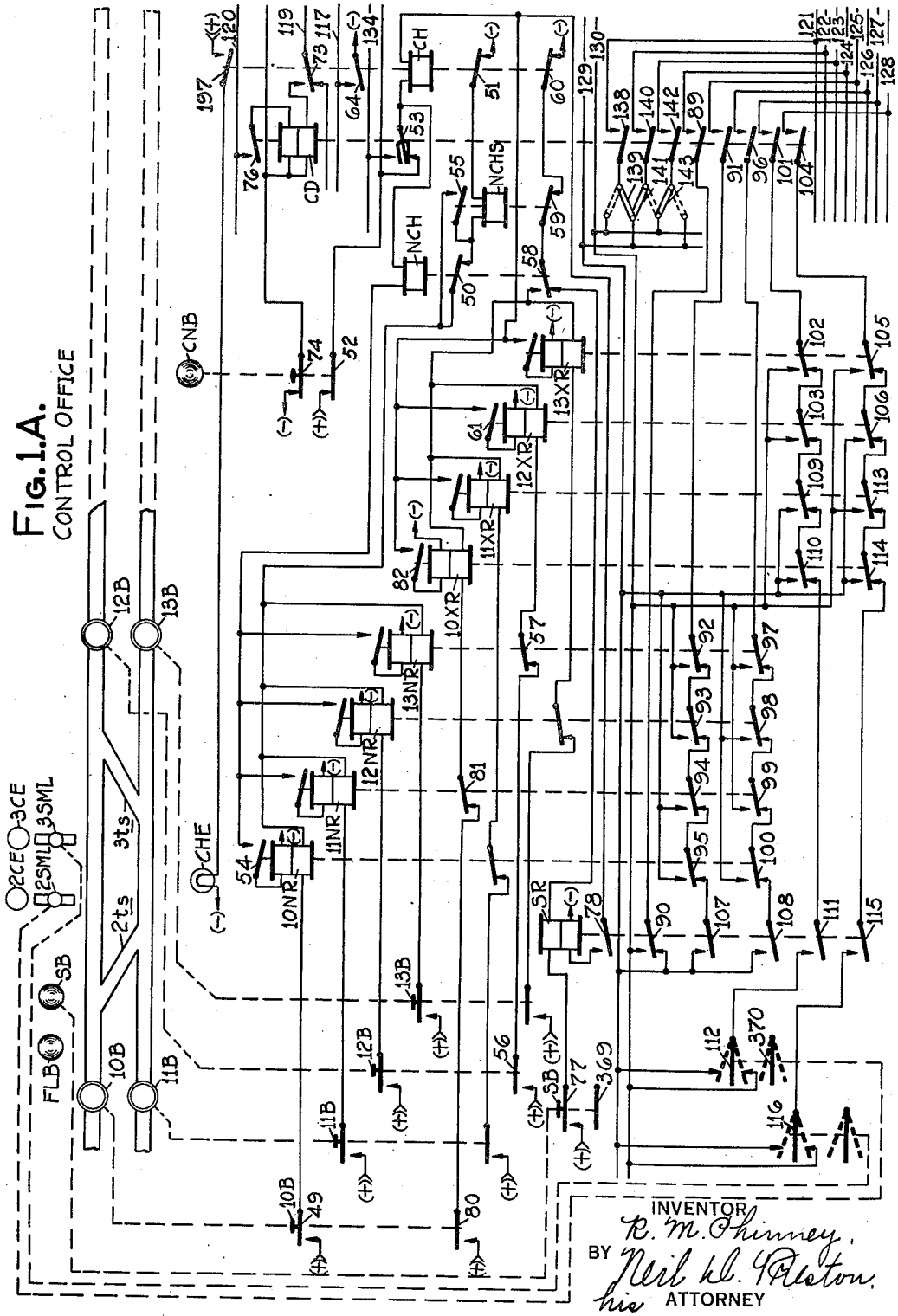
Nov. 26, 1940. R. M. PHINNEY 2,223,126

INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 1

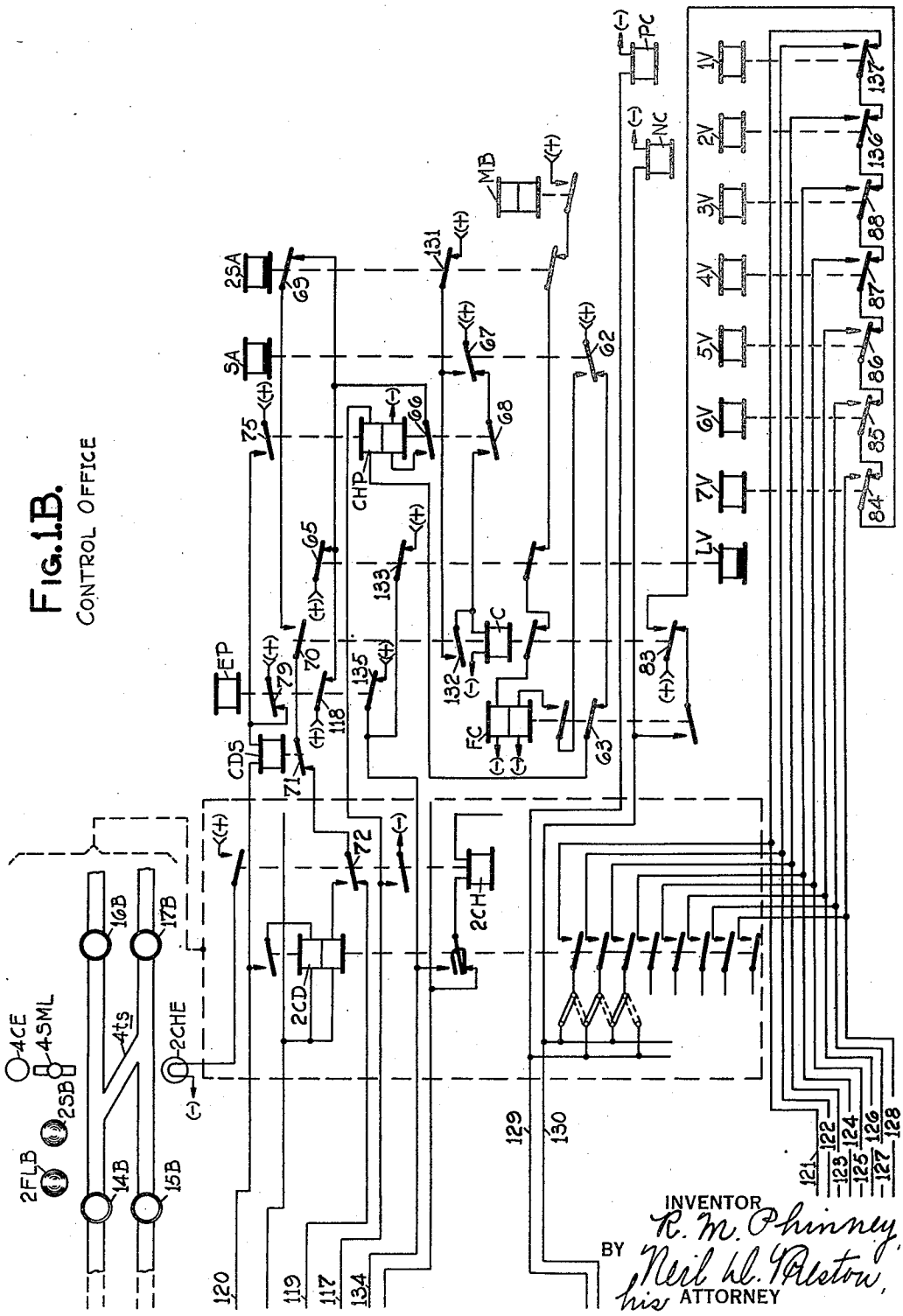


Nov. 26, 1940. R. M. PHINNEY 2,223,126

INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 2

FIG. 1B.
CONTROL OFFICE



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INTERLOCKING SYSTEM FOR RAILROADS

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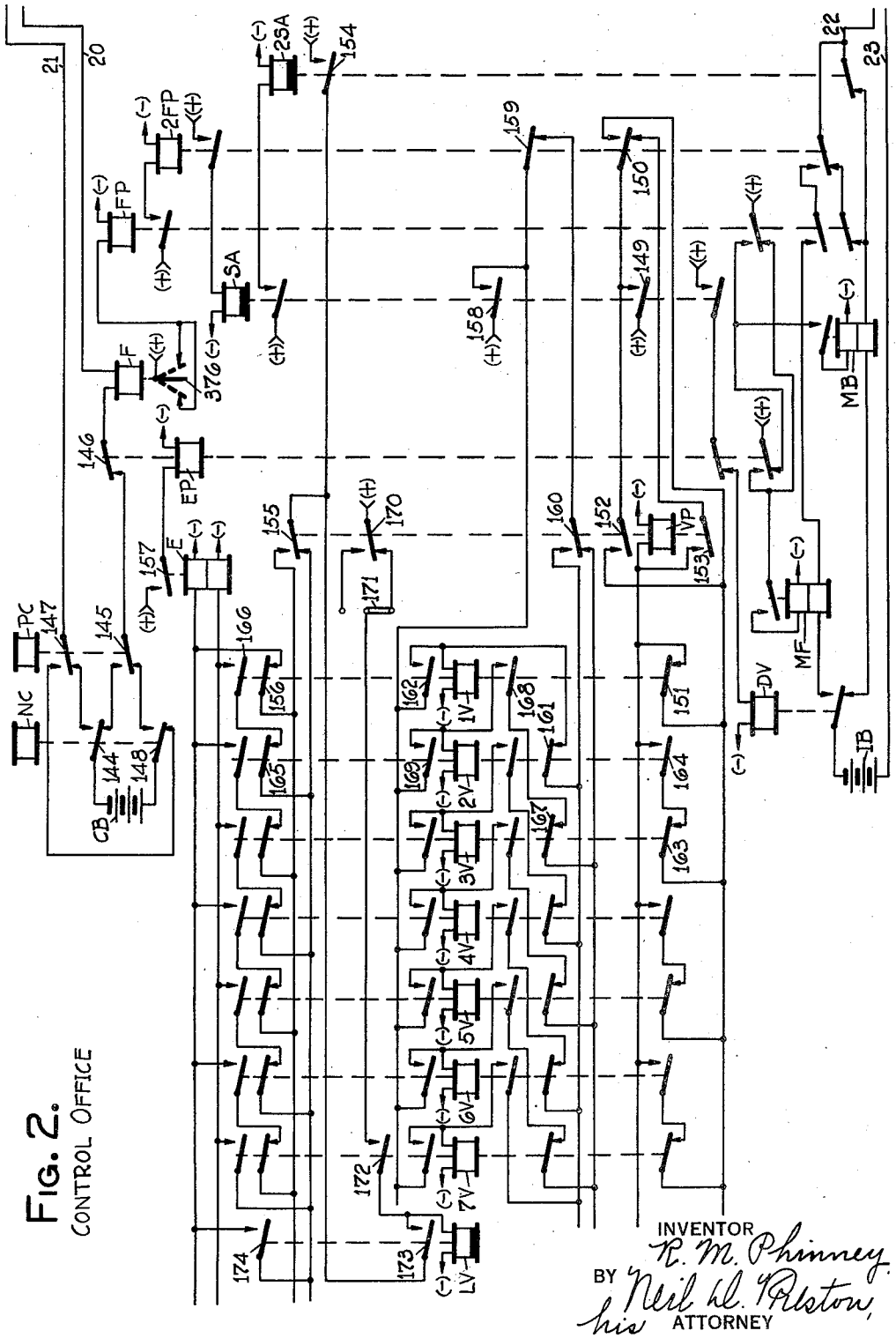


FIG. 2.
CONTROL OFFICE

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INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 4

