back contact 258 of relay 7BN, to (-).

It may be well to point out the system used in designating the relays, such as relay 106NX111. The 106N means that when this relay is picked up, it accomplishes a similar purpose as the actuation of the entrance button 106NB insofar as the clearing of the signal is concerned, as shown in the control of the relay 106G, for example, in Fig. 7; while the X111 means that this relay when picked up causes the energization of the exit relay 111XR in place of the usually required actuation of the exit button 111XB.

In view of the fact that there is no signal shown in the chosen track layout for governing traffic in an east bound direction past the signal

location of signal 110, there is no entrance and exit buttons required for such location. For this reason, it is unnecessary to provide a special relay, such as through route relay 106NX111, to effect an automatic entrance-exit control for such signal location. However, the exit condition is passed on to the interlocked group of Figs. 1 and 2 by a direct wire circuit.

More specifically, energy is passed on from the back point of contact 207 of relay 7BZ, front contact 259 of relay 7R, wire 260³, wire 260², front contact 261 of relay 5AZ, upper winding of relay 5AN, back contact 175 of relay 5R, to (-). The relay 4AN receives energy in multiple with relay 5AN from front contact 261 of relay 5AZ, through the upper winding of relay 4AN, back contact 262 of relay 4R, to (-).

Energy is passed on from front contact 261 of relay 5AZ, through back contact 180 of relay 4R, wire 49², wire 49¹, back contact 50 of relay 3Z, upper winding of relay 3R, back contact 51 of relay 3N, to (-).

The energization of the switch control relays N and R for the several track switches causes the operation of the track switches as required to set up the route from the signal 101 to the signal 109, over the crossover including track switches 7TSA and 7TSB in reverse positions. When the track switches are all in proper positions as repeated by the correspondence relays RCR and NCR for the several track switches, the respective lock relays L are also deenergized, closing the signal clearing circuit for the signal 101.

In this particular route under consideration, it is noted that there is no east bound signal at the west bound signal 110, and for this reason it is necessary to provide a signal circuit repeating relay 110SCR in order to repeat the energy supplied to the signal circuit at the exit end of the route past the west bound signal 110.

More specifically, relay 110SCR has a circuit closed from (+) (see Figs. 8 and 7), through a circuit including front contact 210 of relay 109XR, back contact 211 of relay 11L, front contact 212 of relay 11NCR, front contact 213 of relay 10NCR, back contact 214 of relay 10L, back contact 215 of relay 9L, front contact 216 of relay 9NCR, wire 217⁸, wire 217⁷, back contact 218 of relay 7L, back contact 219 of relay 7NCR, front contact 263 of relay 7RCR, back contact 264 of relay 7NCR, back contact 265 of relay 7L, back contact 266 of relay 110XR, windings of relay 110SCR, to (-).

As soon as the relay 110SCR picks up, the relay 101G receives energy from (+), through a circuit including front contact 267 of relay 110SCR, back contact 268 of relay 5L, front contact 269 of relay 5NCR, front contact 189 of relay 4NCR, back contact 190 of relay 4L, wire 89⁷, wire 89⁶, back contact 90 of relay 3L, back contact 91 of relay 3NCR, front contact 191 of relay 3RCR, back contact 192 of relay 101XR, lever contact 193 of entrance button 101NB in an operated position, windings of 101G, to (-).

The picking up of the relay 101G causes the signal 101 to be cleared allowing the passage of traffic over this through route from signal 101 to signal 109.

This through route can be put to stop by the returning of the entrance button 101NB to its non-operated position. It is noted that this particular through route can not be taken apart, so to speak, by reason of the fact that there is no intermediate east bound signal at the west bound signal 110, or at any other intermediate point.

It is also to be understood that the usual route locking features apply to this through route as pointed out in connection with the other routes described.

If the operator had desired to cause the above through route to include the track switch 9TSA and 9TSB in reverse positions instead of the track switches 7TSA and 7TSB all that would be necessary to accomplish this result would be to operate the auxiliary switch machine control lever 7SML (not shown) to a normal controlling position which would pick up the relays 7AN and 7BN. The opening of back contacts 255 and 256 of relays 7AN and 7BN respectively would prevent the energization of the relay 9BZ so that upon the actuation of the exit button 109XB, the energization of the selecting circuits for the relays N and R would include, by reason of the deenergized condition of relay 9BZ, back contact 205 for energizing the relay 9R to cause the reverse operation of the track switches 9TSA and 9TSB. This is believed sufficient description to point out how the most inferior through route among the optional routes can be selected. If the track layout were such that a route could be in conflict with the through route including track switches 7TSA and 7TSB in reverse positions, but not in conflict with the track switches 9TSA and 9TSB in reverse positions, then the feature of automatic selection would be present to give the most inferior optional route.

Through routes involving run-around movements.—We have considered optional through routes between two points as including one of several ways of getting from an entrance point on one track to an exit point on another track past one or more intermediate signal locations, but the present invention also provides that run-around routes may be automatically set up by the end-to-end operation. In other words, it may be desired to set up a through route which has a main track extending between the entrance and exit points for such route, but because of an obstruction or other routes conflicting with such main route it becomes necessary to run around the points of conflict in order to pass from the entrance point to the exit point.

The end-to-end operation provided by the present invention readily adapts itself to provide such automatic run-around movements in the event of conflicting routes. For example, let us assume that the operator desires to have a train pass from the signal 109 to the signal 103 at a time when a route is established between the signals 108 and 105 and another route is established between the signals 104 and 111. In order to consider how the through run-around route is automatically set up, it will first be necessary to point out the setting up of the routes individual to the two interlocked groups.

The operator first moves the entrance button 108NB to an operated position in a counter-clockwise direction. This energizes the relay 9AZ by a circuit closed from (+), through a circuit including lever contact 270 of entrance button 108NB in an operated position, back contact 271 of relay 108XR, back contact 272 of relay 10R, back contact 273 of relay 9R, windings of relay 9AZ, to (—). Front contact 126 of relay 9AZ passes energy on to the relay 7AZ, but this will not be pointed out in detail as the picking up of the relay 8R, following the actuation of the exit button 105XB causes the opening of such circuit at back contact 274 of relay 8R.

The actuation of the exit button 105XB effects for the energization of the relay 105XR by a circuit closed from (+), through a circuit including lever contact 270 of entrance button 108NB in an operated position, back contact 271 of relay 108XR, back contact 272 of relay 10R, back contact 273 of relay 9R, front contact 126 of relay 9AZ, wire 127⁴, wire 127³, back contact 275 of relay 8N, windings of relay 105XR, back contact 276 of exit button 105XB, lever contact 277 of entrance button 105NB in a non-operated position, to (—). As soon as the relay 105XR picks up, it closes front contact 280 to apply negative potential (—) to the left hand terminal of the relay 105XR so that the exit button 105XB may be immediately released.

The picking up of the relay 105XR applies energy to the relay 8R by a circuit closed from (+) through a circuit including front contact 281 of relay 105XR, lower winding of relay 8R, back contact 282 of relay 8N, to (—).

The picking up of the relay 8R applies energy to the relay 9AN by a circuit closed from (+) through a circuit including front contact 281 of relay 105XR, front contact 283 of relay 8R, wire 154³, wire 154⁴, front contact 155 of relay 9AZ, lower winding of relay 9AN, back contact 47 of relay 9R, to (—).

The relay 10AN is energized in multiple with the relay 9AN from the front contact 155 through the lower winding of relay 10AN, back contact 46 of relay 10R, to (—).

The track switches respond to their respective control relays N and R and the lock relays L drop away when correspondence conditions are indicated so that the signal 108 is cleared by the picking up of the relay 108G which is energized by a circuit closed from (+), through a circuit including front contact 284 of relay 105XR (see Fig. 7), front contact 285 of relay 8RCR, back contact 286 of relay 8NCR, back contact 287 of relay 8L, wire 89⁷, wire 89⁸, back contact 83 of relay 9L, front contact 87 of relay 9NCR, front contact 86 of relay 10NCR, back contact 85 of relay 10L, back contact 84 of relay 108XR, lever contact 288 of entrance button 108NB in an operated position, windings of relay 108G, to (—). The picking up of the relay 108G causes the signal 108 to clear.

The operator now moves the entrance button 104NB to an operated position after which he actuates the exit button 111XB. The actuation of the entrance button 104NB prepares a circuit, so that upon the actuation of the exit button 111XB, the relay 111XR is energized by a circuit closed from (+), through a circuit including lever contact 290 in an operated position, back contact 291 of relay 104XR, wire 292¹, wire 292², back contact 293 of relay 6N, back contact 168 of relay 6Z, windings of relay 111XR, back contact 169 of exit button 111XB, lever contact 170 of entrance button 111NB in a non-operated position, to (—). As soon as the relay 111XR picks up, it closes front contact 171 to apply negative potential (—) to the right hand terminal of the relay 111XR so that the exit button 111XB may be immediately released.

The picking up of the relay 111XR closes a circuit for energizing the relay 6R from (+), through a circuit including front contact 172 of relay 111XR, back contact 173 of relay 6Z, upper winding of relay 6R, back contact 294 of relay 6N, to (—).

After the proper operation of the track switch

6TS, the relay 104G is energized by a circuit closed from (+), through a circuit including front contact 181 of relay 111XR (see Fig. 7), back contact 182 of relay 6L, back contact 183 of relay 6NCR, front contact 295 of relay 6RCR, wire 296⁷, wire 296⁶, back contact 297 of relay 104XR, lever contact 298 of entrance button 104NB in an operated position, windings of relay 104G, to (-). The picking up of the relay 104G causes the signal 104 to clear.

With these two routes individual to their respective interlocked groups set up, we will now consider that the operator actuates the entrance button 109NB followed by the actuation of the exit button 103XB for the establishment of a through route.

The closure of contact 120 of entrance button 109NB energizes the relay 10BZ over a circuit previously pointed out. The picking up of the relay 10BZ does not pass energy to the relay 7AZ by reason of the open back contact 251 of relay 9AN which is energized for the route between signals 105 and 108.

However, energy is passed on for the energization of the relay 4AZ by a circuit closed from (+), through a circuit including lever contact 120 of entrance button 109NB in an operated position, back contact 121 of relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135⁴, wire 135³, back contact 300 of relay 7BN, back contact 301 of relay 7AN, back contact 302 of relay 7AZ, back contact 303 of relay 110XR, wire 304³, wire 304², front contact 305 of relay 16WS, lever contact 306 of entrance button 110NB in a non-operated position, back contact 307 of relay 5R, back contact 308 of relay 4R, windings of relay 4AZ, to (-). But it will be noted here, that the relay 4AZ is dropped away as soon as the through run-around route is established by reason of the picking up of the relay 5R which opens back contact 307 included in the pick up circuit for relay 4AZ, as will be presently pointed out.

If the route between signals 104 and 111 were not established, energy would also be passed on for the relay 5BZ by a circuit closed from (+), through a circuit including lever contact 120 of entrance button 109NB in an operated position, back contact 121 of relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135⁴, wire 135³, back contact 310 of relay 7R, back contact 311 of relay 106XR, front contact 312 of relay 17WS, wire 313³, wire 313², lever contact 314 of entrance button 111NB in a non-operated position, back contact 315 of relay 111XR, back contact 316 of relay 6R, back contact 317 of relay 5R, windings of relay 5BZ, to (-). However, it is noted that the relay 6R is picked up opening back contact 316, and the relay 111XR is also picked up opening back contact 315, so that the relay 5BZ can not be energized. This condition of relay 5BZ has been pointed out in detail because it is the relay which determines the run-around through route.

The actuation of the exit button 103XB now completes a circuit for the relay 103XR from (+), through a circuit including lever contact 120 of entrance button 109NB, in an operated position, back contact 121 of relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135⁴, wire 135³, back contact 300 of relay 7BN, back contact 301 of

relay 7AN, back contact 302 of 7AZ, back contact 303 of relay 110XR, wire 304³, wire 304², front contact 305 of relay 16WS, lever contact 306 of entrance button 110NB in a non-operated position, back contact 320 of relay 5AN, back contact 321 of relay 5BN, back contact 322 of relay 5BZ, back contact 323 of relay 4R, wire 135², wire 135¹, back contact 136 of relay 2R, windings of relay 103XR, back contact 137 of exit button 103XB, lever contact 138 of entrance button 103NB in a non-operated position, to (-). As soon as the exit relay 103XR picks up, it closes front contact 139 to apply negative potential (-) to the left hand terminal of relay 103XR, so that the exit button 103XB may be immediately released.

The picking up of the relay 103XR closes the circuit for energizing the relay 2BN, from (+) through a circuit including front contact 140 of relay 103XR, lower winding of relay 2BN, back contact 141 of relay 2R, to (-). A circuit is also closed for picking up relay 4BN from (+), through a circuit including front contact 140 of relay 103XR, back contact 142 of relay 2R, wire 143¹, wire 143², lower winding of relay 4BN, back contact 262 of relay 4R, to (-).

The relay 5R receives energy from (+), through a circuit including front contact 140 of relay 103XR, back contact 142 of relay 2R, wire 143¹, wire 143², back contact 324 of relay 4R, back contact 325 of relay 5BZ, lower winding of relay 5R, back contact 326 of relay 5BN, back contact 327 of relay 5AN, to (-).

As soon as the relay 5R picks up, a circuit is closed for energizing the relay 110NX110 from (+), through a circuit including front contact 140 of relay 103XR, back contact 142 of relay 2R, wire 143¹, wire 143², back contact 324 of relay 4R, back contact 325 of relay 5BZ, front contact 328 of relay 5R, windings of relay 110NX110, lever contact 329 of entrance button 110NB in a non-operated position, front contact 330 of relay 16WS, wire 331², wire 331³, back contact 332 of relay 110XR, to (-). As soon as the relay 110NX110 picks up, it closes contact 333 to apply negative potential from (-) through lever contact 329 in a non-operated position to its right hand terminal.

The relay 110NX110 picks up and closes a circuit for energizing the exit relay 110XR from (+), through a circuit including lever contact 120 of entrance button 109NB in an operated position, back contact 121 of relay 109XR, back contact 122 of relay 11R, back contact 123 of relay 10R, front contact 124 of relay 10BZ, back contact 134 of relay 9R, wire 135⁴, wire 135³, back contact 300 of relay 7BN, back contact 301 of relay 7AN, back contact 302 of relay 7AZ, windings of relay 110XR, wire 334³, wire 334², front contact 335 of relay 16WS, front contact 336 of relay 110NX110, to (-). As soon as the relay 110XR picks up, it closes front contact 332 to apply negative potential (-) to its left hand terminal, and opens back contact 332 included in the pick up circuit of relay 110NX110.

The picking up of the relay 110XR applies energy to the relay 7R by a circuit closed from (+), through a circuit including front contact 337 of relay 110XR, back contact 338 of relay 7AZ, lower winding of relay 7R, back contact 257 of relay 7AN, back contact 258 of relay 7BN, to (-).

As soon as the relay 7R picks up, it closes a circuit for energizing the relay 9BN from (+), through a circuit including front contact 337 of relay 110XR, back contact 338 of relay 7AZ, front

contact 339 of relay 7R, wire 143³, wire 143⁴, lower winding of relay 9BN, back contact 47 of relay 9R, to (—).

Energy passes on from the wire 143⁴ through back contact 144 of relay 9R, front contact 145 of relay 10BZ, lower winding of relay 10BN, back contact 46 of relay 10R, to (—).

The relay 11N is energized in multiple with the relay 10BN from front contact 145, through lower winding of relay 11N, back contact 146 of relay 11R, to (—).

The energization of these switch control relays N and R through the medium of the self-selecting network in the manner above described, causes the respective track switches to be operated to proper positions to set up a route between the signal 109 and the signal 103 over the trackway, including the track switch 11TS in a normal position, the track switch 10TSB in a normal position, track switch 9TSB in a normal position, track switches 7TSA and 7TSB in reverse positions, track switches 5TSA and 5TSB in reverse positions, track switch 4TSB in a normal position, and track switch 2TSB in a normal position. When the track switches have assumed their proper positions as indicated by the correspondence relays, the lock relays L are dropped away so that a circuit is closed for energizing the relay 109G.

A circuit is closed for the relay 109G from (+), through a circuit including front contact 266 of relay 110XR (see Fig. 7), back contact 265 of relay 7L, back contact 264 of relay 7NCR, front contact 263 of relay 7RCR, back contact 219 of relay 7NCR, back contact 218 of relay 7L, wire 217⁷, wire 217⁸, front contact 216 of relay 9NCR, back contact 215 of relay 9L, back contact 214 of relay 10L, front contact 213 of relay 10NCR, front contact 212 of relay 11NCR, back contact 211 of relay 11L, back contact 210 of relay 109XR, lever contact 244 of entrance button 109NB in an operated position, relay windings of relay 109G, to (—).

The picking up of the relay 109G causes the signal 109 to be cleared so that the train can then proceed up to the signal 110 which is also cleared by the picking up of the relay 110A, by reason of a circuit closed from (+), through a circuit including front contact 241 of relay 103XR, front contact 242 of relay 2NCR, back contact 243 of relay 2L, wire 217⁶, wire 217⁷, front contact 187 of relay 4NCR, back contact 186 of relay 4L, back contact 185 of relay 5L, back contact 184 of relay 5NCR, front contact 340 of relay 5RCR, back contact 269 of relay 5NCR, back contact 268 of relay 5L, back contact 267 of relay 110SCR, front contact 342 of relay 110NX110, windings of relay 110G, to (—).

This through route may be returned to stop by the restoration of the entrance button 109NB to its non-operated position, or may be taken apart, so to speak, and have each of its elements returned to stop for the respective interlocked groups as pointed out in connection with the through routes above described.

Perhaps it should be mentioned that the clearing of the signal 109 causes the relay 16WS to be deenergized so that the continued energization of the relay 103XR is dependent upon the lever contact 306 of entrance button 110NB in a non-operated position through back contact 305 of relay 16WS and front contact 343 of relay 110NX110. But in the time preceding the dropping of relay 16WS after the picking up of the relay 110XR, this energy is supplied

from front contact 343 of relay 110NX110 through front contact 303 of relay 110XR and front contact 305 of relay 16WS to the lever contact 306. These provisions are for similar purposes as pointed out in connection with the relay 15ES above and for the sake of simplicity will not be described in detail in this connection.

The above description of setting up routes involving so-called run-around movements considered such operation with regard to through routes, but it should be understood that routes involving run-around movements may be set up within a single interlocked group, by operation of auxiliary switch levers, as when some switch or crossover is out of order for some reason, and cannot be operated to the position selected by the automatic operation of the route establishing means. For example, a route may be set up from the signal 108 to the signal 110 by the way of track switches 9TSA and 9TSB as well as track switches 10TSA and 10TSB all in reverse positions, but with the track switches 7TSA and 8TS in normal positions. Such a run-around route is not automatically set up but requires the manual manipulation of the auxiliary switch control levers after which the actuation of the entrance button 108NB to an operated position and the momentary actuation of the exit button 110XB will cause the signal 108 to be cleared.

Another run-around route can be established between these two signals 108 and 110 by the way of track switches 7TSA and 7TSB as well as track switches 10TSA and 10TSB in reverse positions with the track 9TSB in a normal position. This run-around route may be desired upon a failure of the track switch 8TS to respond to a proper normal control, that is, it may be stuck in a reverse position due to snow or ice or the like. Such run-around route may be set up either by operating the auxiliary switch control lever 8SML (not shown) to a reverse controlling position or by operating both of the auxiliary switch machine control levers 7SML and 10SML (not shown) to reverse positions. The operation of the track switches in response to their auxiliary control has been described in detail in connection with the auxiliary control lever 9SML shown in Fig. 5.

As another example, considering the interlocked group formed by Figs. 1 and 2, assume that the switch 3 for some reason is out of order and cannot be operated to the normal position, and the operator actuates the auxiliary switch control levers 3SML to the reverse position to energize 3R, and then actuates entrance button 110NB and the exit button 102XB.

The operation of the entrance button 110NB closes a pick up circuit for the preselecting relay 4AZ from (+), through a circuit including lever contact 306 of entrance button 110NB in operated position, back contact 307 of relay 5R, back contact 308 of relay 4R, windings of relay 4AZ, to (—).

The picking up of the relay 4AZ causes energy to be passed on but it can not energize the relay 2AZ as the relay 3R is picked up opening back contact 128. It may also be noted in this connection that the run-around route will subsequently effect the picking up of the relay 5R causing the deenergization of the relay 4AZ by opening back contact 307 which does no harm inasmuch as the relay 4AZ accomplishes no useful purpose in the establishment of the run-around route. The energization of the relay 4AZ

is merely pointed out for the purpose of showing the manner in which the relay 2AZ is prevented from being picked up with the relay 3R picked up. This is because the deenergized condition of the relay 2AZ is the one which determines that the run-around route shall be over the track switches 2TSA and 2TSB in reverse positions.

The actuation of the exit button 102XB causes the energization of the exit relay 102XR by a circuit closed from (+), through a circuit including lever contact 306 of entrance button 110NB in an operated position, back contact 320 of relay 5AN, back contact 321 of relay 5BN, back contact 322 of relay 5BZ, back contact 323 of relay 4R, wire 135², wire 135¹, back contact 158 of relay 2BN, back contact 252 of relay 2AN, back contact 130 of relay 2AZ, windings of relay 102XR, back contact 148 of exit button 102XB, contact 131 of entrance button 102NB in a non-operated position, to (-). As soon as the exit relay 102XR picks up, its front contact 149 applies negative potential (-) to the left hand terminal of relay 102XR so that the exit button may be immediately released.

The picking up of the relay 102XR closes a pick up circuit for 2R from (+), through a circuit including front contact 150 of relay 102XR, back contact 151 of relay 2AZ, lower winding of relay 2R, back contact 159 of relay 2AN, back contact 160 of relay 2BN, to (-).

The picking up of the relay 2R closes a circuit for energizing the relay 4BN from (+) through a circuit including front contact 150 of relay 102XR, back contact 151 of relay 2AZ, front contact 142 of relay 2R, wire 143¹, wire 143², lower windings of relay 4BN, back contact 262 of relay 4R, to (-).

The relay 5R receives energy which is passed on from wire 143², through back contact 324 of relay 4R, back contact 325 of relay 5BZ, lower windings of relay 5R, back contact 326 of relay 5BN, back contact 327 of relay 5AN, to (-).

As soon as the track switches properly responded to their switch control relays and their lock relays have been dropped by the picking up of their correspondence relays, then a circuit is closed for the signal relay 110G from (+), through a circuit including front contact 94 of relay 102XR (see Fig. 6), back contact 93 of relay 2L, back contact 92 of relay 2NCR, front contact 344 of relay 2RCR, back contact 242 of relay 2NCR, back contact 243 of relay 2L, wire 217⁶, wire 217⁷, front contact 187 of relay 4NCR, back contact 186 of relay 4L, back contact 185 of relay 5L, back contact 184 of relay 5NCR, front contact 349 of relay 5RCR, back contact 269 of relay 5NCR, back contact 268 of relay 5L, back contact 267 of relay 110SCR, lever contact 345 of entrance button 110NB in an operated position, windings of relay 110G, to (-).