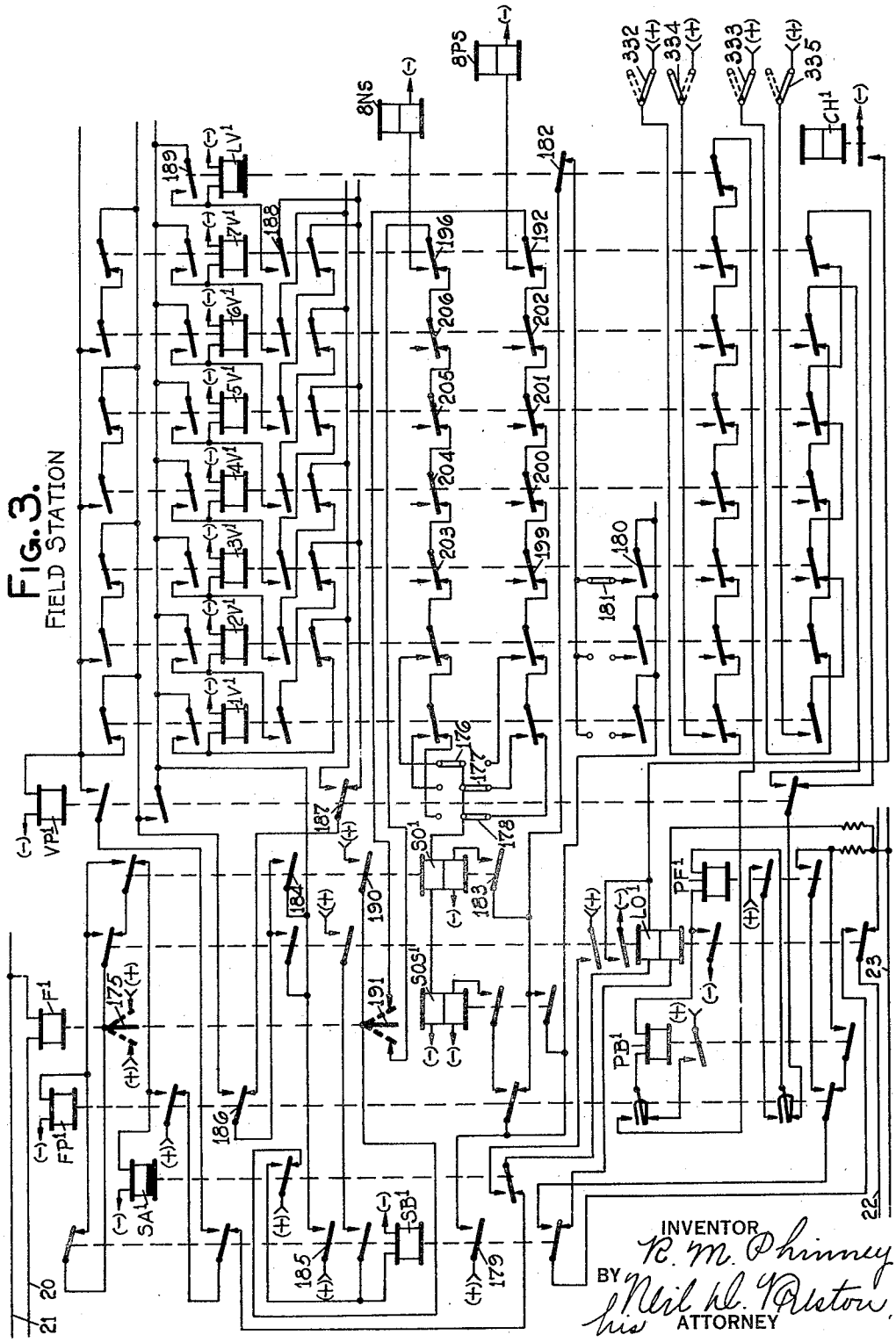


FIG. 3.
FIELD STATION

Nov. 26, 1940. R. M. PHINNEY 2,223,126

INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 5

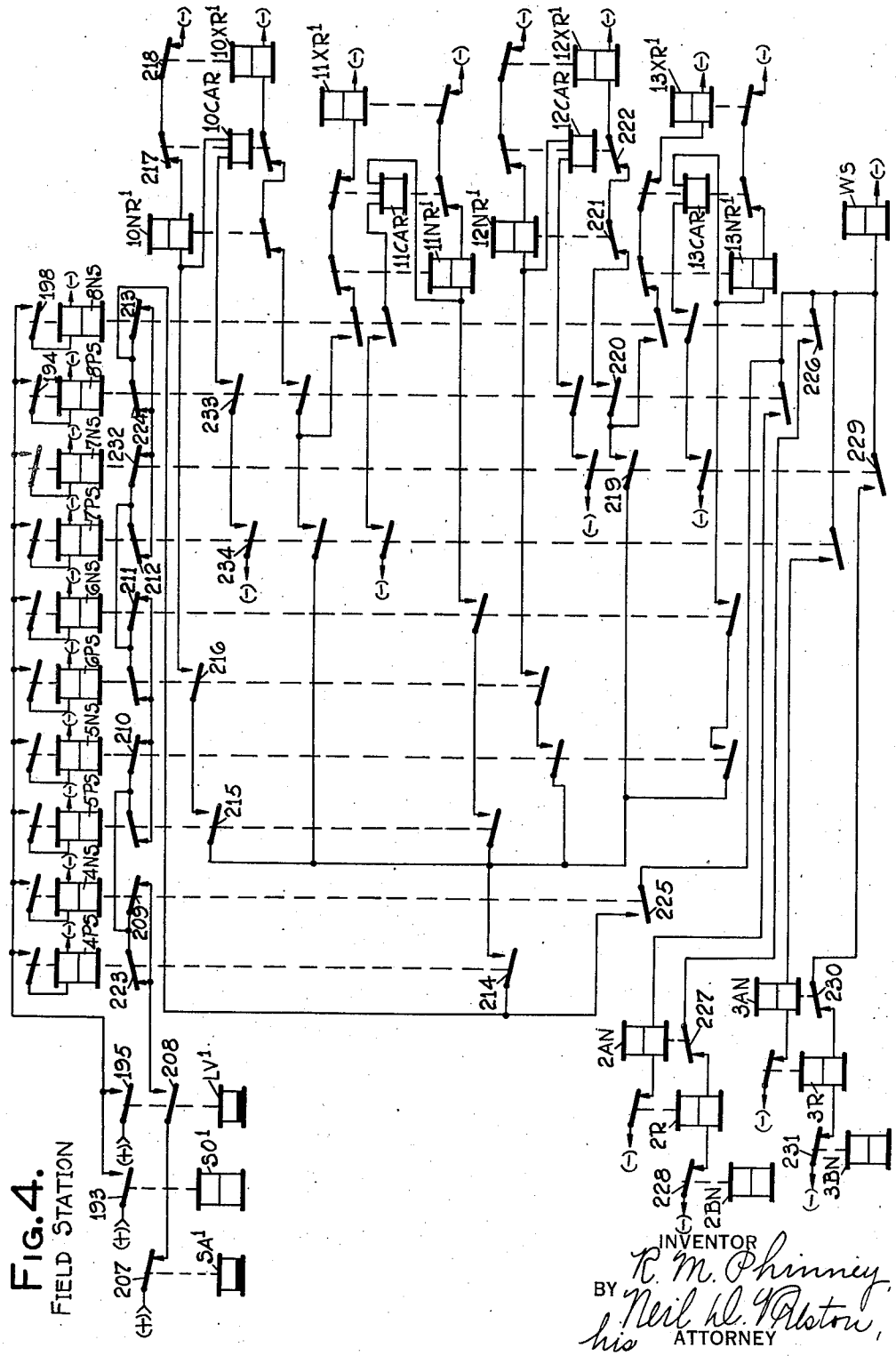


FIG. 4.
FIELD STATION

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INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 6

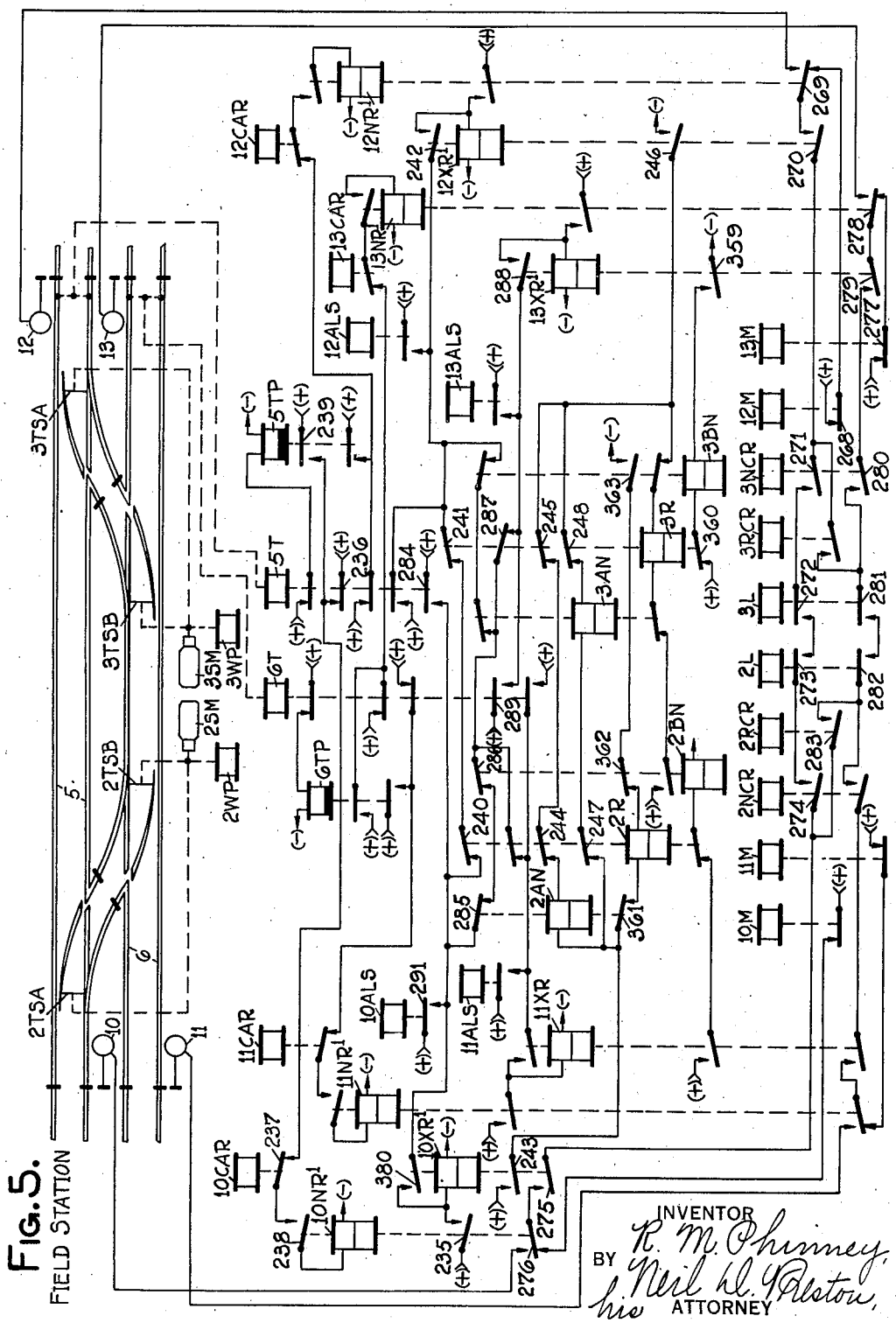


FIG. 5.
FIELD STATION

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INTERLOCKING SYSTEM FOR RAILROADS

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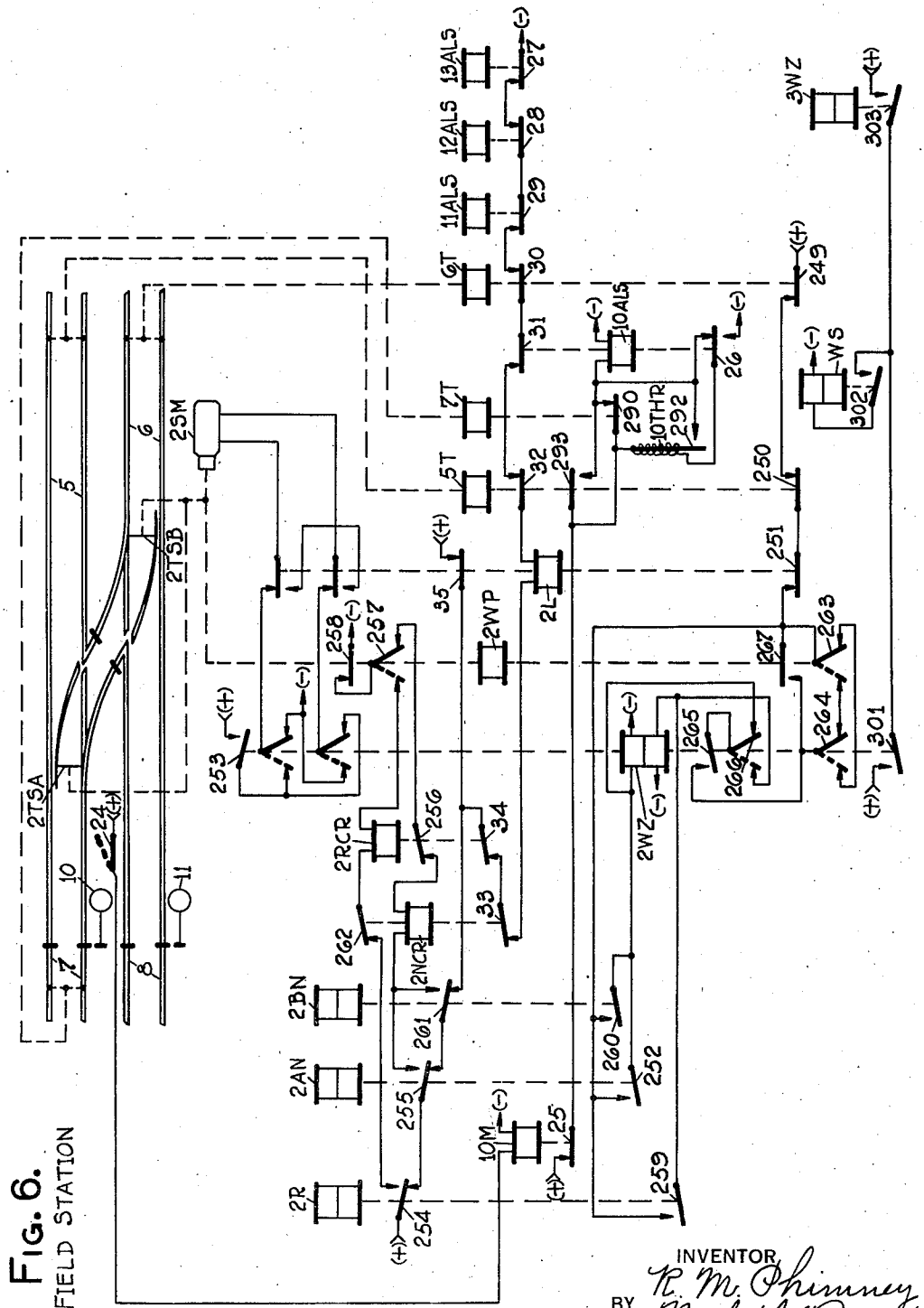


FIG. 6.
FIELD STATION

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INTERLOCKING SYSTEM FOR RAILROADS

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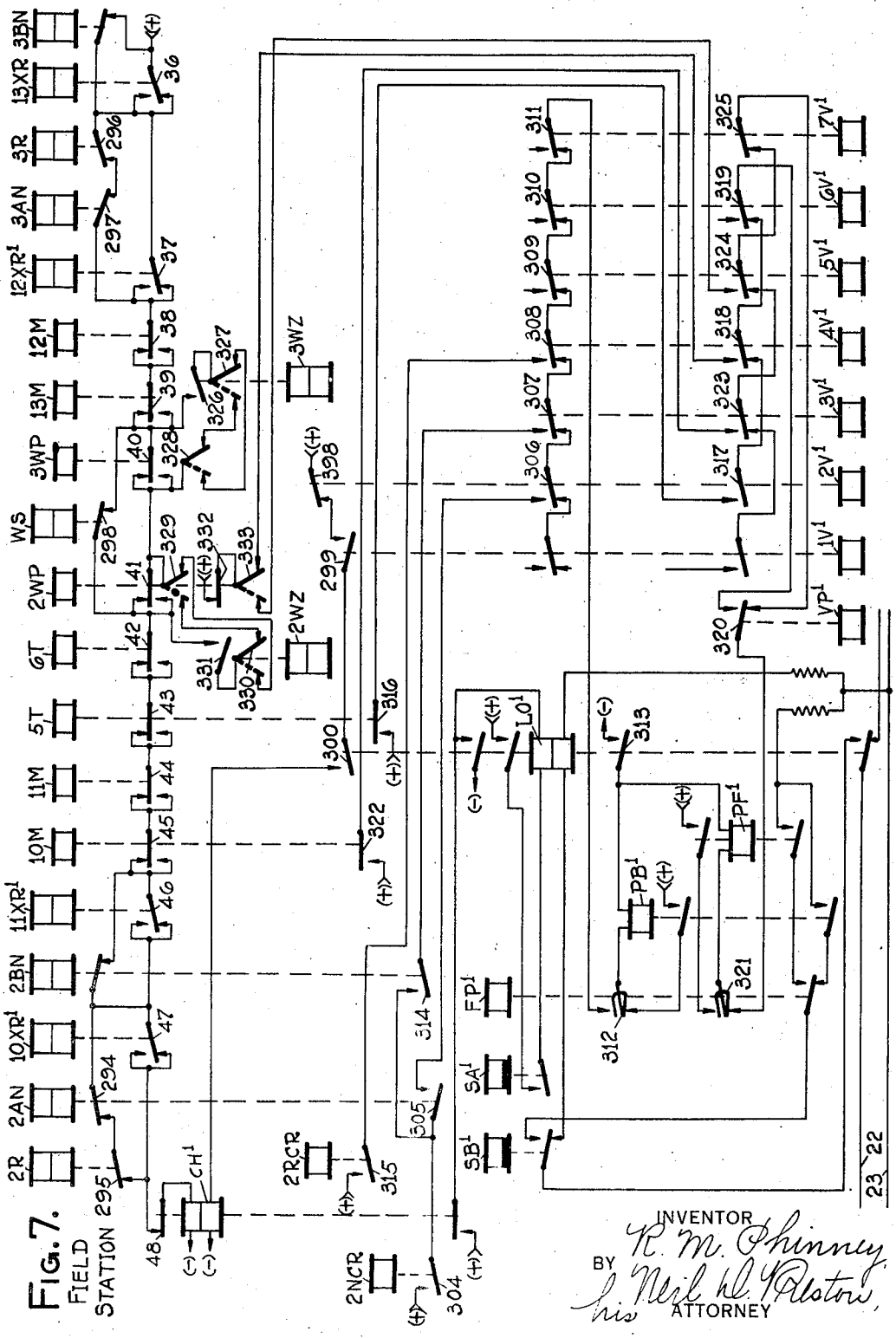


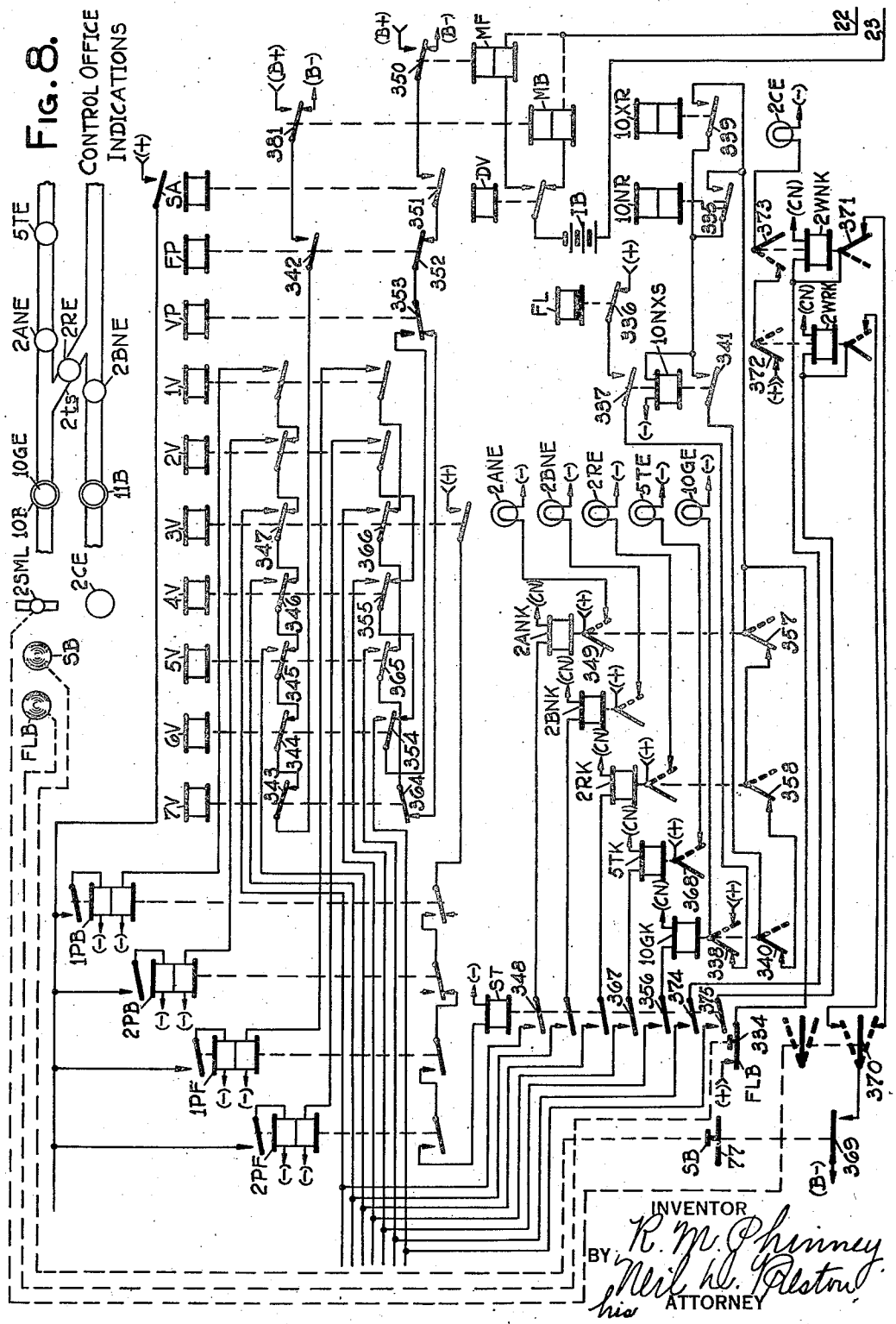
FIG. 7.

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INTERLOCKING SYSTEM FOR RAILROADS

Filed June 29, 1938 9 Sheets-Sheet 9



Patented Nov. 26, 1940 2,223,126

UNITED STATES PATENT OFFICE

2,223,126

INTERLOCKING SYSTEM FOR RAILROADS

Robert M. Phinney, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

Application June 29, 1938, Serial No. 216,459

32 Claims. (Cl. 246—134)

This invention relates to interlocking systems for railroads, and it more particularly pertains to an interlocking system of the entrance-exit type, which includes a coded communication system for communication between remotely located track layouts and a control office.

A system for governing traffic through complex track layouts should be so simple in the manipulations required as to conserve a maximum amount of the operator's time and effort for the planning of train movements and the general dispatching of traffic. In an entrance-exit type of interlocking system, a miniature track diagram of the actual track layout is provided with control buttons and indicators in a manner to make a composite picture of operation and actual conditions. Control buttons are located on the miniature track diagram at points representative of the route ends, and indicators are provided to show the positions of switches, clear or stop conditions of signals, and the locations of trains.

In accordance with this invention only one self-restoring control push button, or the equivalent, is provided for each end of each route. It is to be understood, however, that other types of buttons and control switches can as well be used, and that a button can be provided for each entrance point and another button provided for each exit point, in accordance with the requirements of practice. A route, as referred to in this description, is to be considered as the right of way set up over the track switches between an entering signal and the next signal for governing traffic in the same direction, or to the limit of the interlocking plant, if such second signal is not provided.

This invention provides that the defining of each route to be set up is accomplished by the joint but sequential operation of the buttons for the opposite ends of that route. In order to determine the direction of traffic over each route, the button for the entrance end to that route is operated first, and its operation is followed by the operation of the button for the exit end of that route.

Such a defining of each route is transmitted by code, as provided by this invention, to a particular station in the field, over any suitable type of communication system, such, for example, as the coded communication system shown in the Judge et al. Patent No. 2,082,544, dated June 1, 1937. Such a field station is considered as including track switches and signals and their control apparatus, grouped at a particular location in the field.

A code, which is selected by the operation of individual switch control levers on the control panel, for the auxiliary operation of a group of track switches, can also be transmitted from the control office to the particular field station for which those levers are provided.

In order that the same codes can be used in transmitting route controls as are used in transmitting auxiliary switch controls, for the same field station, distinctive control station codes are provided for each field station. That is, the transmission of each route control code for a particular station is preceded by the transmission of a particular control station code, and the transmission of each auxiliary switch control code for that same field station is preceded by the transmission of a different control station code. Although only two control station codes are assigned to a particular field station in this embodiment of the present invention, it is to be understood that the capacity of the system can be increased in accordance with the requirements of practice by dividing the route controls and the auxiliary switch controls to be transmitted to a particular field station into groups, each group being assigned a particular control station code.

When route controls are transmitted from the control office to a particular field station, a composite code is transmitted consisting respectively of characters forming a control station code, characters forming a route end code corresponding with the entrance point defined by the operator, and characters forming a route end code corresponding with the exit point defined by the operator.

The circuits are so arranged that the transmission of a series of impulses in response to the defining of a route by the operation of buttons for both ends of that route, is rendered effective automatically upon the operation of the button for the exit end of that route. In order to start the transmission of a series of impulses for the auxiliary operation of a group of track switches, a start button is depressed, following the selection of the code to be transmitted by the operation of the auxiliary switch control levers for that group of track switches. Although a separate start push button has been shown in this embodiment of the present invention, it is to be understood that a start contact corresponding with the start button conact could as well be provided on each of the auxiliary switch control levers as a contact to be closed if the lever is operated beyond the regular normal or reverse positions for that lever.

The setting up of routes for different stations which are not receiving codes, can be initiated by the operator during operation of the communication system, and the defining of those routes is stored until the communication system is available for their transmission to their respective field stations, only one condition being stored for each station. The operator can cancel such stored controls, without interfering with the operation of the communication system, by the operation of a cancel button.

To restore parts of the system, which are associated with a route, to normal, after that route has been completely set up, the operator has only to depress the button twice for the entrance to that route. The second time the button is depressed a series of impulses, including a message for the restoration to normal of parts of the system associated with that route, is applied to the line circuit at the control office, provided the line circuit is not being used. If the line circuit is in use during such operation, the message is stored until the line circuit is available for its transmission.

The self-selecting network provided by this invention for each of the field stations is an improvement over the self-selecting network shown in the application of Phinney and Hitchcock Ser. No. 183,272, filed January 4, 1938.

Means is provided for transmitting indications from each field station to the control office. When indicating the setting up of a route, as provided by this invention, the transmission of indications, in accordance with changes in the position of the track switches, is delayed until the signal for that route is cleared. Thus the condition of an entire route is transmitted on one indication cycle. When indicating the position of track switches positioned in accordance with the transmission of auxiliary switch control codes, however, the transmission of indications is initiated as soon as the track switches have completed their operation.

An object of this invention is to provide the above simplified mode of operation for an operator at the control office, by which the track layouts remotely located from that office can be efficiently controlled.

Another object of this invention is to consolidate a number of remotely located interlocking plants into a network of interlocking plants controlled from a single control office, thus centralizing the control of various units of a railway signalling system.

A still further object of the present invention is to include in one message, or cycle of operation, all of the control codes necessary for completely setting up a route at the field station for which those controls are selected, irrespective of the number of track switches included in that route.

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 is made to the accompanying drawings, in which those parts having similar features and functions are designated throughout the several figures by like letter reference characters which are generally made distinctive either by reason of distinctive exponents representative of their location or by reason of preceding numerals, and in which:

Figs. 1A and 1B, when placed side by side, illustrate the means provided for setting up coded messages, in accordance with the manipulation of the control buttons and levers on the panel of the control machine;

Fig. 2 illustrates the means provided at the control office for the stepping, impulsing of the line circuit, and the reception of indications;

Fig. 3 illustrates the means provided at one of the field stations for receiving codes transmitted from the control office, and also illustrates means provided at the field station for transmitting indications to the control office;

Fig. 4 illustrates means provided at one of the field stations for execution of the messages received from the control office;

Fig. 5 illustrates the self-selecting network provided at one of the field stations for setting up routes through the track layout with which it is associated, in accordance with codes received from the control office;

Fig. 6 illustrates certain typical circuits relative to the switch and signal controls at the various field stations;

Fig. 7 illustrates the means provided by this invention for transmitting indications from a field station to the control office, and also illustrates a means provided for delaying the transmission of such indications, under certain conditions, until a route is completely set up; and

Fig. 8 illustrates a means which is provided by this invention for indicating, on the control panel in the control office, various conditions at the field stations.

In order to simplify the description, reference is made from time to time to functions common to all parts of a similar character by use of the letter reference characters without exponents or preceding numerals. It is to be understood that such a reference applies to any parts designated in the drawings by reference characters which are similar except for preceding numerals and exponents.

For the purpose of simplifying the illustration and facilitating in the explanation, the various 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 purpose of facilitating the disclosure as to the principles and mode of operation, than with the idea of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus the various relays and their contacts are illustrated in a conventional manner, and symbols are used to indicate connections to terminals of batteries or other sources of electric current, instead of showing all of the wiring connections to those terminals.

Various relays are shown on different pages of the drawings in block form only, and some parts of the system have been illustrated on more than one page, in order that various features of the system can be more clearly illustrated.

The symbols (+) and (−) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current; and the circuits with which those symbols are used always have current flowing in the same direction. The symbols (B+) and (B−) indicate connections to the opposite terminals of a suitable battery or other direct current source which has a central or intermediate tap designated (CN); and the circuits with which these symbols are used can have current flowing in one direction or the other, depending upon the particular terminal used in combina-

tion with the intermediate tap (CN). When alternating current is used in place of direct current, the particular symbols employed represent the relative instantaneous polarities.

Apparatus

Track layout.—With reference to Figs. 1A, 1B and Fig. 5 of the accompanying drawings, the track layout has been illustrated as having been made up of a stretch of double track, the two tracks of which have been connected at various points by crossovers 2*ts*, 3*ts* and 4*ts*.

Signals 10 and 11 (see Fig. 5) are provided for governing east bound traffic, and signals 12 and 13 are provided for governing west bound traffic. Those signals, together with other apparatus for the track layout for which they are provided, constitute a field station. Although the signals are not shown for governing traffic over cross-over 4ts (see Fig. 1B) it is to be understood that such signals are provided, and that those signals, together with other apparatus for the track layout for which they are provided, constitute another field station. In order to simplify the disclosure of this invention, various parts of the system relative to the field stations are shown only in a typical form for a particular one of the stations.

The crossovers *ts* are provided with switch machines SM for causing the operation of their associated track switches to normal or reverse positions. The switch machines 2SM and 3SM have been shown as being associated with crossovers 2*ts* and 3*ts* respectively. The switch machines may be of any suitable type such, for example, as the type disclosed in the patent to W. K. Howe, Patent No. 1,466,903, dated September 4, 1923. In order to simplify the disclosure only one switch machine SM has been show associated with each crossover, but it is to be understood that separate switch machines can be provided for each end of each crossover in accordance with the requirements of practice. The motors for the switch machines can be controlled, for example, as shown in the patent to W. H. Hoppe et al., Patent No. 1,877,876, dated September 20, 1932. If they are controlled in this manner, the relay CR of that patent is controlled by relay WZ of the present disclosure.

The signals 10, 11, 12 and 13 (see Fig. 5) are of the search light type, having checking contacts associated therewith, as shown, for example, in the patent to O. S. Field, Patent No. 1,835,150, dated December 12, 1931. The signal indications have been assumed as providing a green light for a clear indication and a red light for a stop indication, and it is to be understood that a yellow light can be provided for a caution indication if such an indication is required in practice. It is also to be understood that other types of signals can as well be used, such as the semaphore type, color light signals having individual lamp units, or any other suitable type of signals, all within the scope of the present invention.

Track circuits are provided in the usual manner for the various track layouts included in the system, such, for example, as for the track sections 5, 6 and 7 (see Fig. 6) which have been shown as having track relays 5T, 6T and 7T associated therewith. Although the track batteries and other details of the track circuits are not shown, it is to be understood that they are provided in the usual manner.

A switch point detector relay WP is provided for each crossover, relays 2WP and 3WP having been shown. Each of the relays WP is of the polar neutral type and is energized with one polarity or the other in accordance with the normal or reverse locked position of the track switches for the associated crossover and the corresponding position of the switch machine SM, and it is deenergized whenever the switch points and/or the operating mechanism of the switch machine are unlocked. The circuit for causing such an operation of the relay WP is governed through the medium of a point detector contact mechanism as shown, for example, in the patent to C. S. Bushnell, Patent No. 1,517,236, filed November 25, 1924.

Control machine.—The control machine may be of any suitable type of construction, such, for example, as that shown in the application of J. F. Merkel, Ser. No. 169,436, filed October 16, 1937, in which the machine is made up of sections provided for various stations included in the system. A master unit is provided which consists of various parts of the system which are common to the sections for each of the field stations. The other sections of the machine can be provided as one section for each station, or various stations can be included in one section, according to the requirements of practice. Such an arrangement provides that changes and replacements can be made for parts of the control machine without materially interfering with the operation of other parts.

A control panel is provided on the front of the sections, which has constructed thereon a miniature track diagram similar to the track layout in the field for which that section of the machine is provided. Various indicator lamps are provided on the miniature track diagram at positions to indicate various conditions at the field stations.

A self-restoring push button B, having an operating contact closed when the button is depressed, is provided on the miniature track diagram at each point representative of a route end in the track layout with which that diagram is associated. The buttons B can include indicator lamps, as shown in Fig. 8, or the indicator lamps can be provided on the track diagram separate from the buttons, in accordance with the requirements of practice. Buttons 10B, 11B, 12B, 13B, 14B, 15B, 16B and 17B have been illustrated (see Figs. 1A and 1B) as having been associated with the miniature track diagram in such a manner that it is obvious with which route ends they are associated from their position on the track diagram.

Auxiliary switch control levers are provided on the control panel for the auxiliary operation of the track switches for each of the crossovers included in the various track layouts, of which levers 2SML, 3SML and 4SML have been shown.

Code determining relays.—The series of impulses applied to the line circuit during a cycle of operation for the communication of controls, is made up of several codes for performing various functions. As a means for selecting such codes various code determining relays are provided.

The relays CD (see Figs. 1A and 1B) are provided for rendering codes effective for transmission to only one particular field station at one time, each relay CD having associated therewith code jumpers which select a code of impulses to which only one particular field station is responsive.

Relay NR is provided for the entrance point to each route, and the picking up of that relay determines a code to be transmitted to a particular field station for defining that entrance point at that station. Relays 10NR, 11NR, 12NR and 13NR have been shown as having been provided for the entrance points at signals 10, 11, 12 and 13 respectively.