The energization of the relay 110G causes the clearing of the signal 110 as will be readily understood.

This run-around route may be restored to stop by the return of the entrance button 110NB to a non-operated position.

As another example of this operation, assume that the crossover 4 is out of order and cannot be operated to the normal position, and that the operator actuates the auxiliary switch control levers 4SML to the reverse position. This energizes the reverse switch control relay 4R and opens its back contact 306 to prevent the preselecting relay 4AZ from being energized by the operation of the entrance button 110NB.

However, the relay 2AZ is energized by a run-around circuit closed from (+), through a circuit including lever contact 306 of entrance button 110NB in an operated position, back contact 320 of relay 5AN, back contact 321 of relay 5BN, back contact 322 of relay 5BZ, back contact 346 of relay 4BN, back contact 347 of relay 4AN, back contact 348 of relay 4AZ, wire 127², wire 127¹, back contact 128 of relay 3R, back contact 129 of relay 2R, windings of relay 2AZ, to (-).

It will be readily apparent that the picking up of the relay 2AZ passes energy in from the heel of contact 129 through front contact 130 to the relay 102XR so that the actuation of the button 102XB with the lever contact 131 of entrance button 102NB in a non-operated position effects the picking up of relay 102XR. The picking up of the relay 102XR closes front contact 149 to apply negative potential (-) to the left hand terminal of the relay 102XR.

The picking up of the relay 102XR closes a circuit for the relay 2AN from (+), through a circuit including front contact 150 of relay 102XR, front contact 151 of relay 2AZ, lower winding of relay 2AN, back contact 141 of relay 2R, to (-). The relay 3N is energized in multiple with the relay 2AN from the front contact 151 through lower winding of relay 3N, back contact 152 of relay 3R, to (-).

Energy is passed on from front contact 151 through back contact 153 of relay 3R, wire 154¹, wire 154², back contact 349 of relay 4AZ, lower winding of relay 4R, back contact 178 of relay 4AN, back contact 179 of relay 4BN, to (-). Such energy, of course, maintains a relay 4R picked up although the auxiliary switch machine control lever 4SML (not shown) might be restored to its inactive position, but this relay 4R, of course, was initially picked up by the auxiliary lever.

With the relay 4R picked up, energy is passed on from the back point of contact 349 through front contact 324 of relay 4R, back contact 325 of relay 5BZ, lower winding of relay 5R, back contact 326 of relay 5BN, back contact 327 of relay 5AN, to (-).

The track switches, of course, respond to their respective switch control relays causing the establishment of a signal clearing circuit for the relay 110G from (+) through a circuit including front contact 94 of relay 102XR (see Fig. 6), back contact 93 of relay 2L, front contact 92 of relay 2NCR, front contact 91 of relay 3NCR, back contact 90 of relay 3L, wire 89⁶, wire 89⁷, back contact 190 of relay 4L, back contact 189 of relay 4NCR, front contact 188 of relay 4RCR, back contact 187 of relay 4NCR, back contact 186 of relay 4L, back contact 185 of relay 5L, back contact 184 of relay 5NCR, front contact 340 of relay 5RCR, back contact 269 of relay 5NCR, back contact 268 of relay 5L, back contact 267 of relay 110SCR, lever contact 345, entrance button 110NB in an operated position, windings of relay 110G, to (-). The picking up of the relay 110G causes the signal 110 to be cleared for allowing the passage of traffic over the run-around route.

Thus, it has been pointed out how run-around routes may be established either within a particular interlocked group, or between two interlocked groups. It is also to be understood that the run-around operation might include a whole interlocked group between two other interlocked groups. In other words, when several interlocked groups are placed end-to-end, it may be that,

due to the establishment of an intervening main line route between signals intermediate to the entrance and exit points a run-around route will be established between the entrance and exit points at the extreme ends of several interlocked groups.

The principles of this invention are intended to be applicable to any number of interlocked groups, and when so applied, all operations and functions obtainable with such a combination are considered to have been disclosed herein by the relationship shown between two interlocked groups. This provides for simplicity in the present disclosure, for, if a third interlocked group were added to the present disclosure, it must be admitted that the disclosure would be considerably more complex. It is believed preferable to point out that, when three interlocked groups are placed end-to-end, a run-around route may automatically be selected to avoid two intermediate signal locations upon the operation of the entrance and exit buttons governing a through route.

Conclusion.—Numerous other examples of entrance and exit button operation and establishing of routes in the particular track layout illustrated might be described in detail; but it is believed that the foregoing explanation of certain specific examples of the operation of the system in establishing routes including selection between optional routes automatically and by auxiliary switch lever control, and through route or end-to-end operation in various aspects, will be sufficient to make clear the nature of this invention and the contemplated mode of operation.

From the foregoing detail description of one specific embodiment of the invention, it can be seen that this invention meets the various requirements for a suitable system of entrance-exit control; but in connection with this illustration and description of the invention, it is of course to be understood that the particular arrangement of relays, circuits, and contacts illustrated is that required for the particular track layout shown, and that if the track layout is simplified or varied, there will be a corresponding re-arrangement of circuits and contacts, including the omission of some contacts. For example, the contact 164 of the relay 4AN in Fig. 2 is always required regardless of the form of the track layout including the crossover 4; but in a simple track layout not involving end-to-end or through route operation, contact 253 of relay 4BN becomes unnecessary and may be omitted.

Also, while through route operation is usually desirable for a plurality of interlocked groups, two interlocked groups may be associated with each other, employing initiating and completion circuit networks as shown herein, without providing for end-to-end through route operation at all, or with respect to certain signal locations and routes only, by using or omitting the through route connections and through route relays as desired.

Moreover, an entrance-exit type system embodying this invention has been described more particularly with respect to establishing routes; and it should be understood that various forms of auxiliary means may be employed in the complete system for approach locking, route locking display of indications on the control panel, and the like. Similarly, various other modifications, adaptations, and additions may be made to the specific embodiment of the invention illustrated,

as may be required by the particular track layout or other conditions encountered in practice.

Having described an interlocking system of the entrance-exit type of interlocking as one specific embodiment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume; and furthermore, it is to be understood that variations, modifications, adaptations and alterations may be used to meet the requirements of practice without in any manner departing from the scope or spirit of the invention except as limited by the appended claims.

What I claim is:

1. In an interlocking system for railroads; a track layout having track sections and switches to form a plurality of different routes; entrance and exit buttons for the entrance and exit ends of said routes respectively; a preselecting relay for each of said track switches; normal and reverse control relays for each of said track switches; initiating circuit means for energizing said preselecting relay for each of those track switches which is trailed normal by a train moving over the several routes emanating from a particular entrance point when the entrance button for such entrance point is operated only providing a part of a route for train movement from said particular entrance point to and over the corresponding switch in its normal position is not in conflict with some established route; completion circuit means effective upon the operation of a particular exit button following the operation of said particular entrance button to energize said normal relay for each of said trailed track switches having its preselecting relay energized, and to energize said reverse relay for each of said trailed track switches having its preselecting relay deenergized, said completion circuit means also energizing the normal or reverse relay for all of the other track switches included in the route from said particular entrance point to the particular exit point in accordance with the position said remaining switches must have in order to establish that route.

2. In an interlocking system for railroads; a track layout having track sections interconnected by track switches; entrance and exit buttons for the entrance and exit ends of said sections; preselecting relay means for each of said track switches; normal and reverse control relays for each of said track switches; initiating circuit means for energizing the preselecting relay means for each of those track switches which is trailed for one of its positions and which is included in the several routes emanating from the particular entrance point having its entrance button operated and only providing said switch control relay for the opposite position for each of the corresponding track switches is deenergized; and completion circuit means effective upon the operation of a particular exit button following the operation of said particular entrance button to energize said normal or said reverse relay for each of the remaining facing point switches in the route from said particular entrance point to said particular exit point as required to set up that route, and to energize one or the other of said control relays for each of said trailed switches dependent upon the controlled condition of the corresponding preselecting relay means.

3. In an interlocking system for railroads; a track layout having track sections interconnected

by track switches; an entrance button for each entrance signal location; a self-restoring exit button for each exit signal location; a preselecting relay for each of said track switches; normal and reverse control relays for each of said track switches; initiating circuit means effective upon the actuation of a particular entrance button to energize the preselecting relay for each of those track switches which would be trailed normal by a train moving over the several routes emanating from the corresponding entrance point; an exit relay for each of said exit buttons; pick up circuits prepared by the response of said preselecting relays for said several routes for energizing the exit relay at the end of any given one of such routes upon the actuation of its respective exit button; a stick contact on each exit relay for shunting said exit button for that relay; and completion circuit means effective upon the picking up of a particular exit relay to energize said normal relay for each of said trailed track switches having its preselecting relay energized, and to energize said reverse relay for each of said trailed track switches having its preselecting relay deenergized, said completion circuit means also energizing the normal or reverse relay for all of the other track switches included in the route from said particular entrance point to the particular exit point in accordance with the position said remaining switches must have in order to establish that route.

4. In an interlocking system for railroads; a track layout having successive track sections with turn out track switches in said sections and having a signal at one end of each section governing the movement of traffic in the same direction; entrance and exit buttons for the entrance and exit ends for said sections; route establishing means responsive to the joint operation of the entrance button for the entrance to a section and the operation of the exit button for the exit end of that section to operate said track switches for such section to proper positions to establish a route between such entrance and exit ends and to control the clearing of said signal for said section; and means including said route establishing means and responsive to the joint operation of the entrance button for the entrance to a first one of said sections and the exit button for the exit end of a succeeding one of said sections to operate said track switches for such sections and the intervening sections, if any, to proper positions to establish a through route between such entrance and exit ends and to clear each of said signals at the entrance ends of said sections independently of the operation of the entrance and exit buttons for the intervening section ends.

5. In an interlocking system for railroads; a track layout having two interlocked groups each having track sections interconnected by track switches to form a plurality of routes; entrance and exit buttons for the ends of said routes in each of said groups; control relays associated with each of said track switches for governing its operation; means responsive to the joint operation of an entrance button at one end of a particular route in one of said interlocked groups and an exit button at the opposite end of that route to condition a control relay for each of the track switches in that route to thereby set up said particular route for one direction of train movement; means responsive to the joint operation of an entrance button at one end of another route in said other interlocked group, which another route connects with said particular route,

and an exit button at the opposite end of such another route to condition a control relay for each of the track switches in such another route to thereby set up said another route for the same direction of train movement; and means, including in part said means recited above, responsive to the joint operation of the entrance button at said one end of said particular route and the exit button at said opposite end of said another route to condition a control relay for each of said track switches in both of said routes to thereby set up both said particular route and said another route for said direction of train movement.

6. In an interlocking system for railroads, a track layout including a plurality of stretches of track interconnected by track switches to form different routes, control buttons for the opposite ends of each stretch of track, a preselecting relay for each of said track switches, normal and reverse control relays for each of said track switches, circuit means effective upon the actuation of the control button at one end of a stretch to energize the preselecting relay for each track switch trailed for a particular position in each of the routes emanating from that end of such stretch, and circuit means responsive to the operation of the control button at the opposite end of one of said routes emanating from such entrance end to energize the normal or reverse control relays for each of said track switches in such route depending either upon the condition of the preselecting relay for such switch or the position required to set up that route.