In somewhat of a similar manner relays 10XR, 11XR, 12XR and 13XR are provided to select a code for transmission to a particular field station for the defining of exit points at signals 10, 11, 12 and 13 respectively.

A control station relay SR (see Fig. 1A) is provided at the control office for selecting the control station code for transmission to the particular field station illustrated in detail. If that SR relay is picked up during the transmission of controls to that field station, a control station code identifying the control code as representative of auxiliary switch controls is selected, and if that relay is dropped away during the transmission of controls to that field station a control station code identifying the control code as representative of defined route ends is selected.

Relay NCH is provided in order to select the operation of a second button in setting up a route as being provided for defining the exit point for that route, and its associate relay NCHS provides that the depressing of a button for an entrance point will not energize the relay XR associated with that button for an exit point.

The change relay CH starts the communication system into operation, after the various control codes to be transmitted have been selected.

The change relays CH have associated therewith a manually operable self-restoring cancel button CNB. Suitable relays relative to the communication system are provided at the control office, such as relays CHP, CDS, C, FC, NC, PC, E, EP, F, FP, 2FP, SA, 2SA, DV, MF, MB, VP, 1V, 2V, 3V, 4V, 5V, 6V, 7V and LV. The function and characteristics of all of these relays has been shown in the above mentioned Judge et al. patent, No. 2,082,544. For convenience in referring to relays performing similar functions in that patent as those shown for this invention, the reference characters used in the drawings for this disclosure have been made to correspond with the reference characters for similar parts shown in that patent.

The relays 1V, 2V, 3V, 4V, 5V, 6V, 7V and LV together with half-step relay VP, form a stepping relay bank which is responsive to the impulsing of a line circuit extending from the control office to the various field stations. Such impulsing is effected by impulsing relays E and EP.

Relay F at the control office is a quick acting biased-to-neutral polarized relay and it has associated therewith quick acting neutral repeater relays FP and 2FP. Relays SA and 2SA are slow in dropping away, which provides that after they are picked up at the beginning of the transmission of a series of impulses, they remain picked up throughout that cycle of operation.

Relays PB, PF, ST, GK, TK, (ANK, BNK, RK, WRK, WNX, NXS and FL (see Fig. 8) are used at the control office in registering indications received from the field stations.

Suitable relays relative to the communication system are provided at the field stations such as relays F^1, FP^1, SA^1, SB^1, PB^1, PF^1, $1V^1$, $2V^1$, $3V^1$, $4V^1$, $5V^1$, $6V^1$, $7V^1$, LV^1 and VP^1 (see Fig. 3) provided at the field station illustrated.

The relays $1V^1$, $2V^1$, $3V^1$, $4V^1$, $5V^1$, $6V^1$, $7V^1$ and LV^1, together with half-step relay VP^1, form a stepping relay bank at the field station illustrated that is responsive to the impulsing of the line circuit at the control office.

The relays SO^1 and SOS^1 (see Fig. 3) are provided for selecting the particular station with which they are associated in accordance with a particular station selecting code transmitted from the control office.

The positive and negative receiving relays PS and NS (see Fig. 4) have been shown as including relays 4PS, 4NS, 5PS, 5NS, 6PS, 6NS, 7PS, 7NS, 8PS and 8NS.

A change relay CH^1 (see also Fig. 7) is provided at the field station illustrated in Fig. 3 for the purpose of initiating the transmission of indications from that field station to the control office, and relays LO^1, PB^1 and PF^1 have been provided for purposes relative to the transmission of those indications.

The relays NR^1, XR^1, CAR, AN, BN, R and WS (see Fig. 4) are responsive, at the end of an operating cycle, to the positioning of the code receiving relays PS and NS, and the selective energization of those relays determines the route to be set up at that field station, or the track switches to be positioned in accordance with the positioning of the auxiliary switch control levers for those track switches at the control office.

Relay NR^1 registers the entrance point for the route selected, relay XR^1 registers the exit point for the route selected, and relay CAR, when energized, causes the restoration to normal of a route having an entrance point with which that relay is associated. The relays AN, BN and R cause the normal or reverse positioning of the track switches for the crossover with which those relays are associated. Relay WS, when energized, allows each change in the position of the track switches to initiate an indication cycle.

A relay WZ (see Fig. 6), associated with each crossover, is responsive to the picking up of the AN, BN or R relays for that crossover, and the picking up of relay WZ causes the application of positive or negative energy to the switch machine SM with which it is associated, in accordance with the normal or reverse switch control relays energized. A contact of a lock relay L is included in the circuit of relay WZ in order to allow the operation of the switch machine only under conditions when such operation is safe.

A relay NCR and a relay RCR (see Fig. 6) is provided for each crossover for repeating the position of the track switches for that crossover in correspondence with the picked up position of the switch control relays AN, BN or R, and relays NCR and RCR close a circuit for the entering signal to each route which is set up, thus causing the signal to be cleared only after each of the track switches in the route has completed its operation.

A normally energized relay M (see Fig. 6) is provided for repeating the stop position of each of the signals, the circuit for relay 10M having been shown associated with signal 10 as being typical of the circuit for the other relays M provided for the other signals.

An approach locking relay ALS is associated with each signal, and it is provided with a thermal relay THR, for delaying the picking up of that relay under certain conditions. It is to be understood that modifications of the approach locking can be provided in accordance with the requirements of practice. For example, in some

track layouts only one approach locking relay is required for a plurality of signals.

Having thus considered the apparatus provided for the system in accordance with this invention, consideration will now be given to the mode of operation of the system.

Operation

In considering the details of the operation of the system, little reference is made to the details relative to the communication part of the system, because such details can be obtained by referring to the above mentioned Judge et al. patent, No. 2,082,544. In order to make clear how the description in that Judge et al. patent is applied to the present invention, corresponding relays are shown in this disclosure as having corresponding reference characters. Consideration is given, however, to the mode of operation of the communication system in a general way which should be sufficient for an understanding of the present invention by those familiar with the art.

Communication system general.—The communication system provides that control codes made up of time spaced positive and negative impulses are applied at the control office to a line circuit having a control line wire **20** (see Fig. 2), which includes, in series, the winding of a three-position polar neutral relay F at the control office and at each of the field stations. At the most distant station from the control office the control line wire **20** is connected to a return line wire **21**.

A series of impulses impressed upon the line circuit, having polarities selected in a manner hereinafter described, causes the relay F at all stations to operate in synchronism and thus causes the operation of the stepping relay banks with which those relays F are associated.

When reference is made from time to time to the positive or negative energization of the line circuit, such reference refers to the connecting of the positive or negative terminal respectively to the side of the line circuit including control line wire **20**.

The first impulse of a series applied to the line circuit is used for conditioning apparatus in the control office at each station for a cycle of operation. During the first time space in a series, conveniently called the first "off" period, the first of the stepping relays is picked up, and in a similar manner a successive stepping relay is picked up during each of the following "off" periods.

The stepping at each of the field stations is rendered effective during the transmission of the station selecting code only so long as that code, which is the first group of impulses of a series, corresponds with the position of code jumpers, step-by-step, at that station. Thus it is obvious that the series of impulses carries a message which, through the process of elimination, maintains only one particular station in communication with the control office for the reception of the remainder of the impulses of that series.

After the station selecting code is completed, various control codes are transmitted to the station which remains in communication with the control office after the stepping at all of the other stations has stopped. The period of de-energization of the line circuit at the end of the last impulse of a series, which is conveniently called the clearing out period, provides for the restoration of the communication system to normal at rest conditions.

An indication line circuit consisting of line wires **22** and **23** (see Fig. 2), is opened or closed, at a field station which is transmitting indications, during each step. Such opener or closed condition registers in the control office, the condition of apparatus at the field station which causes such an opened or closed condition. Relay PB^1 (see Fig. 3) is used in closing the indication line circuit during the "off" period, and relay PF^1 is used in closing the indication line circuit during the energization of the line circuit following the "off" periods, conveniently called "on" periods. Relays MB and MF (see Fig. 2) at the control office respond to the closing of the line circuit during "off" and "on" periods respectively. The stepping is effected during an indication cycle, by the transmission of a phantom code from the control office over the line circuit, which causes the operation of the stepping at the field stations, but which renders impulses ineffective for transmitting controls. In other words, a phantom code does not contain code elements corresponding with any station selecting code used.

The station transmitting indications is registered at the control office by means of a registration code, during the beginning of the indication cycle, which is predetermined by jumpers at the sending field station which determine the opened or closed condition of the indication line circuit step-by-step.

The communication system can be operative for the transmission of controls and for the transmission of indications on separate cycles of operation, or both transmitting means can be effective at the same time. Such simultaneous operation is called duplex operation, and is explained in detail in the above mentioned Judge et al. patent. During such operation a station not selected for the reception of controls can transmit indications, and the stepping at that station is effected by the impulses being applied to the line circuit at the control office for the transmission of controls, rather than by the transmission of a phantom code.

Normal conditions.—With reference to Figs. 1A, 1B and 2, it will be noted that, during a period of rest, all of the relays associated with the system at the control office are deenergized, and that both of the relays NC and PC, in a dropped away position, cause the opening of the line circuit extending to the field stations. Likewise, with reference to Fig. 3, it will be noted that each of the relays at the field stations relative to the communication system are in a dropped away position, with the exception of the change relay CH^1.

With reference to Fig. 5, the signals for the track layout illustrated, have been shown as being normally at stop with their red lamps illuminated, which position causes the energization of the signal at stop repeater relay M, as is typically shown, for example, in the circuit for relay **10**M (see Fig. 6), which is closed from (+), through a circuit including contact **24** of the mechanism of signal **10** in a stop position, and winding of relay **10**M, to (—). When relay **10**M is picked up, under normal conditions, a stick circuit is closed for maintaining the approach locking relay **10**ALS, which is associated with signal **10**, energized from (+), through a circuit including front contact **25** of relay **10**M, winding of relay **10**THR, front contact **26** of relay

10ALS, and winding of relay 10ALS, to (—). An approach locking relay ALS has been shown associated with each signal and has a control circuit (not shown) provided in the same manner as has been described for relay 10ALS.

It is assumed that the track layouts are unoccupied, during normal conditions, which would cause the energization of the track circuits for all of the track relays, and cause the track relays 5T and 5T (Fig. 5) and their associated repeater relays, to be in their picked up position. It is also to be understood that under the normal conditions the approach track sections are unoccupied, as shown by the picked up position, for example, of relay 7T (see Fig. 6).

Under normal conditions, when the approach locking relays and the relays for the detector track sections are picked up, the lock relay for each of the track switches with which those relays are associated is energized as is typically shown, for example, in the stick circuit for relay 2L (see Fig. 6) which is closed from (+), through a circuit including front contact 35 of relay 2L, back contact 34 of relay 2RCR, back contact 33 of relay 2NCR, winding of relay 2L, front contact 32 of relay 5T, front contact 31 of relay 10ALS, front contact 30 of relay 6T, front contact 29 of relay 11ALS, front contact 28 of relay 12ALS, and front contact 27 of relay 13ALS, to (—).

Change relay CH[1] (see Fig. 7) is maintained, under normal conditions, in a picked up position by a stick circuit closed from (+), through a circuit including back contact 36 of relay 13XR, back contact 37 of relay 12XR, front contact 38 of relay 12M, front contact 39 of relay 13M, front contact 40 of relay 3WP, front contact 41 of relay 2WP, front contact 42 of relay 6T, front contact 43 of relay 5T, front contact 44 of relay 11M, front contact 45 of relay 10M, back contact 46 of relay 11XR, back contact 47 of relay 10XR, front contact 48 of relay CH[1], and upper winding of relay CH[1], to (—).

The relays associated with the self-selecting network provided for each of the track layouts in the field are dropped away during normal conditions, as is typically shown, for example, in Fig. 5.

Initiation of the system.—When initiating the setting up of a route, the operator first checks the indicator lamps CHE (Fig. 1A) to see that the codes for all other controls initiated for that station have been transmitted. Such indication means is hereinafter described in detail, but, for the purpose of understanding the mode of operation on the part of the operator, it is sufficient to assume that once the setting up of a route, or the auxiliary positioning of the track switches, is initiated, the lamp CHE (see Figs. 1A and 1B) associated with the change relay CH for that station is illuminated, and remains illuminated until those controls are transmitted. The illumination of a lamp CHE indicates to the operator that controls for that station are stored or are being transmitted, and that he should wait until the lamp is extinguished before attempting to initiate the transmission of new controls for that station. It is to be understood that indicator lamps are associated with each route initiated for clearly indicating that route to the operator in order that he will not attempt to set up conflicting routes, although the circuits are so interlocked, that conflicting routes cannot be contemporaneously set up.

After the operator has checked the route indicator lamps for a particular station to see that there are no routes set up which conflict with the route he is about to initiate, and after he has checked the indication of the lamp CHE for that station to determine that all prior initiated controls have been transmitted, he can proceed to initiate the setting up of a route, for example, from signal 10 to signal 12.

In setting up a route from signal 10 to signal 12, the operator first depresses the button 10B for the entrance end of that route, and then, after having allowed that button to be restored, he depresses the button 12B for the exit end of that route. The depression of the button 12B causes the automatic start of the transmission of control codes selected in response to the joint operation of the buttons for both ends of the route.

The depression of button 10B, under such conditions, causes the energization of the lower winding of an entrance relay 10NR in series with the winding of an entrance change stick relay NCHS. Such a circuit is closed from (+), through a circuit including contact 49 of button 10B in a depressed position, lower winding of relay 10NR, back contact 50 of relay NCH, winding of relay NCHS, and back contact 51 of relay CH, to (—).

The picking up of relay 10NR closes a stick circuit for that relay from (+), through a circuit including contact 52 of cancel button CNB in a normal position, back contact 53 of relay CD, winding of relay NCH, front contact 54 of relay 10NR, and upper winding of relay 10NR, to (—).

The picking up of relay NCHS closes a stick circuit including front contact 55 of that relay for shunting contact 50 of relay NCH out of the circuit. Relay NCHS remains in a picked up position so long as the entrance button which has been depressed is held in a depressed position, and the picking up of that relay opens the circuit for the relays associated with the exit points of the routes in order to prevent the energization of the exit relay 10XR which is also associated with the button for the end of the route at signal 10.

When the operator allows the button 10B to be restored to its normal position, after relays 10NR and NCH have been picked up, the circuit for relay NCHS is opened at contact 49 of button 10B in a depressed position, which causes that relay to drop away.

The operator now proceeds to define the exit end for the route which he is setting up from signal 10 to signal 12, by the depression of button 12B, which closes a circuit for energizing the lower winding of relay 12XR from (+), through a circuit including contact 56 of button 12B in a depressed position, back contact 57 of relay 13NR, lower winding of relay 12XR, front contact 58 of relay NCH, back contact 59 of relay NCHS, and back contact 60 of relay CH, to (—). The picking up of relay 12XR closes a stick circuit for that relay from (+), through a circuit including contact 52 of button CNB in a normal position, back contact 53 of relay CD, winding of relay CH, front contact 61 of relay 12XR, and upper winding of relay 12XR, to (—).

When relay CH picks up, due to its energization by the above circuit, it closes a circuit for energizing its repeater relay CHP, from (+), through a circuit including back contact 62 of relay SA, back contact 63 of relay FC, upper winding of relay CHP, wire 117, and front contact 64 of relay CH, to (—). The picking up of relay CHP closes a stick circuit for that relay from (+), through a circuit including back contact 65 of relay LV, front contact 66 of relay CHP, and

lower winding of relay CHP, to (—). Energy is also applied to that stick circuit by back contact 118 of relay EP in order to maintain relay CHP picked up until the end of the last of a series of impulses.

The picking up of relay CHP closes a circuit for energizing relay C from (+), through a circuit including back contact 67 of relay SA, front contact 68 of relay CHP, and winding of relay C, to (—).

The picking up of relay C closes a stick circuit for that relay from (+), through a circuit including back contact 131 of relay 2SA, front contact 132 of relay C, and winding of relay C, to (—). At the start of the cycle, the relay SA picks up and applies energy to that stick circuit at front contact 67 before that stick circuit is opened by the picking up of relay 2SA, which follows the picking up of relay SA; whereby that stick circuit is maintained closed throughout the cycle of operation. At the end of the cycle, however, relay SA drops away prior to the dropping away of relay 2SA, and effects the momentary opening of the stick circuit to cause the dropping away of relay C.

As soon as relay CH is picked up, the indicator lamp CHE is illuminated when an obvious circuit is closed at front contact 197 of relay CH, thus providing an indication that the stored controls for that station must be transmitted before initiating the transmission of other controls for that station.

A circuit is closed for energizing the lower winding of relay CD, from (+), through a circuit including back contact 65 of relay LV, back contact 69 of relay 2SA, front contact 70 of relay C, back contact 71 of relay CDS, back contact 72 of relay 2CH, wire 119, front contact 73 of relay CH, lower winding of relay CD, and contact 74 of cancel button CNB in the normal position, to (—).

The picking up of relay CD closes a stick circuit for that relay, which is also an energizing circuit for relay CDS, from (+), through a circuit including front contact 75 of relay CHP, winding of relay CDS, wire 120, front contact 76 of relay CD, upper winding of relay CD and contact 74 of button CNB in the normal position, to (—). Energy is applied to that circuit by back contact 79 of relay EP to insure the energization of the circuit until the end of the last impulse of the series.

The picking up of relay CD closes a second energizing circuit for relay CH from (+), through a circuit including back contact 133 of relay LV, wire 134, front of make-before-break contact 53 of relay CD, winding of relay CH, front contact 61 of relay 12XR, and upper winding of relay 12XR, to (—). Make-before-break contact 53 provides that relays CH, 10NR, NCH and 12XR are maintained energized during the picking up of relay CD. Part of that circuit is also common to the circuit for relays NCH and 10NR which is closed after relay CD picks up, from (+), through a circuit including back contact 133 of relay LV, wire 134, front of make-before-break contact 53, winding of relay NCH, front contact 54 of relay 10NR, and upper winding of relay 10NR, to (—). Such circuits for relays CH, NCH, 10NR and 12XR are maintained energized throughout the cycle of operation by reason of back contact 133 of relay LV, and energy is also applied to those circuits at back contact 135 of relay EP to insure that those relays remain energized until the end of the last impulse of the series.

The system has thus been conditioned by the above mode of operation, for the start of the transmission of controls relative to the route initiated, by means of the communication system.

Auxiliary means is provided for initiating the positioning of the track switches in order to allow the operator to set up routes through the interlocking plant which are not provided by the self-selecting network, and in order to allow the operator to set up routes through the interlocking plant if the self-selecting network fails to operate. Such auxiliary means for controlling the track switches also provides a means whereby the operator can cause the operation of a particular track switch, or a group of track switches, in order to free the switch points of obstructions, such, for example, as snow and ice.

Assume, for example, that the operator wishes to set up a route, not provided by the self-selecting network, from signal 10 to signal 12 via crossovers 2*ts* and 3*ts*.

In order to initiate the proper positioning of the track switches for such a route, the operator first checks his indicator lamps as mentioned above, and then proceeds to operate the auxiliary levers 2SML and 3SML to a reverse operating position, which has been assumed as being to a downward position. He then depresses the send button SB for that station.

Such operation of the send button SB closes a circuit for energizing a control station relay SR from (+), through a circuit including contact 77 of button SB in a depressed position, upper winding of relay SR, back contact 58 of relay NCH, back contact 59 of relay NCHS, and back contact 60 of relay CH, to (—). The picking up of relay SR closes a stick circuit for that relay, which includes an energizing circuit for relay CH, from (+), through a circuit including contact 52 of button CNB in a normal position, back contact 53 of relay CD, winding of relay CH, front contact 78 of relay SR, and lower winding of relay SR, to (—).

The picking up of relay CH, due to its energization in the stick circuit for relay SR, causes the energization of the relays CHP, C, CDS and CD in the same manner as has been heretofore described, and relay CH is maintained picked up until the end of the control cycle.

In order to initiate the transmission of a message for putting a signal to stop, the operator has only to depress the button twice for the route end with which that signal is associated. The first time the button is depressed, the relay NR for the entrance point at that signal is picked up, and the second time that same button is depressed the relay XR for the exit point at that signal is picked up. The picking up of the relay XR initiates the control cycle in the same manner as was described in detail for the initiation of the system for transmitting route end controls.

In considering an example of the above mentioned mode of operation for putting a signal to stop, assume the operator to initiate the putting of signal 10 to stop. Upon depressing button 10B the first time, relays 10NR, NCHS and NCH are picked up in the same manner and including the same circuits as was heretofore described. After the button 10B is restored, relay NCHS is dropped away, due to its circuit having been opened at contact 49 of button 10B. The operator then depresses the same button a second time, and a circuit is closed for energizing relay 10XR from (+), through a circuit including contact 80 of button 10B in a depressed position, back contact 81 of relay 11NR, lower winding of

relay 10XR, front contact 58 of relay NCH, back contact 59 of relay NCHS, and back contact 60 of relay CH, to (—). It will be noted that relay NCHS does not pick up, upon depressing the button 10B the second time, because its pick up circuit is held open at back contact 50 of relay NCH. The picking up of relay 10XR closes a stick circuit for that relay, which includes the winding of relay CH, from (+), through a circuit including contact 52 of button CNB in a normal position, back contact 53 of relay CD, winding of relay CH, front contact 82 of relay 10XR, and upper winding of relay 10XR, to (—). The picking up of relay CH causes the start of a control cycle in the same manner as has heretofore been described.

Having described various conditions relative to the mode of operation of the system for specific conditions of operation on the part of the operator it is to be understood that such operation is considered as typical for other similar specific conditions relative to the setting up of other routes, relative to the auxiliary operation of track switches to other positions, and relative to the putting of other signals to stop.

The above described circuits include certain interlock features. Whenever a button is depressed a first time, for an entrance point, relay NCHS is maintained in a picked up position to open the circuit for the exit relay associated with that button at back contact 59. The picking up of relay NCH prevents the picking up of the control station relay SR, until the initiated route control has been transmitted or cancelled, by opening the pick up circuit for that relay at back contact 58. The picking up of relay CH opens the pick up circuit for the relays NR and XR at back contacts 51 and 50 respectively, and the opening of back contact 60 also opens the pick up circuit for relay SR. Thus the code to be transmitted cannot be changed after a control cycle has been intiated. The inclusion of back contact 57 of relay 13NR in the pick up circuit for relay 12XR prevents the initiation of an impossible route from signal 13 to signal 12.

In a similar manner, control cycles for each of the stations can be initiated, for example, the operation of buttons for entrance and exit points for the track layout illustrated by the miniature track diagram shown in Fig. 1B causes the energization of the relay 2CH, which causes the start of a cycle in the same manner as described above as being responsive to the energization of relay CH. It is of course to be understood that control cycles for each of the field stations can be initiated by the start button associated with that field station, together with the positioning of the auxiliary switch control levers.

If starts for two or more stations are effected simultaneously or at times prior to the dropping away of relay CDS, the front contact of the relay CH which is included in the pick up circuit of the relay CD associated therewith, and which is nearest the source of energy for the picking up of the relays CD, locks out all other relays CD for starts which have been initiated. For example, if relays CH and 2CH become energized contemporaneously, while relay CDS is picked up, the picking up of relay 2CH opens the circuit for relay CD at back contact 72 and closes the circuit for relay 2CD at front contact 72. Thus relay 2CD is given superiority over relay CD, due to its position in the circuit. The opening of the circuit for the relays CD throughout a control cycle at front contact 71 of relay CDS prevents the picking up of relays CD during a cycle, such as preventing the energization of relay 2CD when a cycle has been initiated by relay CD.

It is therefore obvious that a start can be stored for each station by the energization of the relay CH for that station, and that the order in which those stored starts are transmitted is determined by the order of the location of the relays CD for those starts in their common control circuit.

Polarity selection of stepping impulses.—The polarity of the first group of impulses of a series during a control cycle is selected in accordance with the position of various code jumpers and in accordance with the picked up or dropped away position of the control station relay SR. That first group of impulses defines the field station for which the controls are intended, and also defines the particular nature of the controls to be transmitted during that cycle of operation. That is, it defines, in this particular embodiment of the present invention, whether the controls to be transmitted during that cycle are for the designation of route ends, or whether the controls to be transmitted during that cycle are for the auxiliary positioning of a group of track switches. The first three impulses of that group are determined by the position of the code jumpers in a manner described in detail in the above mentioned Judge et al. Patent No. 2,082,544.

The number of impulses included in the group is dependent upon the number of field stations included in the system, and the number of control station codes required for each of those field stations. The maximum number of different codes that can be provided by a particular number of impulses is equal to two raised to the power of the number of impulses. One of the codes is usually reserved, as in the present system, for the stepping during an indication cycle, and it is conveniently called a phantom code.

To consider an example of how the station codes are selected, consider the system to have been initiated for the transmission of controls to the field station illustrated in Fig. 3. The picking up of relay C (see Figs. 1A and 1B) due to such initiation, closes a circuit for the energization of relay PC from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85, 86, 87, 88, 136 and 137 of relays 7V, 6V, 5V, 4V, 3V, 2V and 1V respectively, wire 121, front contact 138 of relay CD, jumper 139, wire 129, and winding of relay PC, to (—).

After the line circuit is deenergized by the picking up of the impulsing relay EP, (see Fig. 2) in a manner to be described in detail later, the first of the stepping relays 1V is picked up and the above described circuit for relay PC is opened at back contact 137 of relay 1V. A second energizing circuit is closed however, for that relay PC from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85, 86, 87, 88 and 136 of relays 7V, 6V, 5V, 4V, 3V and 2V respectively, front contact 137 of relay 1V, wire 122, front contact 140 of relay CD, jumper 141, wire 129, and winding of relay PC, to (—).

With relay PC picked up, the line circuit is energized for a second impulse which is of a positive polarity, as soon as the impulsing relay EP is dropped away to close that line circuit. After relay EP has again picked up to mark the end of the second impulse, relay 2V is caused to pick up and open the circuit just described for relay PC at back contact 136, to cause that relay to

drop away. A circuit is closed for the energization of relay NC by the picking up of relay 2V, from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85, 86, 87 and 88 of relays 7V, 6V, 5V, 4V and 3V respectively, front contact 136 of relay 2V, wire 123, front contact 142 of relay CD, jumper 143, wire 130, and winding of relay NC, to (—).

With relay NC picked up, the line circuit is energized for a third impulse which is of a negative polarity, as soon as the impulsing relay EP is dropped away to close the line circuit. After relay EP has again picked up to mark the end of the third impulse, relay 3V is caused to pick up and open the circuit just described for relay NC at back contact 88, to cause that relay to drop away. A circuit is closed for the energization of relay PC by the picking up of relay 3V, if the system has been initiated for the transmission of route end controls, from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85, 86 and 87 of relays 7V, 6V, 5V and 4V respectively, front contact 88 of relay 3V, wire 124, front contact 89 of relay CD, back contact 90 of relay SR, wire 129, and winding of relay PC, to (—).

With relay PC picked up, the line circuit is energized for a fourth impulse which is of negative polarity, as soon as the impulsing relay EP is dropped away to close the line circuit.

If, however, the system has been initiated for the transmission of auxiliary switch controls, a circuit is closed for the energization of relay NC instead of relay PC by the picking up of relay 3V. Such a circuit for relay NC is closed from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85, 86 and 87 of relay 7V, 6V, 5V and 4V respectively, front contact 88 of relay 3V, wire 124, front contact 89 of relay CD, front contact 90 of relay SR, wire 130, and winding of relay NC, to (—).

With relay NC picked up, the line circuit is energized for a fourth impulse which is of negative polarity, as soon as the impulsing relay is dropped away to close the line circuit.

Thus, two control station codes are provided for the field station illustrated in detail. One code, composed of the characters (+) (+) (—) (+), selects that field station for the reception of route end controls, and another code composed of the characters (+) (+) (—) (—), selects that field station for the reception of auxiliary switch controls.

It is easily understood by those familiar with the art from the simple example shown and described, how several control station codes can be selected for each field station to be included in the system, in accordance with the requirements of practice.

The next group of impulses for defining routes is made up of two parts, the first of which defines the entrance point for the route, and the second of which defines the exit point for the route. Each route end for a field station is provided with a different code, thus if the track layout has four route ends, a code of two impulses is sufficient. If a greater number of route ends is provided, the number of impulses must be increased in order to provide a different code for each route end. The maximum number of different codes available for a particular number of impulses is equal to two raised to the power of the number of impulses.

The two impulses immediately following the fourth impulses, in this embodiment of the invention, define the route end which is used as an entrance point for the route initiated. The two impulses immediately following the sixth impulse in this embodiment of the invention, define the route end which is used as an exit point for the route initiated. In accordance with this embodiment of the invention the following code table is provided which shows the codes used for controlling various devices associated with a particular field station.

Code table

No.	Impulse numbers								Use.
	Station codes				Control codes				
					Entrance		exit		
	1	2	3	4	5	6	7	8	
1	+	+	—	+	+	+	+	+	10 stop.
2	+	+	—	+	+	+	+	—	Not used.
3	+	+	—	+	+	+	—	+	Route 10-12.
4	+	+	—	+	+	+	—	—	Route 10-13.
5	+	+	—	+	+	—	+	+	Not used.
6	+	+	—	+	+	—	+	—	11 stop.
7	+	+	—	+	+	—	—	+	Route 11-12.
8	+	+	—	+	+	—	—	—	Route 11-13.
9	+	+	—	+	—	+	+	+	Route 12-10.
10	+	+	—	+	—	+	+	—	Route 12-11.
11	+	+	—	+	—	+	—	+	12 stop.
12	+	+	—	+	—	+	—	—	Not used.
13	+	+	—	+	—	—	+	+	Route 13-10.
14	+	+	—	+	—	—	+	—	Route 13-11.
15	+	+	—	+	—	—	—	+	Not used.
16	+	+	—	+	—	—	—	—	13 stop.
					Switches				
					SP	SP	#2	#3	
17	+	+	—	—	+	+	+	+	2N, 3N.
18	+	+	—	—	+	+	+	—	2N, 3R.
19	+	+	—	—	+	+	—	+	2R, 3N.
20	+	+	—	—	+	+	—	—	2R, 3R.
21	—	—	—	—	—	—	—	—	Phantom.

In considering an example of the polarities selected for setting up a route between two particular route ends, assume a route to be initiated, as heretofore described, from signal 10 to signal 12. With reference to the above code table, code No. 3 is to be transmitted for such a route. The station selection code (+)(+)(—)(+) is transmitted for the first four impulses. The fourth impulse is (+), due to the energization of relay PC through a circuit heretofore described. The picking up of stepping relay 4V at the end of the fourth impulse closes a circuit for energizing relay PC from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85 and 86 of relays 7V, 6V and 5V respectively, front contact 87 of relay 4V, wire 125, front contact 91 of relay CD, back contact 92 of relay 13NR, back contact 93 of relay 12NR, back contact 94 of relay 11NR, front contact 95 of relay 10NR, wire 129, and winding of relay PC, to (—).

The picking up of stepping relay 5V, at the end of the fifth impulse, in setting up a route from signal 10 to signal 12, closes a circuit for energizing relay PC from (+), through a circuit including front contact 83 of relay C, back contacts 84 and 85 of relays 7V and 6V respectively, front contact 86 of relay 5V, wire 126, front contact 96 of relay CD, back contact 97 of relay 13NR, back contact 98 of relay 12NR, back contact 99 of relay 11NR, front contact 100 of relay 10NR, wire 129, and winding of relay PC, to (—).