7. In a switch and signal control system of the character described for a track layout including a number of track switches and providing a plurality of routes between entrance and exit points, a manually operable entrance button associated with the entrance point for each of the various routes, a manually operable exit button associated with the exit point for each of said routes, a selecting relay for each switch, a normal and a reverse control relay for each switch, circuit networks for governing the energization of said relays and including certain contacts operated thereby, said circuit networks comprising initiating circuit paths and completion circuit paths for each direction of train movement over each route, means responsive to the operation of a given entrance button for applying electrical potential to the initiating circuit paths for the direction of train movement away from the corresponding entrance point over all of the available routes originating at that entrance point and thereby energizing those selecting relays belonging to these switches which a train would trail in the normal position in traveling from such given entering point in said direction over any one of said available routes, said initiating circuit path for energizing a selecting relay being closed only if a part of a route for train movement from said entrance point to and over the corresponding switch in its normal position is not in conflict with some established route, means responsive to the operation of an exit button for a given one of said available routes and effective only if the initiating circuit paths to the corresponding exit point has been completed for energizing the completion circuit paths of that particular route, such energization of said completion circuit paths energizing the normal or reverse control relays as the case may be for each of said trailed switches in accordance with the condition of the corresponding selecting relay, the energization of said completion circuit path

also energizing the normal or reverse control relay of the other facing point switches in such given route in accordance with the position which such switches must have in order to bring a train to said exit point, means for operating each switch in response to the energization of its normal or reverse control relay, and means for clearing a signal corresponding to the entrance button actuated only if all of the switches in the given route to the exit point belonging to the exit button actuated have been operated by their control relays to corresponding normal or reverse positions.

8. In a switch and signal control system of the type described for a railway track layout having a number of power operated track switches operable to different positions to provide various routes through the track layout between signal locations; manually operable devices associated with said signal locations which constitute entrance and exit points of said routes; switch control means for governing the operation of each switch to the normal or reverse position; circuit means responsive to the manual operation of a device for any given entrance point for conditioning the switch control means of all of those switches of the layout which a train would trail in moving away from said given entrance point over any of the available routes originating at such point, said switch control means for said trailed switches being conditioned to operate its corresponding switch to the normal or reverse position as required for such trailing movement; circuit means responsive to the manual operation of the manually operable device associated with the exit point of a given one of said available routes for operating said trailed switches in that route to positions in accordance with said conditioning of their respective switch control means and for operating the remaining switches in the route to the normal or reverse position as required to bring a train to such exit point; and a circuit for clearing the signal for any one of said routes including contacts closed only if the manually operable devices for the entrance and exit ends of that route have been operated and also contacts closed only if all of the switches in that route have been operated to positions in accordance with the condition of their respective switch control means.

9. In a switch and signal control system of the character described for operating the track switches and clearing the signals of a track layout providing various routes through the track layout between signal locations; a manually operable device associated with each signal location constituting an entering or an exit point for one or more routes; a preselecting relay for each switch of the track layout; a normal and a reverse control relay for each of said switches; an initiating circuit network for energizing said preselecting relays and including contacts operated thereby, certain conductors of said network being energized by the operation of a manually operable device associated with the entrance end of a given route to condition the preselecting relays for those switches which would be trailed by a train in moving from such entrance point over any of the various routes through the track layout originating at said entering point, another completion circuit network energized by manual operation of a device belonging to the exit point of one of said various routes and energizing the normal or reverse control relay for each of the trailed switches in that route dependent upon the condition of said preselecting

relays, and also energizing the normal or reverse control relays of the remaining switches in that particular route to cause operation of such remaining switches to the positions required to bring a train to such exit point; and means responsive to the energization of certain switch control relays of the switches involved in such route for cancelling the conditioning of the preselecting relays of such trailed switches as are not involved in such route.

10. In a switch and signal control system of the entrance-exit type described; a track layout having power operated track switches providing various routes through such layout between signal locations; manually operable buttons associated with the signal locations constituting entrance and exit points for a route through said layout; a preselecting relay for each switch to be energized for the normal position of that switch and to be deenergized for the reverse position; a normal and a reverse control relay for each switch; a circuit network for controlling the energization of said preselecting relays comprising with respect to each route, a circuit path energized in response to the operation of the button at the entrance end of said route and extending to the preselecting relay for the switch which would be first encountered and trailed by a train moving away from said entrance point, said circuit path being connected to and energizing said preselecting relay if that switch should be normal and being connected to a back contact of said relay if said switch should be reverse, another circuit path connected to the first circuit path through the front or the back contact of said preselecting relay for similarly controlling the energization of the preselecting relay for the switch that would be next encountered and trailed by such train movement, other similar circuit paths for such other trailed switches, each of said circuit paths connected to and energizing a preselecting relay including a back contact of the reverse control relay for the corresponding trailed switch and a back contact of the reverse control relay for any intervening facing point switch over which a train must move to reach said trailed switch, each of said circuit paths which are connected to a back contact of a preselecting relay including a back contact of the normal control relay for the corresponding trailed switch, an exit relay receiving current from the circuit paths belonging to said route and energized by actuation of the button for the exit point of said route, and completion circuits energized upon energization of said exit relay for energizing either the normal or the reverse control relay of each of said trailed switches in accordance with the condition of its preselecting relay and for also energizing either the normal or the reverse control relay for the other switches in the route as required for train movement over said route.

11. In a switch and signal control system of the character described for governing the operation of power operated switches over a track layout providing various routes between signal locations, said system comprising with respect to any given route for one direction of train movement over a facing point switch and a trailing switch, an entrance button and an exit button associated with the signal locations constituting the entrance and exit points of said route, preselecting relay means for said trailed switch, an initiating circuit energized by operation of said entrance button for conditioning said pre-

selecting relay means to conform with the position said trailed switch must assume for train movement over said route, and a completion circuit energized upon operation of said exit button for operating said trailing switch to the position to conform with the condition of said preselecting relay means and for also operating said facing point switch to the position which it should assume if a train should be considered as trailing such switch in travelling from the exit point toward the entrance point.

12. In a switch control system of the character described for a track layout including crossovers operable to provide two optional routes between common entrance and exit points and one of such optional routes being preferred for normal use; preselecting means for each crossover which, when energized, corresponds to a particular position of that crossover and when deenergized to the other position; manually operable buttons associated with said entrance and exit points; circuit means responsive to the operation of the button for said common entrance point for governing the energization of said preselecting means for the crossover more remote from such entrance point in accordance with the position required of that crossover for a preferred one of said optional routes; means for rendering said circuit means ineffective if said preferred optional route is in conflict with some established route, thereby conditioning said preselecting means for said remote crossover in accordance with the position required of that crossover for the other of said optional routes; and means responsive to the operation of the button for said common exit point for operating said remote crossover to a position in accordance with the condition of its preselecting means and for also operating said near crossover to the position required to establish the particular optional route for the operated position of said remote crossover.

13. In a switch and signal control system of the character described for a railroad track layout having two crossovers providing alternative routes between common entrance and exit points; manually operable buttons associated with said entrance and exit points; two preselecting relays for each crossover, one for each track switch of the crossover; normal and reverse control relays for each cross-over; and initiating and completion circuit networks for controlling the energization of said preselecting relays and said normal and reverse control relays comprising with respect to said alternative routes for one direction of train movement, an initiating circuit path energized upon operation of the button for the entrance end of said alternative routes, for energizing the particular preselecting relay for the track switch of the crossover remote from said entrance end which would be trailed in a predetermined position by a train travelling over one of said routes to said exit end, and a completion circuit path energized upon actuation of the button for the exit end of said alternative routes for energizing the normal or the reverse control relay for said remote crossover dependent upon the energized or deenergized condition of said particular preselecting relay for the remote crossover and for also energizing the normal or reverse control relay for the near crossover to conform with the position it should have for a train movement toward said entrance end with said remote crossover in its selected position, said initiating circuit path be-

ing closed only if there is no route established in conflict with the alternative route over said remote crossover trailed in said predetermined position.

14. In a switch and signal control system of the entrance-exit type governing train movement in one direction over two adjoining portions of track of a railroad track layout having power operated switches in said portions of track and a signal at one end of each portion governing train movement in the same direction, a manually operable entrance button associated with the entrance end of each of said track portions, a manually operable exit button associated with the exit end of each of said track portions, route establishing means for governing the position of the track switches for said track portions and the clearing of the signals, said route establishing means comprising switch control and signal control relays and circuit means governing the energization thereof, said circuit means including an electro-responsive means and a circuit path energized by the actuation of the entrance and the exit buttons for the remote ends of said track portions for governing the energization of the switch control and signal control relays of both of said track portions the same as if the entrance button and the exit button associated with the adjoining ends of said track portions had been manually operated, said electro-responsive means interrupting when energized said circuit path and individually energizing the circuit means belonging to its track portion more remote from the designated entrance end, and means including a stick circuit for maintaining said electro-responsive means energized until a train passes the signal at the adjoining ends of said track portion.

15. In a switch and signal control system of the character described for a railroad track layout affording through routes over track switches in two or more adjoining portions of track each having a signal at the entrance thereof for governing train movement in the same direction and certain of which signals may become an intermediate signal in some through route, manually operable entrance and exit buttons associated with the signal locations of each of said track portions, route establishing means for each track portion operable to position the track switches of that portion to provide a route or part of a through route and govern the clearing of the signal for that track portion, means responsive to the manual actuation of the entrance button and the exit button of any given one of said track portions for rendering effective said route establishing means for that track portion, electro-responsive means associated with each signal which may become an intermediate signal in some through route and operable to govern the route establishing means of the two track portions terminating at such signal location in the same way as if an entrance button and an exit button for said adjoining track portions have been manually operated, and means responsive to the actuation of the entrance and exit buttons at any two signal locations for operating the electro-responsive means for the one or more intervening signal locations and thereby establishing a through route over two or more track portions by the actuation of the entrance and exit buttons at the ends thereof without actuation of the buttons at the intervening signal locations.

16. In a switch and signal control system of

the entrance-exit type described for establishing routes through a railroad track layout by the manual operation of entrance and exit buttons associated with the signal locations at the ends of said routes, said track layout providing through routes over two or more adjoining portions of track each having a signal at an entrance end governing train movement in the same direction, route establishing means for each of said track portions operable to position the track switches in that portion and also governing the clearing of the entrance signal for that track portion, a manually operable device associated with each signal location, and circuit means responsive to the manual actuation of the devices at any two given entrance and exit signal locations for governing the route establishing means for the one or more track portions between the points with which said actuated devices are associated, whereby through routes including two or more of said track portions may be established and the entrance signal for such track portions cleared by actuation of the two devices belonging to the remote ends of such through route as well as routes individual to each track portion.

17. In a switch and signal control system of the character described for railway track layouts including routes over track switches in two or more adjoining portions of track each having a signal at the entrance thereof for governing train movement in the same direction, route establishing means for each track portion including normal and reverse switch control relays and a circuit network for controlling the energization of said relays, manually operable entrance and exit buttons associated with the ends of each of said track portions, and means responsive to the actuation of a given entrance button and a given exit button for controlling the energization of said circuit network to position the track switches in the one or more track portions intervening between the points with which said given entrance and exit buttons are associated, whereby through routes including two or more of said track portions may be established by the actuation of the buttons at the remote ends thereof and without actuation of the buttons for any intervening signal location.

18. In a switch and signal control system of the entrance-exit type for railroad track layouts having power operated switches movable to provide various routes, said layout having routes in end-to-end relation over two or more adjoining portions of track between entrance and exit signal locations each of which track portions has a signal at one end for governing train movement in the same direction, a manually operable button associated with the entrance and exit signal locations for each of said track portions, switch control and signal control means associated with each track portion and operable in response to actuation of the buttons for the entrance and exit signal locations of that track portion to position the track switches therein as required to establish the route over that track portion and control the clearing of said signal at the entrance thereof, and means responsive to the operation of the button for any given entrance signal location and the button for any given exit signal location for governing the switch control and signal control means for the one or more track portions intervening between the points with which said buttons are associated, whereby through routes including the routes over two or more track portions may be established by the

manual actuation of the two buttons for the remote ends thereof as well as routes for said track portions individually, as may be desired by the operator.