The picking up of stepping relay 6V at the end of the fifth impulse, in setting up a route from signal 10 to signal 12, causes the dropping away of relay PC by opening its circuit at back contact 85, and closes a circuit for energizing relay NC

from (+), through a circuit including front contact 83 of relay C, back contact 84 of relay 7V, front contact 85 of relay 6V, wire 127, front contact 101 of relay CD, back contact 102 of relay 13XR, front contact 103 of relay 12XR, wire 130, and winding of relay NC, to (—).

The picking up of stepping relay 7V at the end of the seventh impulse, in setting up a route from signal 10 to signal 12, causes the dropping away of relay PC by opening its circuit at back contact 84, and closes a circuit for energizing relay PC from (+), through a circuit including front contact 83 of relay C, front contact 84 of relay 7V, wire 128, front contact 104 of relay CD, back contact 105 of relay 13XR, front contact 106 of relay 12XR, wire 129, and winding of relay PC, to (—).

If the initiation of a cycle has been accomplished by the positioning of the auxiliary switch control lever and the depression of the start button, the picking up of relay SR determines that the fourth impulse shall be (—), as has been heretofore described.

Assume, for example, the operator to initiate the transmission of a message for the operation of the track switches for crossovers 2*ts* and 3*ts* as has been heretofore described. Such a message includes code impulses as shown in the above code chart for code number 26. Levers 2SML and 3SML are operated to their downward position to cause corresponding positioning of the contacts shown associated therewith by dotted lines. Relays SR and CD are picked up, and relay NC is energized during the fourth impulse in a manner heretofore described.

The picking up of stepping relay 4V at the end of the fourth impulse, in considering the above selection of controls, causing the dropping away of relay NC by opening its circuit at back contact 87, and causes relay PC to be energized by a circuit closed from (+), through a circuit including front contact 83 of relay C, back contacts 84, 85 and 86 of relays 7V, 6V and 5V respectively, front contact 87 of relay 4V, wire 125, front contact 91 of relay CD, back contact 92 of relay 13NR, back contact 93 of relay 12NR, back contact 94 of relay 11NR, back contact 95 of relay 10NR, front contact 107 of relay SR, wire 129, and winding of relay PC, to (—). The picking up of relay PC causes the fifth impulse to be (+).

The picking up of stepping relay 5V at the end of the fifth impulse, in considering the above selection of controls, causes relay PC to be energized by a circuit closed from (+), through a circuit including front contact 83 of relay C, back contacts 84 and 85 of relays 7V and 6V respectively, front contact 86 of relay 5V, wire 126, front contact 96 of relay CD, back contacts 97, 98, 99 and 100 of relays 13NR, 12NR, 11NR and 10NR respectively, front contact 108 of relay SR, wire 129, and winding of relay PC, to (—). The picking up of relay PC causes the sixth impulse to be (+).

The picking up of stepping relay 6V at the end of the sixth impulse, in considering the above selection of controls, causes the dropping away of relay PC by opening its circuit at back contact 85, and causes relay NC to be energized by a circuit closed from (+), through a circuit including front contact 83 of relay C, back contact 84 of relay 7V, front contact 85 of relay 6V, wire 127, front contact 101 of relay CD, back contacts 102, 103, 109 and 110 of relays 13XR, 12XR, 11XR and 10XR respectively, front contact 111 of relay SR, contact 112 of lever 2SML in a downwardly position, wire 130, and winding of relay NC, to (—). The picking up of relay NC causes the seventh impulse to be (—).

The picking up of stepping relay 7V at the end of the seventh impulse, in considering the above selection of controls, causes relay NC to be energized by a circuit closed from (+), through a circuit including front contact 83 of relay C, front contact 84 of relay 7V, wire 128, front contact 104 of relay CD, back contact 105, 106, 113 and 114 of relays 13XR, 12XR, 11XR and 10XR respectively, front contact 115 of relay SR, contact 116 of lever 3SML in a downward position, and winding of relay NC, to (—). The picking up of relay NC causes the eighth and last impulse of the series to be (—).

It is obvious from the above description that the fifth and sixth impulses are (+), only to provide for the stepping, because the particular track layout shown requires only the last two steps for the transmission of controls for crossovers 2*ts* and 3*ts* respectively. It is therefore apparent that a greater number of switch controls can be transmitted on one cycle, in accordance with the requirements of practice. That is, each impulse following the station code can be used for controlling the track switches for a crossover or a single track switch.

If the operator initiates the transmission of a code for putting a signal to stop by the depression twice of the button for the route at that signal, the polarity of the impulses for the entire series is selected in the same manner as heretofore described in setting up a route. The polarity of the fifth and sixth impulses is, however, the same as the polarity of the seventh and eighth impulses respectively. This is true because a different code is assigned to each route end rather than to each entrance or exit point. Thus the picking up of an entrance relay NR and an exit relay XR, as has been described, for the same route end causes the same code to be selected by each of those relays.

Consider, for example, that the operator has depressed button 10NB twice to cause the picking up of relays 10NR and 10XR, the message to be transmitted under such conditions is code No. 1 of the above code chart. With relay 10NR picked up, the first six impulses are the same as described for transmission of a message for setting up a route from signal 10 to signal 12.

The picking up of stepping relay 6V at the end of the sixth impulse, in the transmission of a message for putting signal 10 to stop, closes a circuit for energizing relay PC from (+), through a circuit including front contact 83 of relay C, back contact 84 of relay 7V, front contact 85 of relay 6V, wire 127, front contact 101 of relay CD, back contacts 102, 103 and 109 of relays 13XR, 12XR and 11XR respectively, front contact 119 of relay 10XR, wire 129, and winding of relay PC, to (—). The picking up of relay PC causes the seventh impulse to be (+).

The picking up of stepping relay 7V at the end of the seventh impulse, in transmitting a message for putting signal 10 to stop, closes a circuit for energizing relay PC from (+), through a circuit including front contact 83 of relay C, front contact 84 of relay 7V, wire 128, front contact 104 of relay CD, back contacts 105, 106 and 113 of relays 13XR, 12XR and 11XR respectively, front contact 114 of relay 10XR, and winding of relay PC, to (—).

It is of course to be understood, as is explained

in detail later, that the transmission of a message for putting a signal to stop also restores the parts of the self-selecting network associated with that route to their normal position.

Having described various conditions relative to the selection of polarities for specific conditions of operation, such operation is to be considered as typical for other similar specific conditions relative to the setting up of other routes, relative to the auxiliary operation of track switches to other positions, and relative to the restoration of other signals to stop.

Stepping and Impulsing at the Control Office.—As has been heretofore pointed out, the stepping and impulsing is accomplished in the same manner as the stepping and impulsing shown in the Judge et al. Patent No. 2,082,544, dated June 1, 1937, to which reference can be made for details of the circuits.

Assuming relay PC to be picked up at the beginning of a control cycle, as is effected when controls are to be transmitted to the field station illustrated in this disclosure, the line circuit is energized from the positive terminal of the battery CB (see Fig. 2), through a circuit including back contact **144** of relay NC, front contact **145** of relay PC, back contact **146** of relay EP, winding of relay F, line wire **20**, winding of relay F^1 (see Fig. 3), a line relay for each of the other field stations included in the line circuit, return line wire **21**, front contact **147** of relay PC (see Fig. 2), and back contact **148** of relay NC to the negative terminal of battery CB.

Whenever relay NC is picked up at the beginning of a control cycle, in accordance with a station selecting code requiring its energization, the line circuit is energized from the negative terminal of battery CB, through a circuit including front contact **148** of relay NC, back contact **145** of relay PC, back contact **146** of relay EP, winding of relay F, line wire **20**, winding of relay F^1 (see Fig. 3), a line relay at each of the other field stations included in the line circuit, return line wire **21**, back contact **147** of relay PC, and front contact **144** of relay NC, to the positive terminal of battery CB.

The energization of control line wire **20** from either the positive or the negative terminal of battery CB, causes polar contact **376** of relay F to close an obvious circuit to cause the picking up of the repeater relay FP, which in turn effects the picking up of relay **2FP**. These relays are all quick acting relays and are positioned in response to each change in the condition of the line circuit. The picking up of relay **2FP** closes an obvious circuit for the energization of relay SA, which in turn closes a circuit for the energization of relay 2SA. Relays SA and 2SA are maintained picked up throughout a cycle of operation due to their slow acting characteristics in combination with the intermittent energization of relay SA when relay **2FP** is picked up.

The picking up of relay SA during the conditioning period at the start of a cycle of operation, closes a circuit for the energization of relay VP from (+), through a circuit including front contact **149** of relay SA, front contact **150** of relay **2FP**, back contact **151** of relay 1V, and winding of relay VP, to (—). The picking up of relay VP closes a stick circuit for maintaining that relay energized during the dropping away of relay **2FP** at the end of the first impulse, from (+), through a circuit including front contact **149** of relay SA, front contact **152** of relay VP, back contact **151** of relay 1V, and winding of relay VP, to (—).

The dropping away of relay **2FP**, at the beginning of the first period of deenergization of the line circuit, closes a second stick circuit for relay VP, from (+), through a circuit including front contact **149** of relay SA, back contact **150** of relay **2FP**, front contact **153** of relay VP, and winding of relay VP, to (—).

The first of the above described stick circuits for relay VP is opened at back contact **151** of relay 1V when relay 1V is picked up during the first period of deenergization of the line circuit, but relay VP is maintained picked up by the second of the above described stick circuits until relay **2FP** is picked up to open back contact **150** during the second period of energization of the line circuit.

The picking up of relay 2SA during the first period of energization of the line circuit closes a circuit for the energization of relay E from (+), through a circuit including front contact **154** of relay 2SA, front contact **155** of relay VP, back contact **156** of relay 1V, and upper winding of relay E, to (—). The picking up of relay E closes an obvious circuit for its repeater relay at front contact **157**, and the picking up of that repeater relay EP opens the line circuit at back contact **146** to mark the end of the first in the series of impulses.

The dropping away of relays FP and **2FP**, as a result of the deenergization of the line circuit, closes a circuit for the energization of the first of the stepping relays, 1V, from (+), through a circuit including front contact **158** of relay SA, back contact **159** of relay **2FP**, front contact **160** of relay VP, back contact **161** of relay 2V, and winding of relay 1V, to (—). A stick circuit is closed for relay 1V, upon the picking up of that relay, from (+), through a circuit including front contact **158** of relay SA, front contact **162** of relay 1V, and winding of relay 1V, to (—). That stick circuit maintains relay 1V picked up throughout the series of impulses. The picking up of relay 1V opens the above described circuit for the energization of relay E at back contact **156** to cause relay E and its repeater relay EP to drop away and again close the line circuit at front contact **146** to effect the energization of the line circuit during a second period, in accordance with the picked up position of either of the relays NC or PC, depending upon the selected polarity for that impulse.

The picking up of relay **2FP** as a result of such energization of the line circuit causes the dropping away of relay VP by the opening of the only circuit for that relay which remains energized, at back contact **150**, thus causing relay VP to drop away and remain in a dropped away position until the next period of energization of the line circuit, at which time it is energized by a pick up circuit closed from (+), through a circuit including front contact **149** of relay SA, front contact **150** of relay **2FP**, back contact **163** of relay 3V, front contact **164** of relay 2V, and winding of relay VP, to (—).

The dropping away of relay VP during the second period of energization of the line circuit closes a circuit for the energization of the lower winding of relay E, from (+), through a circuit including front contact **154** of relay 2SA, back contact **155** of relay VP, back contact **165** of relay 2V, front contact **166** of relay 1V, and lower winding of relay E, to (—). The picking up of relay E causes the picking up of its repeater relay EP to open the line circuit at back contact **146** and mark the end of the second im-

pulse. As a result of the deenergization of the line circuit, the dropping away of relay 2FP closes a circuit for relay 2V from (+), through a circuit including front contact 158 of relay SA, back contact 159 of relay 2FP, back contact 160 of relay VP, back contact 167 of relay 3V, front contact 168 of relay 1V, and winding of relay 2V, to (−). When that relay is picked up, a stick circuit is closed from (+), through a circuit including front contact 158 of relay SA, front contact 169 of relay 2V, and winding of relay 2V, to (−). The picking up of relay 2V opens the above described circuit for relay E at back contact 165 to cause that relay and its repeater relay EP to drop away and close the line circuit to mark the beginning of a third period of energization.

Thus each successive step is provided by the same mode of operation as described for the first two steps for as many steps as are required for the particular conditions encountered in practice; that is, relay VP shifts its position during each period of energization of the line circuit, one stepping relay is picked up during each period of energization of the line circuit, and the relay E is picked up in response to the picking up of each stepping relay and is dropped away in response to the shifting of the relay VP during each period of energization of the line circuit.

When relay VP shifts during the last period of energization of the line circuit of the series of periods transmitted, the last step relay LV is picked up. For the present embodiment of this invention the relay LV is picked up when relay VP drops away during the eighth period of energization of the line circuit, as a result of the energization of a circuit closed from (+), through a circuit including back contact 170 of relay VP, jumper 171, front contact 172 of relay 7V, and winding of relay LV, to (−). A stick circuit is closed upon the picking up of relay LV, from (+), through a circuit including front contact 154 of relay 2SA, front contact 173 of relay LV, and winding of relay LV, to (−). Jumper 171 assumes a position dependent upon the position of the relay VP on the last step provided. If there are an odd number of steps, the jumper 171 is provided as shown connecting back contact 170 of relay VP to the pick up circuit for relay LV, and if an even number of steps are provided the jumper 171 assumes an upper position connecting front contact 170 of relay VP to the pick up circuit for relay LV.

The picking up of relay LV causes the picking up of relay E as a result of the energization of a circuit closed from (+), through a circuit including front contact 154 of relay 2SA, back contact 155 of relay VP, front contact 174 of relay LV, and upper winding of relay E, to (−).

Relay E in picking up causes the picking up of its repeater relay EP, which opens the line circuit at back contact 146 to mark the end of the last in the series of impulses, and to mark the beginning of the clearing out period.

Assuming that the stepping for the above described cycle of operation is for the transmission of controls for setting up a route from signal 10 to signal 12, the picking up of relay EP at the end of the cycle effects the release of relays 10NR, NCH, 12XR, CH and CHP (see Figs. 1A and 1B) by opening their circuits at back contact 135, back contact 133 of relay LV having been opened by the picking up of that relay during the last impulse of the series.

In a similar manner, if a cycle of operation is for the transmission of auxiliary controls for a group of track switches, the picking up of relay EP at the end of the cycle effects the release of relays CH, SR and CHP by opening their circuits at back contact 135. At the end of a cycle of operation for putting signal 10 to stop, the picking up of relay EP effects the release of relays 10NR, NCH, 10XR, CH and CHP by opening their circuits at back contact 135.

The dropping away of relay CHP, under any of the conditions described above, causes the release of relays CD and CDS by opening their circuit at front contact 75, back contact 79 of relay EP having previously been opened by the picking up of that relay at the end of the last impulse.

The dropping away of the line relay F at the end of the last impulse of a series causes the successive release of relays FP, 2FP, SA and 2SA respectively in an obvious manner. The dropping away of relay SA causes the release of all of the stepping relays except relay LV, by opening the stick circuit for those relays at front contact 158 (see Fig. 2); and the dropping away of relay 2SA causes the release of relays LV, E and EP by opening the circuits for relays LV and E at front contact 154.

Field Station Reception of Codes.—In considering the reception of control codes at the field stations, little reference is made to the details of the circuits for the communication part of the system, because such details are included in the above mentioned Judge et al. patent No. 2,082,544. The general mode of operation at a field station in receiving station selecting and control codes will, however, be hereinafter considered.

In response to the energization of the line wires 20 and 21 (see Fig. 2) at the control office, at the start of the first of a series of impulses, relay F^1 (see Fig. 3) is positioned in accordance with the polarity of the impulse, and its repeater relay FP^1 is picked up, irrespective of the polarity of that impulse, when its circuit is closed at polar contact 175 of relay F^1. The picking up of relay FP^1 closes an obvious circuit for relay SA^1, and relay SA^1 in picking up causes the picking up of relay SB^1 by the closure of an obvious circuit.