19. In a switch and signal control system of the entrance-exit type for railroad track layouts having power operated switches operable to different positions to establish various routes over various portions of track through said track layout, said track layout including through routes over one or more adjoining portions of track each constituting an interlocked group and having a signal at one end thereof governing train movement in the same direction, manually operable buttons located on a track diagram of said layout adjacent said signal locations, route establishing means for each of said track portions including a normal and a reverse switch control relay for each switch and a circuit network for the energization of said relays, the parts of said circuit network belonging to a given track portion being energized by the actuation of the entrance and exit buttons at the ends of that track portion, and means including circuits connecting the networks of adjoining interlocked groups and responsive including circuits connecting the networks of adjoining interlocked groups and to the actuation of the entrance and exit buttons at the remote ends of two or more adjoining track portions for governing the energization of said networks of said track portions the same as if the buttons for the one or more intervening signal locations had also been actuated, whereby through routes over two or more of said track portions may be established at will by the actuation of the entrance and exit buttons for the remote ends thereof and without manual actuation of the buttons for any intervening signal location.

20. In a switch and signal control system of the entrance-exit type for track layouts including stretches of track and track switches to provide two or more adjoining portions of track in end-to-end relation with signals at the entrance ends of said track portions governing train movement in the same direction, a manually operable device located on a track diagram of said track layout adjacent each of said signal locations, route establishing means for each track portion responsive to the operation of the two devices associated with the entrance and exit signal locations of said track portion for governing the positioning of all of the track switches in that portion and the clearing of the signal of that track portion, and means responsive to the operation of said devices at the remote ends of two or more adjoining track portions for governing the route establishing means of said track portions in the same way as if the devices for the one or more intervening signal locations had been manually operated, whereby in addition to establishing a route over any one of said track portions individually by the manual actuation of the devices at the ends thereof, through routes over said adjoining track portions may be established by manual actuation of said devices at the remote ends of such through routes and without manual operation of the devices for any intermediate signal location.

21. In a switch and signal control system of the entrance-exit type described for track layouts having power operated track switches and signals governing train movement over various routes through said track layout, said track layout including two or more adjoining portions of track with a signal at the entrance to each por-

tion governing train movement in the same direction; manually operable entrance and exit buttons associated with the ends of said track portions; route establishing means for each track portion operable to position the track switches of that portion and govern the clearing of the signals thereof, said route establishing means including initiating and completion circuit paths for each direction of train movement; means responsive to the operation of an entrance button for energizing the initiating circuit paths for at least the corresponding track portion, said initiating circuit paths for said track portions being normally connected so that the actuation of a given entrance button causes energization of the initiating circuit paths for two or more track portions; means responsive to the operation of an exit button at the end of the given one of said track portions for energizing the completion circuit path for that track portion and for interrupting such normal connection between the initiating circuit paths of that track portion and the adjoining track portion; and means responsive to the energization of the completion circuit paths of one track portion for energizing the completion circuit paths for an adjoining track portion the same as if the exit button thereof had been manually operated only if a through route is being established over such adjoining track portion; whereby a through route including two or more of said track portions may be established by actuation of the entrance and exit buttons at the ends of such through route and without manual actuation of the intervening buttons.

22. In an interlocking system for railroads, a first signal at one end of a track layout for governing the movement of traffic over a first portion of a traffic route through said layout, a second signal at an intermediate point in said route for governing the movement of traffic in the same direction over a second portion of said route, manually operable devices for each end of the route and for said intermediate point, route control means responsive to the joint operation of the devices for the two ends of the route only to establish said route and to clear both said signals, means responsive to the joint operation of the devices for the two ends of the first portion of the route to establish the first portion of said route and to clear said first signal, and means responsive to the joint operation of the devices for the two ends of the second portion of the route to establish said second portion and to clear said second signal.

23. In a switch and signal control system of the entrance-exit type for a railroad track layout having power operated switch points movable to provide various routes between signal locations, said layout having adjoining routes over two adjoining track portions, and said track portions having a signal at corresponding ends for governing train movement in the same direction, manually operable buttons for the ends of said track portions and associated with the signal locations; and route establishing means responsive to the operation of the buttons for the opposite ends of either of said track portions for governing the track switch points to set up a route over the corresponding track portion and clearing a signal at the entrance end of such track portion, said route establishing means also responding to the operation of the buttons at the extreme ends of said two track portions for governing the track switches in both said track portions to set up a

through route over both track portions and clearing the signals at the corresponding ends of both track portions, whereby a through route including two track portions may be established by the manual actuation of the buttons for the remote ends thereof without manual operation for an intermediate point as well as providing for the establishment of routes individual to the track portions between any two signal locations as may be desired by the operator.

24. In a switch and signal control system of the entrance-exit type for a railroad track layout having power operated track switches movable to provide various routes, said layout including at least two adjoining track portions having signals at corresponding ends for governing train movement in the same direction, a control panel having a miniature track diagram of said track layout located thereon, manually operable buttons on said control panel for the ends of each of said two adjoining track portions, route establishing means for each of said track portions, each of said route establishing means being responsive to the joint operation of the buttons at the opposite ends of its track portion only for governing the track switches in that portion and clearing the signal at the entrance thereof, through route circuit means interconnecting said route establishing means for said two track portions to render both of said route establishing means responsive to the joint operation of the buttons alone for the remote ends of said two track portions for governing the track switches in their respective track portions and to clear the signal at corresponding ends for allowing train movement through both of said track portions, and relay means controlled by the operation of both said route establishing means in response to the operation of the buttons at the remote ends of said two track portions for acting on said through route circuit means to isolate said two route establishing means.

25. In an interlocking control system, a track layout including parallel tracks interconnected by track switches adapted to form different traffic routes, entrance and exit buttons for the ends of the routes, preliminary and final route selecting circuits for each route, contacts for controlling said circuits including a contact controlled by each entrance button for energizing the preliminary circuits for each available route having its entrance end marked by such button, a contact controlled by each button marking the exit end of a route having its preliminary selecting circuits closed for energizing the final selecting circuits for such route, relays governed by said energized preliminary circuits to open contacts controlling the preliminary selecting circuits for conflicting routes having different entrance ends, relays governed by the energized final selecting circuits for opening contacts controlling the preliminary selecting circuits for conflicting routes having different exit ends, and means controlled by said energized final selecting circuits for operating the track switches as required to establish the corresponding route.

26. In an interlocking control system, a track layout including parallel tracks interconnected by track switches adapted to form different traffic routes, freely movable entrance and exit buttons for the ends of the routes, a preliminary and a final electro-responsive route selector for each route, contacts controlled by said selectors in circuits controlling selectors for conflicting routes, means controlled by each entrance but-

ton for energizing the preliminary selector for each available route having its entrance end marked by such button, means controlled jointly by each button marking the exit end of a route having its preliminary selector energized and by such selector for energizing the final selector for such route, means controlled by an energized preliminary selector for opening said contacts in circuits controlling selectors for conflicting routes having different entrance ends, means controlled by said energized final selector for opening said contacts in circuits controlling the preliminary selectors for conflicting routes having different exit ends, and relay means associated with each switch and responsive to the energization of said final selector for operating the corresponding track switches as required to establish the corresponding route.

27. In an interlocking control system, a track layout including parallel tracks interconnected by track switches adapted to form different traffic routes, entrance and exit buttons for the ends of the routes, a preliminary and a final selector for said routes each comprising a plurality of tandem-connected relays, said final selector including one relay for each switch of each route, a circuit for each such relay including back contacts of relays for conflicting routes, means controlled by each entrance button for energizing those preliminary selector relays associated with each available route having its entrance end marked by said button to thereby open said contacts in the circuits for conflicting routes having different entrance ends, relay means controlled by the energized preliminary selector of one such available route and by the button marking the exit end of that route for energizing the final selector relays for such route to open the back contacts of such relays to thereby release the energized relays for routes having different exit ends, and means controlled by each energized final selector relay for operating the corresponding track switch as required to establish the corresponding route.

28. In an interlocking control system, a track layout including parallel tracks interconnected by track switches adapted to form different traffic routes, entrance and exit buttons for the ends of the routes, a preliminary and a final electro-responsive route selector for each route, means controlled by each button marking the entrance end of a route for energizing the preliminary selector for such route, means controlled jointly by each button marking the exit end of a route having its preliminary selector energized and by such selector for energizing the final selector for such route, circuits including contacts which open when said selectors are energized for controlling selectors for conflicting routes, and means controlled by each final selector for operating the track switches as required to establish the corresponding route.

29. In an interlocking control system, a track layout including a plurality of track switches adapted to be arranged to form different traffic routes including two alternative routes between the same route ends, a route button for each route end, an electro-responsive route selector including a circuit for each route, means responsive to the operation of a button for applying energy to the selector circuit for each route having one end marked by such button, said electro-responsive route selector being normally responsive to the operation of the button at one end of said alternative routes to energize the selector

circuit for one of said alternative routes and to open the selector circuit for the other alternative route, means responsive to the subsequent operation of the button for the other end of a selected route for opening all of said selector circuits except the one for the selected route and for operating the track switches as required for the route, and selecting means for at times preventing the energization of said selector circuit for said one alternative route to thereby permit the energization of the selector circuit for the other in response to the operation of the button at one end of said routes.

30. In an interlocking control system, a track layout including a plurality of track switches adapted to be arranged to form different traffic routes including two alternative routes between the same route ends, a route button for each route end, an electro-responsive route selector including a circuit for each route, means responsive to the operation of a button for applying energy to the selector circuit for each route having one end marked by such button, said electro-responsive route selector being normally effective when a button at one end of said alternative routes is operated to cause the energization of the selector circuit for one of said alternative routes and to open the selector circuit for the other alternative route, means responsive to the subsequent operation of the button for the other end of a selected route for opening all of said selector circuits except the one for the selected route and for operating the track switches as required for the route, and manually controllable selecting means effective when operated to prevent the energization of the selector circuit for said one alternative route to thereby permit the energization of the selector circuit for the other in response to the operation of the button at one end of said routes.

31. A switch and signal control system of the entrance-exit type for governing the power operation of switches to establish routes over a track layout comprising, a control panel having thereon a miniature track diagram of the track layout, freely movable manual control devices associated with points on said track diagram corresponding to signal locations and operable to designate said signal locations as the entrance or exit ends of routes, initiating circuit means energized by the operation of a manual control device to designate any given entrance signal location for preselecting the position of the trailed switches included in all of the establishable routes originating at that entrance signal location, and completion circuit means responsive to the subsequent actuation of a manual control device to designate the exit signal location of a particular one of said routes for controlling power operation of switches dependent upon the initiating circuits energized and thereby establishing said route and for at the same time deenergizing the initiating circuits relating to all other routes originating at the same entrance signal location.

32. A switch and signal control system of the entrance-exit type for governing the operation of power-operated switch points of a railway track layout to set up different routes for train movement over the track layout, comprising freely movable manual control devices associated with the signal locations constituting entrance or exit ends of such routes, route establishing means including initiating circuits and completion circuits for the energization of relay means to cause operation of switches to different positions as may

be required to establish the various routes through the track layout, said route establishing means acting in response to the actuation of a manual control device to designate any given entrance signal location to energize those initiating circuits which relate to the positions of switches included in the various establishable routes originating at said entrance signal location, said route establishing means acting in response to the subsequent actuation of a manual control device to designate the exit end of a particular one of said routes to energize certain of said completion circuits dependent upon the energized initiating circuit, said energization of said completion circuits acting to cause operation of appropriate switches to the proper positions to establish that particular route and at the same time to deenergize the initiating circuits relating to all other routes originating at the same entrance signal location, and signal clearing circuits one for each signal closed at one point in response to the actuation of a manual control device to designate the corresponding signal location as the entrance end of some route and completely closed to clear the signal only if all of the switch points in some route originating at that signal are in normal or reverse positions corresponding with the control then exercised by said route establishing means.

33. A switch and signal control system of the entrance-exit type for governing the power operation of switches to establish routes over a railway track layout comprising, freely movable manual control devices for designating the entrance and exit signal locations of the track layout, route establishing means responding to the operation of a manual control device to designate any given entrance signal location to preselect the position of the trailed switches in the various routes originating at the corresponding entrance signal location, said route establishing means acting upon the subsequent actuation of a manual control device to designate the exit end of a particular one of said routes to govern the operation of the appropriate switches in accordance with such preselecting operation to establish that route, track circuits for the track layout and associated relay means governed thereby for preventing power operation of each switch in a route while a train is passing over or approaching said switch in traversing the route, and means for preventing a manipulation of manual control devices tending to change the position of switches in a route occupied by a train and occurring while said train is present from being effective to precondition said switches for operation to different positions after the train has passed over said switches.

34. In a switch and signal control system of the entrance-exit type, manual control devices operable to designate entrance and exit signal locations and including a normally open self-restoring exit contact associated with each exit signal location, initiating means responsive to the operation of a manual control device to designate any given entrance signal location for preselecting the position of trailed switches included in all of the establishable routes originating at that entrance signal location, completion means responsive to the subsequent manual closing of an exit contact for the exit end of a particular one of said routes for controlling the power operation of switches dependent upon such preselecting operation to establish that route, and means responsive to the closing of an

exit contact for maintaining said completion means effective independently of the restoration of said exit contact.

35. A switch and signal control system of the entrance-exit type for governing the operation of power-operated track switches of a railway track layout, comprising a control panel having thereon a miniature track diagram of the track layout, freely movable buttons associated with the points on said diagram corresponding with entrance and exit signal locations of the track layout for governing the manual closing of entrance and exit contacts, each exit contact being automatically restored to normal after each manual closing thereof, route establishing means responsive to the closing of an entrance contact for preselecting the position of switches included in the various establishable routes originating at the corresponding entrance signal location and for supplying an operating potential to render effective the manual closing of exit contacts belonging to the exit ends of said routes, said route establishing means including completion means responsive to the closing of an exit contact for a particular one of said establishable routes for operating switches dependent upon said preselecting operation to establish that route, said completion means including relay means energized by the closing of said exit contact for providing a shunt for said exit contact, whereby said route establishing means is maintained effective independently of the restoration of said exit contact.

36. A switch and signal control system of the entrance-exit type for governing the power operation of switches of a railway track layout affording various routes between entrance and exit signal locations, including a plurality of alternative routes between common entrance and exit signal locations comprising, manual control devices operable to designate signal locations as the entrance and exit ends of routes, and route establishing means responsive to the operation of the manual control devices to designate the entrance and exit signal locations of any given route for causing power operation of the appropriate switches to the proper positions to provide that route, said route establishing means including means responsive to the actuation alone of the manual control device to designate the common entrance signal location of said alternative routes for automatically selecting the one of said alternative routes to be established upon actuation of the manual control device to designate the common exit signal location of said alternative routes.

37. An entrance-exit type of switch and signal control system for track layouts which includes an arrangement of switches affording a plurality of alternative routes between the same common entrance and exit signal locations comprising, freely movable buttons operable to designate entrance and exit signal locations of the various routes of the track layout, route establishing means operable to establish any given route by preselecting the position of certain switches in response to the actuation of a button to designate the entrance signal location of the route and operating switches in accordance with such preselecting in response to the actuation of a button to designate the exit signal location of that route, the actuation of a button to designate the common entrance signal location for said alternative routes acting to preselect a switch required to be in different positions for said

alternative routes for operation to one predetermined position in preference to the other position, such preselection being effective only if the alternative route including said switch in said predetermined position is not in conflict with some established route, whereby alternative routes are automatically selected one at a time in a predetermined order of preference and dependent upon conflict of the respective alternative routes with other routes then established.

33. In an entrance-exit type of switch and signal control system for track layouts including a plurality of alternative routes between common entrance and exit signal locations, route establishing means operable to establish routes over the track layout in response to the actuation of manual control devices to designate the entrance and exit signal locations of such routes, route establishing means including contact means responsive to the actuation of a manual control device alone to designate the common entrance signal location of said alternative routes to condition said route establishing means to act so as to establish only one of said alternative routes without race or conflict in the energization of relays in response to the actuation of a manual control device to designate the common exit end of said alternative routes, said contact means acting to select a predetermined superior one of said alternative routes if it is not in conflict with some other route then established by the route establishing means and to select automatically another one of said alternative routes if such conflict exists.

39. An entrance-exit type of switch control system for track layouts affording alternative routes between common entrance and exit signal locations comprising, freely movable buttons manually operable to designate said common entrance and exit signal locations, route establishing means governed by said buttons for controlling the power operation of the switches included in said alternative routes, said route establishing means including a preselecting relay for each switch required to be in different positions for different alternative routes, initiating circuit means energized by the operation of a button to designate said common entrance signal location for energizing the preselecting relay of each switch in said alternative routes disposed in trailing relation in its normal position to said entrance signal location, only if that part of a route for train movement from said common entrance signal location to and over the corresponding switch in its normal position is not in conflict with some other established route, said route establishing means acting in response to the operation of the exit buttons for the common exit signal location of said alternative routes to cause operation of the switch or switches in accordance with the energized or non-energized condition of the corresponding preselecting relay, whereby a particular one of said alternative routes is automatically selected and established by entrance and exit button manipulation in accordance with a predetermined order of preference and dependent upon conflict of the respective alternative routes with other routes then established.

40. A switch and signal control system of the entrance-exit type for railway track layouts including one or more switches disposed in a trailing relation to an entrance signal location and operable to different positions to provide different alternative routes from said entrance

signal location to a common exit signal location, manually operable buttons for closing entrance and exit contacts associated with said entrance and exit signal locations, preselecting relay means for each of said switches, initiating circuit means rendered effective by closing of said entrance contact for controlling said preselecting relay means to preselect the corresponding switch for operation to one predetermined position in preference to the other position, provided that part of a route for train movement from said entrance signal location to and over the corresponding switch in said predetermined position is not in conflict with some other route then established, said preselecting means acting to preselect said other position of the switch if said initiating circuit means is not effective on account of such conflict, and means responsive to the subsequent closing of said exit contact for operating said switch or switches in accordance with the condition of the corresponding preselecting relay means, whereby the alternative routes are automatically selected in a predetermined order of preference and dependent upon conflict of the respective alternative routes with other routes then established.

41. In a switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over two adjoining interlocked groups past one or more intermediate signal locations, said system comprising manual control devices for designating the signal locations of said track layout to constitute the entrance or exit ends of desired routes or through routes, route establishing means for each of said interlocked groups to set up the different routes between the signal locations of that group, circuit means responsive to the actuation of a manual control device to designate any given entrance signal location to prepare for operation said route establishing means for those of said interlocked groups involved in any through route originating at said entrance signal location, the actuation of a manual control device to designate the exit signal location of a particular one of said through routes rendering the route establishing means of the remote group effective to establish a route through that group to the entrance signal thereof constituting an intermediate signal in that particular through route, electro-responsive means associated with each intermediate signal location and responding to the establishment of a route from that signal location through the remote interlocked group to control the clearing of that signal and to exercise a control on the route establishing means of the adjoining interlocked group the same as if the manual control device for such intermediate signal location had been operated.

42. A switch and signal control system of the entrance-exit type for governing the power operation of switches and the clearing of signals of a railway track layout including a plurality of interlocked groups and affording through routes over adjoining interlocked groups past one or more intermediate signal locations, said system comprising manual control devices operable to designate the signal locations of said track layout as the entrance ends or the exit ends of desired routes, route establishing means associated with each interlocked group and including relays controlling the operated position of the switches and the clearing of the signals to provide routes for train movement over that interlocked group be-

tween entrance and exit signal locations thereof, circuit means responsive to the operation of a manual control device to designate any given entrance signal location for rendering effective the actuation of only those manual control devices to designate the exit signal location of some establishable route or through route over the track layout originating at said entrance signal location, said circuit means also rendering effective said route establishing means associated with those interlocked groups involving said establishable routes to be operated when an exit function is performed for that interlocked group and establish a route over that interlocked group connecting with said designated entrance signal location, the operation of a manual control device to designate the exit signal location of a through route over two or more interlocked groups governing the route establishing means of the remote interlocked group to establish the route connecting with the signal location of that interlocked group constituting an intermediate signal location in said through route, electro-responsive means associated with said intermediate signal location and responsive to said operation of said route establishing means of said remote interlocked group to perform entrance and exit functions for controlling the clearing of the signal for said route over said remote interlocked group and also for governing the route establishing means for the adjoining interlocked group to establish a route over that interlocked group, said operation being repeated for other intermediate signal locations if any in the through route, whereby a through route may be established over a plurality of interlocked groups and the intermediate signals controlled to assume the clear conditions merely by the actuation of manual control devices to designate the extreme entrance and exit ends of said through route and without manipulation of manual control devices associated with the intermediate signal locations of said through route.

43. A switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over two adjoining interlocked groups past one or more intermediate signal locations, said system comprising manually operable buttons for designating the signal locations of said track layout to constitute the entrance or exit ends of a desired route or through route, preselecting circuit means energized in response to the actuation of a button to designate any given entrance signal location for preselecting the position of the trailed switches included in any establishable route originating at said signal location, and also preselecting the position of the trailed switches in the remote interlocked group involved in a through route originating at said entrance signal location, route completion means responding to the operation of a button to designate the exit end of a through route only if said preselecting circuit means is effective for that through route for governing the operation of the switches in the associated remote interlocked group in accordance with such preselecting operation to establish a route through that interlocked group connecting to an entrance signal thereof constituting an intermediate signal location in said through route, and electro-responsive means associated with said intermediate signal location and responding to the completion of a route from that signal location through the remote interlocked group to control the clearing of the signal at that location and to exercise an

exit control upon the route completion means of the near adjoining interlocked group, the operation of the route completion means to establish a route through each interlocked group rendering ineffective the preselecting circuit means for all other routes originating at the same entrance and intermediate signal locations.

44. 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 of said track layout as the entrance and exit ends of a desired route or through route, initiating circuit means associated with each interlocked group and energized by the operation of a button to designate any given entrance signal location of that interlocked group for preselecting the position of the trailed switches in all of the establishable routes originating at that signal location, circuit connections associated with each signal location which may become an intermediate signal location in some through route for connecting the initiating circuit means for the corresponding adjoining interlocked groups, whereby operation of the button to designate the entrance signal location of one or more through routes pre-selects the position of the trailed switches in the various interlocked groups involved in such through routes, means for rendering ineffective said circuit connections at an intermediate signal location when that signal location constitutes the entrance or exit end of an established route, completion circuit means for each interlocked group effective upon designation of an exit signal location thereof only if said initiating circuit means is effective for a route terminating at that exit signal location for governing the operation of the switches to establish a route over that interlocked group dependent upon the position of switches preselected by the initiating circuits energized, the operation of said completion circuit means to establish such a route rendering ineffective the initiating circuits relating to all other routes originating at the same entrance signal location, and means responsive to the completion of a route of an interlocked group from an entrance signal location thereof for exercising an exit control for the corresponding signal location upon the completion circuit means of the adjoining interlocked group, provided buttons have not been manually actuated to designate that signal location as the entrance or exit end of a route.