The positioning of the polar contacts of relay F^1 at the beginning of the impulse also causes the picking up of relays SO^1 and SOS^1, if the line circuit is energized with positive polarity. Relay SOS^1, together with the stick circuit for the lower winding of relay SO^1, provides that relay SO^1 remains picked up during the reception of the station selecting code so long as each character of that code corresponds in character with the position of the code jumpers 176, 177 and 178. The code jumpers illustrated have been positioned for the station selecting code (+) (+) (−). After the code is received, a stick circuit for relay SO^1 is closed throughout the remainder of the cycle of operation, from (+), through a circuit including front contact 179 of relay SB^1, front contact 180 of relay $3V^1$, jumper 181, back contact 182 of relay LV^1, front contact 183 of relay SO^1, and lower winding of relay SO^1, to (−).

Thus, the station illustrated in Fig. 3 is selected for the reception of controls when relay CD (see Fig. 1A) at the control office is picked up. In a similar manner the field station (not shown) which is associated with relay 2CD (see

Fig. 1B) is selected for the reception of controls when relay 2CD is picked up.

The stepping is effected in a manner similar to that described for the stepping relay bank at the control office. Relay VP^1 is picked up during the first period of energization of the line circuit, and shifts in its position during each impulse of the series, provided that the station relay SO^1 is picked up to close front contact 184.

The stepping relays pick up successively, one relay at the end of each impulse, and the last stepping relay LV^1 is picked up at the end of the last impulse of a series by the energization of a circuit closed from (+), through a circuit including front contact 185 of relay SB^1, front contact 184 of relay SO^1, back contact 186 of relay FP^1, back contact 187 of relay VP^1, front contact 188 of relay $7V^1$, and winding of relay LV^1, to (—). After that relay has picked up, a stick circuit is closed from (+), through a circuit including front contact 185 of relay SB^1, front contact 189 of relay LV^1, and winding of relay LV^1, to (—). The stick circuit for relay LV^1 maintains that relay picked up until relay SB^1 is dropped away to open its circuit at front contact 185, and, due to its slow dropping away characteristics, it remains picked up, after its stick circuit is deenergized, long enough to provide an execution period as is hereinafter described.

After a particular station has been selected for the reception of controls, either a positive decoding relay PS or a negative decoding NS is selected for each step in accordance with the polarity of the impulse for that step. For example, a circuit is closed for the energization of relay 8PS, if the eighth impulse of the series is positive in character, from (+), through a circuit including front contact 190 of relay SO^1, polar contact 191 of relay F^1 in a right hand position, front contact 192 of relay $7V^1$, and lower winding of relay 8PS, to (—). The picking up of relay 8PS closes a stick circuit for that relay (see Fig. 4) and (+), through a circuit including front contact 193 of relay SO^1, front contact 194 of relay 8PS, and upper winding of relay 8PS, to (—). Energy is applied to that stick circuit at front contact 195 of relay LV^1 at the end of a control cycle to provide that relay 8PS remains picked up until the end of the execution period.

In a much similar manner, if the eighth impulse is negative in character, a circuit is closed for the energization of relay 8NS (see Fig. 3) from (+), through a circuit including front contact 190 of relay SO^1, polar contact 191 of relay F^1 in a left hand position, front contact 196 of relay $7V^1$, and lower winding of relay 8NS, to (—). The picking up of that relay closes a stick circuit (see Fig. 4) from (+), through a circuit including front contact 193 of relay SO^1, front contact 198 of relay 8NS, and upper winding of relay 8NS, to (—). Energy is applied to that stick circuit at the end of a control cycle by front contact 195 of relay LV^1, for the same purpose as described above.

Thus, the pick up and stick circuits for relays 8PS and 8NS are to be considered as typical of the pick up and stick circuits provided for the other PS and NS relays shown in Fig. 4. Relays 4PS, 5PS, 6PS and 7PS, shown in Fig. 4, are respectively connected to front contacts 199, 200, 201 and 202 of the stepping relays shown in Fig. 3; and the decoding relays 4NS, 5NS, 6NS and 7NS, shown in Fig. 4, are respectively connected to front contacts 203, 204, 205 and 206 of the stepping relays shown in Fig. 3.

Execution of Stored Control Codes.—Having considered how the various codes are received and stored until the end of a control cycle at a particular field station, such as the station illustrated in detail, consideration is now given to the execution of those stored codes at the end of a control cycle.

Inasmuch as the transmission of a control code for setting up a route between signal 10 and signal 12 has been considered as an example of the transmitting means provided, it is to be assumed, for the purpose of illustration, that such a control code is received at the field station illustrated in Fig. 3, and that the code is stored by the relays PS and NS shown in Fig. 4. Such a code corresponds with code No. 3 of the code chart, and causes the picking up of relays 4PS, 5PS, 6PS, 7NS and 8PS respectively.

After relay SA^1 has dropped away at the end of the last of the series of impulses, and before relay LV^1 has had time to drop away, relay $10NR^1$ (see Fig. 4) is picked up as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA^1, front contact 208 of relay LV^1, back contacts 209, 210, 211, 212 and 213 of relays 4NS, 5NS, 6NS, 7PS and 8NS respectively, front contact 214 of relay 4PS, front contact 215 of relay 5PS, front contact 216 of relay 6PS, lower winding of relay $10NR^1$, back contact 217 of relay 10CAR and back contact 218 of relay $10XR^1$, to (—). At the same time a circuit is closed to cause the picking up of relay $12XR^1$ as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA^1, front contact 208 of relay LV^1, back contacts 209, 210, 211, 212 and 213 of relays 4NS 5NS, 6NS, 7PS and 8NS respectively, front contact 214 of relay 4PS, front contact 219 of relay 7NS, front contact 220 of relay 8PS, back contact 221 of relay $12NR^1$, back contact 222 of relay 12CAR, and lower winding of relay $12XR^1$, to (—).

Thus relay $10NR^1$ is picked up to define the entrance point for the route, and relay $12XR^1$ is picked up to define the exit point for that route. The dropping away of relay LV^1 as a result of the opening of its stick circuit at front contact 185 of relay SB^1 (see Fig. 3), opens both of the above described pick up circuits at front contact 208 (see Fig. 4), but relays $10NR^1$ and $12XR^1$ remain in a picked up position by reason of their stick circuits which are hereinafter described when considering the self-selecting network.

In a much similar manner, the execution of control codes for the auxiliary operation of the switch control relays is effected after they have been transmitted from the control office as heretofore described, and after they have been received and stored by the relays PS and NS. To consider an example of the execution of codes for the auxiliary operation of the track switches, assume the operator to have effected the transmission of control code No. 20 of the code chart. When such a code is received at the field station, relays 4NS, 5PS, 6PS, 7NS and 8NS are picked up.

After relay SA^1 has dropped away at the end of the last of that series of code impulses, and before relay LV^1 has had time to drop away, relay 2R is picked up as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA^1, front contact 208 of relay LV^1, back contacts 223,

210, 211, 212 and 224 of relays 4PS, 5NS, 6NS, 7PS and 8PS respectively, front contact 225 of relay 4NS, front contact 226 of relay 8NS, front contact 227 of relay 2AN, lower winding of relay 2R and back contact 228 of relay 2BN, to (—). At the same time a circuit is also closed to cause the picking up of relay 3R as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA1, front contact 208 of relay LV1, back contacts 223, 210, 211, 212 and 224 of relays 4PS, 5NS, 6NS, 7PS and 8PS respectively, front contact 225 of relay 4NS, front contact 229 of relay 7NS, back contact 230 of relay 3AN, lower winding of relay 3R, and back contact 231 of relay 3BN, to (—). Relay WS is also picked up at the same time, as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA1, front contact 208 of relay LV1, back contacts 223, 210, 211, 212 and 224 of relays 4PS, 5NS, 6NS, 7PS and 8PS respectively, front contact 225 of relay 4NS, and lower winding of relay WS, to (—). It is obvious in considering the circuit for relay WS that the circuit is closed whenever the fourth impulse in the control code is (+) (+) (—) (—), irrespective of the particular switch control relays to be picked up.

The picking up of relays 2R and 3R, under the above conditions, causes the positioning of their associated track switches in a manner to be hereinafter described when considering the details of the switch control circuits. Relay WS is maintained in a picked up position by a stick circuit as described hereinafter when considering the transmission of indications.

If the operator causes the transmission of a control code for putting a signal to stop and causing the restoration of the network associated with that route, such a control code is executed at the end of the control cycle to cause the picking up of a cancel relay CAR. To consider an example of such operation, assume the operator to have caused the transmission of control code No. 1 of the code chart, for putting signal 10 to stop and restoring the self-selecting network associated with the route emanating from that signal. When that control code is received the code storing relays 4PS, 5PS, 6PS, 7PS and 8PS are picked up.

After relay SA1 has dropped away at the end of the last of that series of impulses, and before relay LV1 has had time to drop away, relay 10CAR is picked up as a result of the energization of a circuit closed from (+), through a circuit including back contact 207 of relay SA1, front contact 208 of relay LV1, back contacts 209, 210, 211, 232 and 213 of relays 4NS, 5NS, 6NS, 7NS and 8NS respectively, front contact 214 of relay 4PS, front contact 215 of relay 5PS, front contact 216 of relay 6PS, winding of relay 10CAR, front contact 233 of relay 8PS, and front contact 234 of relays 7PS, to (—). Relay 10CAR in a picked up position opens the pick up circuit for relay 10NR1 at back contact 217 and also opens the stick circuit for the upper winding of relay 10NR1 as shown in Fig. 5 and as hereinafter described when considering the details of the restoration to normal of signal 10 and the self-selecting network relays associated with the route emanating from that point. The dropping away of relay LV1 as a result of the opening of its stick circuit at front contact 185 of relay SB1 (see Fig. 3), opens the circuit for the cancel relay CAR at front contact 208 and causes that relay to drop away.

Self-selecting network.—Having heretofore described how the entrance and exit relays at the field stations are picked up in accordance with the designation of corresponding entrance and exit points at the control office, how the switch control relays at the field stations are picked up in accordance with the operation of corresponding auxiliary switch control levers, and how the cancel relays CAR at the field stations are picked up in accordance with the operation of corresponding entrance buttons at the control office for putting signals to stop, consideration is now given to the means provided at the field stations for governing the track switches and signals in accordance with the reception of such controls.

To consider an example of how a route is set up in accordance with designated entrance and exit points, assume relays 10NR1 and 12XR1 to be picked up during the execution period at the end of a control cycle when the track layout is unoccupied by a train and when the heretofore described normal conditions exist for the network system as illustrated in Fig. 5. Under such conditions relay 10XR1 is also picked up (see Fig. 5) as a result of the energization of an obvious circuit for its upper winding closed at front contact 235 of relay 10NR1.

After relay 10NR1 has been picked up during the execution period, it is maintained in a picked up position by the energization of a stick circuit closed from (+), through a circuit including front contact 236 of relay 5T, back contact 237 of relay 10CAR, front contact 238 of relay 10NR1, and upper winding of relay 10NR1, to (—). Energy is also applied to that stick circuit whenever the track repeater relay 5TP is in a dropped away position to apply energy to that stick circuit at back contact 239 connected in multiple with front contact 236 of relay 5T. The combination of front contact 236 of relay 5T and back contact 239 of relay 5TP to provide energy for the stick circuit for the entrance relay 10NR1 provides that the stick circuit is momentarily opened for sufficient time to cause relay 10NR1 to drop away when the train enters track section 5 upon passing signal 10.

A stick circuit is closed during the execution period, for relay 12XR1 from (+), through a circuit including front contact 235 of relay 10NR1, front contact 300 of relay 10XR1, back contact 240 of relay 2R, back contact 241 of relay 3R, front contact 242 of relay 12XR1, and upper winding of relay 12XR1, to (—). It is obvious from the above described circuits that relays 10XR1 and 12XR1 are maintained picked up dependent upon front contact 235 of relay 10NR1, thus providing that they are dropped away as soon as relay 10NR1 is dropped away, except when they are maintained picked up by the approach and route locking as hereinafter described.

As a result of the picking up of relays 10XR1 and 12XR1 relay 2AN is picked up by the energization of a circuit closed from (+), through a circuit including front contact 243 of relay 10XR1, upper winding of relay 2AN, back contact 244 of relay 2R, back contact 245 of relay 3R, and front contact 246 of relay 12XR1, to (—). A circuit is also closed at the same time for relay 3AN from (+), through a circuit including front contact 243 of relay 10XR1, back contact 247 of relay 2R, upper winding of relay 3AN, back contact 248 of relay 3R, and front contact 246 of relay 12XR1, to (—). The above described circuits for relays 2AN and 3AN provide that they are maintained picked up as long as relays 10XR1 and 12XR1 are

picked up to close front contacts 243 and 246 respectively.

To consider another example of how a route is set up by the self-selecting network, assume the operator to initiate the setting up of a route from signal 10 to signal 13 at a time when that route is available. When such controls are received at the field station, relays 10NR¹ and 13XR¹ are picked up during the execution period at the end of the control cycle. Relay 10NR¹ is maintained by a stick circuit as heretofore described, and the picking up of that relay also causes the picking up of relay 10XR¹ by the energization of an obvious circuit. A stick circuit is closed for maintaining relay 13XR¹ picked up, dependent upon relay 10NR¹, from (+), through a circuit including front contact 235 of relay 10NR¹, front contact 389 of relay 10XR¹, back contact 285 of relay 2AN, back contact 286 of relay 2BN, back contact 287 of relay 3R, front contact 288 of relay 13XR¹, and upper winding of relay 13XR¹, to (−).

The picking up of relay 13XR¹ causes the picking up of relay 3BN by the energization of a circuit closed from (+), through a circuit including back contact 360 of relay 3R, upper winding of relay 3BN, and front contact 359 of relay 13XR¹, to (−). The picking up of relay 3BN closes a circuit for relay 2R from (+), through a circuit including front contact 243 of relay 10XR¹, back contact 361 of relay 2AN, upper winding of relay 2R, back contact 362 of relay 2BN, and front contact 363 of relay 3BN, to (−). The track switches 2TSA and 2TSB are operated to a reverse position in accordance with the picking up of relay 2R, and the track switches 3TSA and 3TSB are operated to a normal position in accordance with the picking up of relay 3BN.

Thus it is obvious that each available route can be set up by a similar mode of operation, irrespective of the direction of traffic, and irrespective of the character of the particular track layout.

The relays of the self-selecting network are so interlocked that no route can be set up which conflicts with a route already set up, although the controls for such a route can be transmitted from the control office. For example, consider the operator to transmit controls for the setting up of a route from signal 10 to signal 13 when there is a route already set up from signal 10 to signal 12. Relay 13XR¹ is picked up during the execution period of that control cycle, but it is dropped away at the end of that period because its stick circuit is opened at back contact 285 of relay 2AN. Relay 3BN can be energized when relay 13XR¹ is picked up, because the track switches 3TSA and 3TSB are in a normal position in accordance with the picked up position of relay 3AN for the route previously set up, but the picking up of relay 3BN cannot cause the picking up of relay 2R because relay 2AN is picked up to open that circuit at back contact 361. Thus no two conflicting switch control relays can be picked up at the same time and no two conflicting routes can be set up at the same time.

When the relays for the entrance end to a route are picked up, but that route cannot be completed, the operator causes the restoration of those relays in the same manner in which he causes the restoration of a signal to stop and its associated network relays.

The stick circuit for the XR¹ relays are so selected that the response of the AN, BN and R relays so breaks up the network circuit selections that the relays for the ends to each route are maintained dependent upon the route locking, approach locking and the entrance relay for that route only, irrespective of the number of parallel routes set up through that track layout at the same time.

Inasmuch as the self-selecting network is an improvement over the self-selecting network shown in a prior Phinney and Hitchcock application Ser. No. 183,272, filed January 4, 1938, reference can be made to that application for a more detailed description of the network system, and for an illustration of how the system can be applied to more complex track layouts.