45. In a switch and signal control system of the entrance-exit type described for track layouts having power operated track switches and signals for governing train movement over various routes afforded by said track layout, said track layout including two or more adjoining interlocked groups affording through routes past one or more intermediate signal locations, said system comprising route establishing means for each interlocked group operable to position the track switches of that interlocked group and govern the clearing of entrance signals thereof, manually operable entrance and exit buttons for governing said route establishing means, said route establishing means including a network of initiating circuits energized by the operation of entrance buttons alone and completion circuits controlled by the operation of exit buttons for controlling the operation of the track switches in accordance with the energized condition of said initiat-

ing circuits, means for controlling the continuity of said initiating circuits to supply current to points of the network corresponding with the locations of switches in the track layout only if a path for train movement from the designated entrance signal location to the respective switch location is afforded by the track layout and is not in conflict with some route then established, circuit connections associated with each signal location which may become an intermediate signal location in some through route for normally connecting the initiating circuits for adjoining interlocked groups whereby operation of an entrance button may energize the initiating circuits for a plurality of interlocked groups involving the various through routes originating at the corresponding entrance signal location, and means responsive to the energization of completion circuits to establish a route over an interlocked group to an entrance signal location thereof and effective only if that signal location has not been made the entrance or exit end of some route by previous operation of the associated entrance or exit button for energizing the completion circuits for the next adjoining interlocked group in the same way as if the corresponding exit button had been manually operated, whereby a through route including two or more interlocked groups may be established by the actuation of the entrance and exit buttons at the extreme ends of such through route and without manual actuation of the buttons for intervening intermediate signal locations.

46. A switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over a plurality of successive interlocked groups past one or more intermediate signal locations, said system comprising freely movable buttons manually operable to designate entrance and exit ends of a desired route or through route, route establishing means for each interlocked group operable to position the track switches thereof to set up routes and govern the clearing of entrance signals for such routes, circuit means responsive to the actuation of an entrance button for the entrance end of any through route for preparing the route establishing means of the interlocked groups involved in that through route for operation when an exit control for the corresponding interlocked group exists, means for rendering said circuit means ineffective with respect to those routes past an intermediate signal location when any route terminating at that signal location is established or occupied by a train, and through route control means associated with each signal location which may become an intermediate signal in some through route and responsive to the establishing of a route over the interlocked group over which that signal governs train movement for controlling the clearing of that signal and for governing the route establishing means of the next adjoining interlocked group in the same way as if a button had been operated to designate the location of that signal as the exit end of a route over said adjoining interlocked group, whereby the actuation of an exit button for a through route causes operation of the route establishing means for the remote interlocked group to establish a route connecting to an entrance signal thereof and also governs the through route control means at that signal to cause operation of the route establishing means for the next adjoining interlocked group, and in turn the route establishing means

and through route control means of other interlocked groups if any, until the complete through route is established and each intermediate signal is controlled to assume its clear condition.

47. In a switch and signal control system of the character described for governing the position of power-operated track switches and the clearing of signals for a railway track layout including one or more interlocked groups and affording one or more through routes past one or more intermediate signals, said system comprising manually operable buttons for actuating entrance and exit contacts to designate the signal locations of said track layout as the entrance or exit ends of some desired route or through route, route establishing means operated in response to the actuation of entrance and exit contacts of any given route or through route for governing the position of the track switches in one or more interlocked groups to establish that route and control the clearing of an entrance signal and each intermediate signal if any for that route, and electro-responsive means associated with each intermediate signal location and responsive to the operation of said route establishing means to provide a route originating at that signal location for closing circuits for shunting the corresponding entrance and exit contacts and thereby control the route establishing means in the same way as if said entrance and exit contacts had been manually operated, said electro-responsive means being ineffective if the corresponding entrance and exit contacts had been previously actuated manually.

48. A switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over successive interlocked groups past one or more intermediate signals comprising, buttons associated with the signal locations of the track layout and adapted to be manipulated to actuate entrance and exit contacts to designate the corresponding signal location as the entrance or the exit end of a desired route, route establishing means responsive to the actuation of entrance and exit contacts of different interlocked groups for governing the power operation of the switches in said interlocked groups and intervening interlocked groups if any and for controlling the clearing of the entrance signal and each intermediate signal in the through route between the signal locations corresponding to the entrance and exit contacts actuated, said route establishing means including circuit connections associated with each signal location which may become an intermediate signal location in some through route for permitting said route establishing means to set up a through route past that intermediate signal location, and means including directional stick relays controlled by track circuits and rendered effective upon clearing of a signal at the entrance to a route established over an interlocked group for interrupting said circuit connections if any associated with the signal location of that interlocked group constituting the exit end of said route.

49. A switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over successive interlocked groups past one or more intermediate signal locations comprising, manually operable control devices associated with the signal locations of said track layout and operable to designate said signal locations as the entrance or exit ends of some desired route, a signal control re-

lay for each intermediate signal, route establishing means responsive to the operation of manual control devices to designate the entrance and exit ends of any given route or through route for governing the operation of the switches in the one or more interlocked groups involved to positions required for that route and for energizing the signal control relay for each intermediate signal of that route, a signal clearing circuit for each intermediate signal closed only if the corresponding signal control relay is energized and all of the switches in some route originating at the corresponding entrance signal location are operated to positions to correspond with the control then being exercised by said route establishing means, track circuit controlled means for maintaining a signal control relay for each intermediate signal energized until a train passes that signal, and means for deenergizing each signal control relay in response to the manipulation of the corresponding manual control device.

50. A switch and signal control system of the entrance-exit type for track layouts including a plurality of interlocked groups and affording one or more through routes past one or more intermediate signals comprising, buttons manually operable to designate the signal locations of said track layout as the entrance or exit ends of some desired route, route establishing means responsive to the operation of said buttons for the entrance and exit ends of any given route or through route for establishing that route over one or more interlocked groups and for controlling the clearing of one or more signals in said route, said route establishing means including relay means associated with the various switches and initiating circuits for governing the selective energization of said relay means, the operation of a button to designate any given entrance signal location acting to energize certain initiating circuits to cause energization of said relay means associated with those trailed switches in one or more interlocked groups included in some establishable route or through route originating at said entrance signal location, the initiating circuits for energizing the relay means for any given trailed switch being effective only if some path for train movement from the designated entrance signal location up to that switch is available and not in conflict with some route then established, and means for interrupting said initiating circuits relating to routes past an intermediate signal location when a route terminating at that signal location is occupied by a train.

51. A switch and signal control system of the type described for governing the power operation of switches and the clearing of signals of a railway track layout including a plurality of interlocked groups and affording two alternative through routes between common entrance and exit signal locations of different interlocked groups past different intermediate signal locations, said system comprising freely movable buttons manually operable to designate the signal locations of said track layout as the entrance or exit ends of a desired route or through route, and route establishing means responsive to the operation of buttons to designate the common entrance and exit signal locations of said alternative through routes for governing operation of the switches in said different interlocked groups to positions required to establish a superior one of said alternative routes in preference

to the other and for controlling the clearing of the signal at each intermediate signal location in said superior alternative route, said route establishing means acting automatically to establish the other of said alternative through routes and clearing each of the intermediate signals therein if said superior alternative through route is in conflict with any established route in any interlocked group.

52. In a switch and signal control system of the entrance-exit type, a track layout including at least two interlocked groups with power-operated track switches to set up different routes between the signal locations of such group and also to afford through routes including at least two or more alternative through routes over said interlocked groups past different intermediate signal locations, manual control devices for said signal locations for designating such locations as the entrance or exit ends of the desired routes or through routes, initiating circuit means rendered effective upon the actuation of a manual control device to designate an entrance signal location to preselect the position of the trailed switches in all through routes originating at said entrance signal location, said initiating circuit means acting to preselect the normal position in preference to the reverse position in the case of those trailed switches which may be in either position for said alternative through routes and thereby preselect a predetermined one of said alternative through routes, completion circuit means rendered effective upon the actuation of a manual control device to designate the exit end of a particular one of said through routes to cause the power operation of said track switches in accordance with said preselection to establish that particular through route and to render ineffective the initiating circuit means for all routes in conflict with said particular through route, electro-responsive means associated with each signal location which may become an intermediate signal location in some through route and responsive to the establishment of any particular through route past such intermediate signal location to control the clearing of said intermediate signal, and means acting when a through route is established past an intermediate signal location to segregate the respective initiating circuit means and the completion circuit means for the adjoining interlocked groups and render such circuit means for the remote group dependent upon traffic conditions.

53. A switch and signal control system of the entrance-exit type described for track layouts affording alternative through routes over a plurality of interlocked groups between common and entrance exit signal locations of different interlocked groups, said system comprising freely movable buttons associated with the signal locations of said track layout and manually operable as entrance and exit buttons to designate the corresponding signal locations as the entrance or the exit end of a desired route or through route, route establishing means associated with said interlocked groups and including initiating circuits, certain of said initiating circuits being energized by operation of any given entrance button to preselect the position of all trailed switches included in any one of the routes or through routes originating at the corresponding entrance signal location, said initiating circuits acting to preselect those trailed switches required to be in different positions for different alternative routes for operation to the normal

position in preference to the reverse position, means for controlling the initiating circuits for said switches trailed in different positions for alternative routes to select the preferred normal position only if there is a path for train movement from the designated entrance signal location to and over that switch in its normal position, and route completion means responding to the operation of an exit button for operating the appropriate switches to positions in accordance with the energized condition of said initiating circuits and as required to establish a route over one or more interlocked groups between the entrance and exit buttons actuated and also governing the clearing of the entrance signal and each intermediate signal if any governing train movement over said one or more interlocked groups.

54. A switch and signal control system of the entrance-exit type for a railway track layout affording one or more through routes past one or more intermediate signal locations comprising, manually operable devices for designating the signal locations of said track layout to constitute entrance and exit ends of a desired route or through route, route establishing means operating in response to the operation of buttons to designate entrance and exit ends of a route to govern the operation of the switches in the one or more interlocked groups to positions required for establishing said route and for controlling the clearing of a signal at the entrance end of said route and at each intermediate signal location if any in that route, and track circuit controlled means for maintaining in the clear condition the signal at each intermediate signal location in a through route ahead of a train traversing that route until the train passes the respective signal location.

55. A switch and signal control system of the entrance-exit type for establishing routes over track layouts affording different optional routes between certain entrance and exit signal locations comprising, entrance and exit buttons for said signal locations, initiating circuits energized by the operation of said entrance button alone for preselecting the appropriate switches of the track layout for operation to the proper positions to establish a preferred one of said optional routes, completion circuit means responsive to the operation of said exit button for operating said switches in accordance with said preselection to establish said preferred route, and auxiliary manual control means for governing said initiating circuits to modify said preselection and thereby cause said completion circuit means to establish a different optional route in response to the operation of said exit button following the operation of said entrance button.

56. A switch and signal control system of the entrance-exit type for establishing routes over a track layout affording different alternative routes between entrance and exit signal locations comprising, entrance and exit buttons for said signal locations, switch control relays associated with each switch and acting when energized to control the operation of that switch to the normal or the reverse position, initiating circuits energized by the operation of said entrance button alone and normally acting to preselect the switch control relays of certain switches to correspond with a preferred one of said alternative routes, the continuity of said initiating circuits relating to said preferred route being controlled by contacts operated by the energization of

switch control relays to position switches for a different route, completion circuit means responsive to the operation of said exit button for energizing switch control relays to establish a route in accordance with said preselection, and an auxiliary manual control device for each switch for controlling the energization of the corresponding switch control relays to cause operation of the individual switch to normal or reverse positions as desired, the operation of an auxiliary manual control device for certain switches included in said alternative routes acting to change the initiating circuits normally energized by operation of said entrance button and thereby cause said completion circuit means to establish a different one of said alternative routes in response to the operation of said exit button.

57. A route controlled system of the entrance-exit type for railway track layouts having switches and signals in a plurality of interlocked groups and including parallel tracks and associated crossovers to provide alternative through routes over successive interlocked groups past different intermediate signals, manually operable buttons for designating the entrance and exit ends of desired routes, route establishing means for operating switches to establish any given route or through route in response to the actuation of buttons to designate entrance and exit ends thereof, means responsive to the actuation of a button to designate the common entrance end of said alternative through routes for conditioning said route establishing means to set up one of said alternative routes past a particular intermediate signal upon actuation of a button to designate the exit end of said through routes, and track circuit controlled means responsive to the presence of a train in a route terminating at said particular intermediate signal for rendering said conditioning ineffective with respect to the through route including that intermediate signal and thereby cause said route establishing means to set up another alternative route including a different intermediate signal.

58. A switch and signal control system of the entrance-exit type for railway track layouts having switches and signals arranged in a plurality of interlocked groups, with parallel tracks and associated crossovers adapted to provide alternative through routes between certain entrance and exit signal locations of adjoining interlocked groups past different intermediate signals, said system comprising manually operable buttons for designating the signal locations to constitute the entrance and exit ends of desired routes and through routes, route establishing means associated with each interlocked group and including route completion circuits for operating switches in response to the actuation of a button to designate the exit end of a route dependent upon the energization of corresponding initiating circuits by the actuation of a button to designate the entrance end of said route, said initiating circuits when energized by the actuation of a button to designate the common entrance signal location for said alternative through routes normally acting to preselect the position of a crossover in a remote interlocked group required to be in different positions for said alternative through routes for operation to the normal position in preference to the reverse position and thereby select a superior through route including a particular intermediate signal, and track circuit controlled means responsive to the presence of a train in any route terminating at said particular

intermediate signal for rendering ineffective the preselection of said crossover for operation to the normal position, and thereby automatically select a route past a different intermediate signal for moving a second train around the first train.

59. A switch and signal control system of the entrance-exit type for track layouts affording through routes past one or more intermediate signals comprising, manually operable buttons for designating entrance and exit ends of desired routes, route establishing means for establishing any given route or through route in response to the actuation of buttons to designate the entrance and exit ends thereof, said route establishing means including completion circuits for initiating operation of switches to establish the routes, said completion circuits relating to each route being different for opposite directions of train movement over that route, and means associated with each signal location which may become an intermediate signal location in some through route and responsive to the energization of the completion circuits relating to the direction of train movement away from that signal location for controlling the clearing of the intermediate signal at that location.

60. A switch and signal control system of the entrance-exit type for track layouts affording one or more through routes over successive interlocked groups past one or more intermediate signal locations, said system comprising manually operable buttons for designating the entrance and exit ends of the desired routes, route establishing means for each interlocked group including initiating circuits and completion circuits, said completion circuits relating to each route being different for opposite directions of train movement over that route, the actuation of a button to designate any given entrance signal location acting to energize the initiating circuits for rendering effective the actuation of buttons to designate exit ends of all available routes and through routes originating at that signal location and for preselecting the position of switches in all interlocked groups in accordance with said routes; the subsequent actuation of a button to designate the exit end of an available through route acting to energize those completion circuits of the remote interlocked group relating to the direction of train movement away from said entrance signal location, said energization of said completion circuits acting to establish a route over said remote interlocked group in accordance with the preselected position of the switches therein and connecting with a particular entrance signal thereof constituting an intermediate signal in the through route, and means associated with said intermediate signal location and responsive to the energization of said completion circuits for said direction of train movement for controlling the clearing of the entrance signal for a corresponding direction of train movement.

61. In a switch and signal control system of the entrance-exit type for governing the power operation of the track switches in a track layout including at least two adjoining interlocked groups, a control panel having thereon a miniature track diagram of the track layout, freely movable manual control devices located on said track diagram at points corresponding to the ends of the respective interlocked groups, route establishing means for each of said interlocked groups, the route establishing means for any

given interlocked group being responsive to the actuation of the manual control devices at the opposite ends of any particular route of its interlocked group to cause the operation of the track switches as required to establish that particular route, and through route electro-responsive relay means for interconnecting each of said route establishing means for adjoining interlocked groups to cause the route establishing means of the several interlocked groups to be responsive to the actuation of manual control devices at the extreme ends of two or more such interlocked groups to establish adjoining routes in the intervening interlocked groups to form a through route the same as if manual control devices had been actuated for each of the respective adjoining interlocked groups.

62. A switch and signal control system of the entrance-exit type for a track layout including a plurality of adjacent interlocked groups and thereby affording different routes in each group between signal locations as well as various through routes past one or more intermediate signal locations, manual control devices for said signal locations operable to designate entrance and exit signal locations, route establishing means acting in response to the operation of a manual control device for any given entrance signal location followed by the actuation of a manual control device for an exit end of any establishable route originating at said given entrance signal location to control the power operation of the track switches to set up a route connecting such entrance and exit signal locations, means acting in response to the actuation of a manual control device to designate a given entrance signal location to render effective for operation the manual control device at the exit ends of the various available routes and through routes originating at said given entrance signal location and also acting to condition for operation said route establishing means for the associated interlocked group and each succeeding interlocked group including a route or routes forming a part of some through route originating at said given entrance signal location, such conditioning operation of the succeeding interlocked groups being with respect to each intermediate signal location included in the various through routes originating at said given entrance signal only if such through route in which such signal location is included is not occupied by a train, the operation of a manual control device to designate exit signal locations of some through route causing the associated route establishing means to set up a route in accordance with said conditioning, and electro-responsive means for each signal which may become an intermediate signal location in some through route responsive to the setting up of a route in its interlocked group in advance of such signal by its associated route establishing means to cause the clearing of its associated signal and perform an exit operation for the route establishing means of the next preceding interlocked group.

63. In a switch and signal control system for railroads, a track layout having power operated track switches for setting up different routes between signal locations, manual control devices associated with each of said signal locations for designating the corresponding location as an entrance or exit signal location of a desired route, switch control relay means for each of said track switches for governing its normal or reverse operation when actuated, initiating circuit means

energized upon the actuation of any given control device to designate an entrance signal location to render the manual control device at the exit end of each of the available routes originating at said entrance signal location effective to designate an exit signal location and also to preselect for operation the switch control relay means for only those switches in the routes originating at said given entrance signal location, and completion circuit means energized upon the actuation of the manual control device rendered effective at the exit end of a particular one of said routes to designate an exit signal location, said completion circuit means thus energized acting to operate the switch control relay means for the switches of only that particular route and also acting at the same time to render ineffective the initiating circuit means for the other routes originating at said entrance signal location.

64. In a switch and signal control system of the entrance-exit type for governing the power operation of switches to establish routes over a track layout between signal locations, a control panel having thereon a miniature track diagram of said track layout, freely movable manually control devices on said track diagram at points corresponding to said signal locations and operable to designate said signal locations as the entrance or exit ends of routes, preselecting relay means for said track switches, initiating circuit means energized upon the actuation of any given manual control device to designate an entrance signal location for controlling the preselecting relay means to select the position of the trailed track switches included in all of the available routes originating at that given entrance signal location to thereby preselect the position of such switches, said initiating circuits also including contacts of said preselecting relay means for the trailed track switches to limit the current flow in the circuit portions of said initiating circuit means corresponding to the possible routes afforded by the track layout and originating at said given entrance signal location, and said initiating circuit means also supplying current to the manual control devices for the exit ends of said available routes, and completion circuit means responsive to the subsequent actuation of a manual control device to designate the exit signal location of a particular one of said available routes for determining the positions of the remaining switches in that route not having their positions selected by a preselecting relay means while concurrently effecting the power operation of all the track switches required to establish said particular route, and also at the same time acting to open contacts to isolate the initiating circuits for said particular route and render ineffective the initiating circuits relating to all conflicting routes, and means responsive to the actuation of a manual control device for the exit end of said particular route for maintaining said completion circuit means effective dependent upon said isolated initiating circuits for said particular route and independently of the restoration of said manual control device.

65. In a switch and signal control system of the entrance-exit type for governing the power operation of switches to establish routes over a track layout between signal locations, a control panel having thereon a miniature track diagram of said track layout, freely movable manual control devices on said track diagram at points corresponding to said signal locations and operable to designate said signal locations as the entrance

or exit ends of routes, preselecting relay means associated with said track switches, initiating circuit means including contacts of said preselecting relay means and acting to control said preselecting relay means for preselecting the positions of those trailed switches included in the various available routes originating at that given entrance signal location in response to the actuation of the manual control device for such entrance signal location, said initiating circuit means thus acting with respect to the preselecting relay means for any trailed switch only providing there is a path available for train movement from said given entrance signal location to and over the corresponding track switch which path is not in conflict with any route then established, and completion circuit means responsive to the subsequent actuation of a manual control device to designate the exit signal location of a particular one of said available routes for determining the positions of the remaining switches which are facing point switches in that route while concurrently effecting the power operation of all the track switches required to establish said particular route, and also at the same time acting to restore to normal conditions the preselecting relay means for all of the other routes originating at said given entrance signal location.

66. In a switch and signal control system of the character described for railroad track layouts having a number of switches operable to provide various routes through said track layout between signal locations and in which all of the switches for a given route are positioned by the actuation of manually operable buttons associated with the signal locations constituting the entrance and exit ends of that route, said system comprising with respect to any given route for one direction of train movement, a normal and reverse control relay for each switch, a preselecting relay means for each switch trailed by train movement in said direction, means responsive to the manual operation of the button for the entrance end of said route for energizing initiating circuits for controlling said preselecting relay means for each trailed switch in accordance with the position thereof required to establish said route, said preselecting relay means for a switch being controlled by its initiating circuit only if the portion of a route from the entrance signal location to said switch is not in conflict with some route then established, an exit relay responsive to the operation of the button associated with the exit end of said route and receiving current from said initiating circuits, and completion circuits energized upon energization of said exit relay for energizing the normal or reverse switch control relay for each trailed switch in accordance with the condition of its preselecting relay means and for also energizing the normal or the reverse switch control relay for each facing point switch according to the position such switch must assume to establish said route, said switch control relays when energized to establish said route acting to open the initiating circuits relating to all other routes originating at the same entrance end.

67. In an interlocking control system, a track layout including track switches arranged to form different routes for governing traffic in two directions, route levers for the ends of said routes, a route selecting circuit network for each direction including a route selecting circuit for each route for the corresponding direction each said network including selecting relays energized in

response to the operation of certain ones of the route levers for the entrance ends of converging routes, normal and reverse route relays for governing the operation of the track switches to their normal and reverse positions, a route circuit network comprising a route circuit for each route selected in response to the operation of said selecting relays for controlling said route relays, means responsive to the operation of the route lever for the exit end of a route having its

5 selecting circuit energized for connecting a source of current to the corresponding end of the route circuit for such route to energize in multiple the route relays for the switches of the selected route as required to establish said route, and means controlled by said energized route relays for isolating the energized route circuit from the route circuits for conflicting routes irrespective of the condition of said selecting relays.

10 ANDREW LANGDON.