Switch control.—After having considered how the switch control relays AN, BN and R can be picked up in the self-selecting network in accordance with the defining of the route ends, and after having considered how those relays can also be picked up by the operation of auxiliary switch control levers at the control office, consideration will now be given to further details in the control of the track switches for one of the crossovers as typical of the controls provided for other track switches included in the present embodiment of the invention and other track switches to be provided in accordance with the requirements of practice.

With reference to Fig. 6, consider, for example, that relay 2AN has been picked up as a result of the defining of a route from signal 10 to signal 12 as heretofore described, and that the normal conditions exist at the time relay 2AN is picked up as heretofore described and as shown in Fig. 6 of the accompanying drawings.

The picking up of relay 2AN, under the above conditions, closes a circuit for the polar neutral switch control relay 2WZ, from (+), through a circuit including front contact 249 of relay 6T, front contact 250 of relay 5T, front contact 251 of relay 2L, front contact 252 of relay 2AN, and upper winding of relay 2WZ, to (−). The picking up of relay 2WZ, due to such energization, applies energy of a particular polarity to the switch machine 2SM to cause its operation to a normal position by the energization of an obvious circuit including front contact 253 of relay 2WZ.

After the track switch has completed its operation to a normal position, or provided the track switch is already in a normal position as illustrated, correspondence relay 2NCR is picked up by the energization of a circuit closed from (+), through a circuit including back contact 254 of relay 2R, front contact 255 of relay 2AN, winding of relay 2NCR, back contact 256 of relay 2RCR, polar contact 257 of relay 2WP in a right hand position, and front contact 258 of relay 2WP, to (−). The picking up of relay 2NCR opens the heretofore described stick circuit for the lock relay 2L at back contact 33 to cause that relay to drop away and close the branch of the signal control circuit associated with that crossover.

If, however, the operator initiates the setting up of a route from 11 to either 12 or 13, at a time when the heretofore described normal conditions exist, relay 2BN is picked up in accordance with the self-selecting network, and in picking up it causes the operation of the switch machine 2SM to a normal position by the energization of the same circuits described in considering the operation of the switch machine 2SM in accordance with the picking up of relay 2AN. The difference in the circuits being that the circuit for relay 2WZ is closed at front contact 260 of relay 2BN instead of at front contact 252 of relay 2AN, and

the circuit for relay 2NCR is closed at front contact 261 of relay 2BN instead of at front contact 255 of relay 2AN.

If, however, the operator defines a route requiring the track switches 2TSA and 2TSB to be operated to their reverse positions, such as the defining of a route from signal 10 to signal 13, relay 2R is picked up by the self-selecting network, provided that route does not conflict with a route already set up.

Assuming that relay 2R is picked up under such conditions, with the lock relay normally energized as heretofore described, a circuit is closed for the energization of relay 2WZ with reverse polarity from (+), through a circuit including front contact 249 of relay 6T, front contact 250 of relay 5T, front contact 251 of relay 2L, front contact 259 of relay 2R, and lower winding of relay 2WZ, to (—). The picking up of relay 2WZ, due to energization with reverse polarity, causes the operation of the switch machine 2SM to a reverse position when energy is applied at front contact 253 and the polar contacts are operated to a left hand position. After the track switches 2TSA and 2TSB have been operated to their reverse positions in accordance with the reverse controls provided, a circuit is closed for the energization of the reverse correspondence relay 2RCR from (+), through a circuit including front contact 254 of relay 2R, back contact 262 of relay 2NCR, winding of relay 2RCR, polar contact 257 of relay 2WP in a left hand position, and front contact 258 of relay 2WP, to (—). The picking up of relay 2RCR, due to such energization, causes the dropping away of the lock relay 2L by the opening of its stick circuit at back contact 34. When relay 2RCR is picked up and relay 2L is dropped away the branch of the signal control circuit associated with track switches 2TSA and 2TSB is closed for the route being set up from signal 10 to signal 13.

When considering the execution of the control codes received for the auxiliary operation of the track switch, it has been described how relays 2R and 2AN can be picked up in accordance with the code received. Such pick up circuit is closed only during the execution period, and whichever one of those relays is picked up during that period is dropped away when that pick up circuit is opened by the dropping away of relay LV^1. Because relays 2AN and 2R are only momentarily picked up upon the reception of auxiliary switch controls, a stick circuit is provided for relay 2WZ to provide that after it has been picked up as a result of the picking up of either of relays 2AN or 2R, it remains in a picked up position until the track switch has completed its operation. Thus if relay 2AN is picked up when a code is received for the auxiliary operation of switch machine 2SM, relay 2WZ is picked up by the energization of the same circuit heretofore described to cause the switch machine 2SM to be operated to a normal position. If the track switch is in a normal position as has been illustrated, relay 2WZ is dropped away at the end of the execution period as a result of the opening of its pick up circuit at front contact 252 of relay 2AN. If, however, the track switches 2TSA and 2TSB are in their reverse position when relay 2AN is picked up to cause their operation to a normal position, the polar contacts of the switch repeater relay 2WP are in a left hand position and out of correspondence with the polar contacts of the relay 2WZ which are in a right hand position. Under such conditions a stick circuit is closed for relay 2WZ to provide that that relay remains picked up after the execution period has ended, until the track switches 2TSA and 2TSB have been operated to a reverse position and locked. Such a stick circuit is closed from (+), through a circuit including front contact 249 of relay 6T, front contact 250 of relay 5T, front contact 251 of relay 2L, polar contact 263 of relay 2WP in a left hand position, polar contact 264 of relay 2WZ in a right hand position, front contact 265 of relay 2WZ, polar contact 266 of relay 2WZ in a right hand position, and upper winding of relay 2WZ, to (—). After the track switches 2TSA and 2TSB have been operated to their full reverse positions and locked, relay 2WP is picked up with a polarity that causes the operation of its polar contacts to a right hand position to open the stick circuit for relay 2WZ at polar contact 263 of relay 2WP in a left hand position.

A similar stick circuit is closed to maintain relay 2WZ picked up until the track switches 2TSA and 2TSB have been operated to a reverse position from a normal position when relay 2R has been picked up to cause the picking up of relay 2WZ when energized with reverse polarity. Such a stick circuit is closed from (+), through a circuit including front contact 249 of relay 6T front contact 250 of relay 5T, front contact 251 of relay 2L, polar contact 263 of relay 2WP in a right hand position, polar contact 264 of relay 2WZ in a left hand position, front contact 265 of relay 2WZ, polar contact 266 of relay 2WZ in a left hand position, and lower winding of relay 2WZ, to (—).

Means are also provided whereby relay 2WZ is maintained picked up until the track switch has been operated to a locked position if it should happen that the track switches should become unlocked to cause the dropping away of relay 2WP, but under conditions where the polar contacts of relays 2WZ and 2WP remain in correspondence. Under such conditions relay 2WZ is maintained picked up, if energized, for the operation of the switch machine 2SM to a normal position, by the energization of a stick circuit closed from (+), through a circuit including front contact 249 of relay 6T, front contact 250 of relay 5T, front contact 251 of relay 2L, back contact 267 of relay 2WP, front contact 265 of relay 2WZ, polar contact 266 of relay 2WZ in a right hand position, and upper winding of relay 2WZ, to (—). After the track switches have completed their operation to a normal locked position relay 2WP is picked up to open the stick circuit for relay 2WZ at back contact 267 and cause that relay to drop away. In a similar manner a stick circuit is provided for the lower winding of relay 2WZ, under similar conditions in which the polar contacts of relay 2WP are in a left hand position and relay 2WZ has been picked up when energized with reverse polarity. Under such conditions the stick circuit is closed from (+), through a circuit including front contact 249 of relay 6T, front contact 250 of relay 5T, front contact 251 of relay 2L, back contact 267 of relay 2WP, front contact 265 of relay 2WZ, polar contact 266 of relay 2WZ in a left hand position, and lower winding of relay 2WZ, to (—).

After the track switches 2TSA and 2TSB have completed their operation and become locked by the dropping away of relay 2L, that lock relay can be again picked up only after all of relays 2AN, 2BN and 2R have been restored to their nor-

mally deenergized position. Those relays, however, are maintained picked up, after having been picked up in setting up a route, by the route locking and approach locking and by the entrance relays. It is therefore necessary that a route must either be restored by the operator or released by the passage of a train before the AN, BN or R relay picked up for each track switch included in that route can be released.

Thus, relay 2L can be picked up only when the relays 2AN, 2BN and 2R are in a dropped away position, and when the associated track and approach locking relays are picked up. Under such conditions, the pick up circuit for relay 2L is closed from (+), through a circuit including back contact 254 of relay 2R, back contact 255 of relay 2AN, back contact 261 of relay 2BN, back contact 34 of relay 2RCR, back contact 33 of relay 2NCR, winding of relay 2L, front contact 32 of relay 5T, front contact 31 of relay 10ALS, front contact 30 of relay 6T, front contact 29 of relay 11ALS, front contact 28 of relay 12ALS, and front contact 27 of relay 13ALS, to (−).

In accordance with the typical switch control circuit illustrated in Fig. 6, the lock relay 2L can be picked up only when the relays 2AN, 2BN and 2R are all in their dropped away positions. This feature of the control of the lock relay 2L, combined with the features in the control of the switch control relays 2AN, 2BN and 2R provides what is conveniently called "lever lock equivalent". That is, the switch control relays associated with the self-selecting network must be restored to their dropped away position after having been picked up and must remain in a dropped away position until the track switch can safely be operated to another position before that track switch can be again unlocked. Such a mode of operation provides that the operator cannot precondition a route, that is, he can set up a route only when that route is available at the time when the defining of that route is received at the field station.

Signal controls.—After having considered how a particular route is selected by the self-selecting network, and how the track switches are operated to a position corresponding with the designated route and are locked, consideration can now be given to the means provided for controlling the signals in accordance with the setting up of routes.

Consider, for example, that the operator has caused the setting up of a route from signal 10 to signal 12, and that the correspondence relays 2NCR and 3NCR have been picked up after their associated track switches have completed their operation, and assume that the lock relays 2L and 3L have been dropped away as a result of the completion of such operation.

Under such conditions, with signal 12 normally at stop, a circuit is closed for the energization of signal 10 (see Fig. 5) to cause that signal to clear, from (+), through a circuit including front contact 268 of relay 12M, back contact 269 of relay 12NR^1, front contact 270 of relay 12XR^1, front contact 271 of relay 3NCR, back contact 272 of relay 3L, back contact 273 of relay 2L, front contact 274 of relay 2NCR, front contact 275 of relay 10XR^1, front contact 276 of relay 10NR^1, and mechanism of signal 10, to (−). When a train accepts that signal, relay 10CNR^1 is dropped away to cause signal 10 to be restored to stop by opening its circuit at front contact 276.

In a similar manner signal 10 can as well be cleared when a route is set up from signal 10 to signal 13. Under such conditions signal 10 is cleared when signal 13 is at stop and a circuit is closed from (+), through a circuit including front contact 277 of relay 13M, back contact 278 of relay 13NR^1, front contact 279 of relay 13XR^1, front contact 280 of relay 3NCR, back contact 281 of relay 3L, back contact 282 of relay 2L, front contact 283 of relay 2RCR, front contact 275 of relay 10XR^1, front contact 276 of relay 10NR^1, and mechanism of signal 10, to (−). It is obvious from the circuits described as typical, that each of the signals can be cleared after a route has been set up emanating from that point, and that each of the signals is restored to stop when a train accepts that signal.

Approach and Route Locking.—In considering the mode of operation of the self-selecting network in setting up a route, it has been pointed out that the exit relays are picked up for the ends of each route set up, and that they remain picked up dependent upon the entrance relay which is restored as soon as the approaching train accepts the signal associated with that route. Those exit relays are, however, maintained energized after the entrance relay has been dropped away when a train enters that route, and they are maintained picked up as long as any part of that route is occupied. Such energization is provided by track contacts connected to the stick circuit for the exit relays.

To consider an example of how the route is locked so long as it is occupied by a train, assume a route to be set up from signal 10 to signal 12, and assume a train to have accepted signal 10 and entered that route. Relay 10NR^1 (see Fig. 5) is dropped away by the interruption in its stick circuit when track relay 5T drops away and opens front contact 236 prior to the closing of back contact 239 of track repeater relay 5TP. The dropping away of relay 5T closes a stick circuit for relay 10XR^1 from (+), through a circuit including back contact 284 of relay 5T, front contact 380 of relay 10XR^1, and upper winding of relay 10XR^1, to (−); and the dropping away of relay 5T also closes a stick circuit for relay 12XR^1 from (+), through a circuit including back contact 284 of relay 5T, back contact 240 of relay 2R, back contact 241 of relay 3R, front contact 242 of relay 12XR^1, and upper winding of relay 12XR^1, to (−).

When the train leaves track section 5, under the above assumed conditions, those stick circuits are opened by the picking up of relay 5T at back contact 284 to cause the dropping away of relays 10XR^1 and 12XR^1.

The route locking is effective in a similar manner for each of the other routes included in the interlocking plant such as for a route from the signal 10 to signal 13. When a route has been set up from signal 10 to signal 13, and after a train has passed signal 10 to cause the dropping away of relay 5T, the stick circuit is closed for relay 10XR^1, as described above, and a stick circuit is also closed for relay 13XR^1 from (+), through a circuit including back contact 284 of relay 5T, back contact 285 of relay 2AN, back contact 286 of relay 2BN, back contact 287 of relay 3R, front contact 288 of relay 13XR^1, and upper winding of relay 13XR^1, to (−). As the train progresses through the route set up, and enters track section 6 to cause the dropping away of relay 6T, new stick circuits are closed

for relays 10XR¹ and 13XR¹. The dropping away of relay 6T closes a stick circuit for relay 10XR¹ from (+), through a circuit including back contact 289 of relay 6T, back contact 287 of relay 3R, back contact 286 of relay 2BN, back contact 285 of relay 2AN, front contact 380 of relay 10XR¹, and upper winding of relay 10XR¹, to (−). A stick circuit is also closed for relay 13XR¹ from (+), through a circuit including back contact 289 of relay 6T, front contact 288 of relay 13XR¹, and upper winding of relay 13XR¹, to (−).

In order to provide that a train has sufficient time to either come to a stop before passing an entering signal which it is approaching, after that signal is restored from clear to stop, or to allow that train to enter the interlocking plant to make the route locking effective, an approach locking relay is provided for each signal to provide that a conflicting route can be set up after a signal has been restored by the operator, only after a predetermined time, provided there is a train approaching that entering signal.

With reference to Fig. 6, the details of the circuit control for approach locking relay 10ALS have been shown. Such controls are to be considered as typical of the controls provided for each of the other approach locking relays which have, for simplicity, been illustrated only in block form.

To consider an example of the mode of operation of the system with respect to the approach locking assume a route to be set up from signal 10 to signal 12 which causes the clearing of signal 10. The clearing of signal 10 causes the dropping away of signal repeater relay 10M by opening the circuit for that relay at contact 24. The dropping away of relay 10M causes the dropping away of relay 10ALS by opening its circuit at front contact 25.

When relay 10ALS drops away it closes a stick circuit for relay 10XR¹ from (+), through a circuit including back contact 291 of relay 10ALS, (see Fig. 5) front contact 380 of relay 10XR¹, and upper winding of relay 10XR¹, to (−). A stick circuit is also closed by the dropping away of relay 10ALS for relay 12XR¹ from (+), through a circuit including back contact 291 of relay 10ALS, back contact 240 of relay 2R, back contact 241 of relay 3R, front contact 242 of relay 12XR¹, and upper winding of relay 12XR¹, to (−). Stick circuits are thus provided for the exit relays whenever the approach locking relay for the entering signal is dropped away, thus maintaining the route set up so as to prevent the setting up of conflicting routes until the end of a predetermined time interval when the approach locking relay is again picked up.

To consider an example of how the approach locking relay is picked up when the track sections involved are unoccupied, assume the operator to restore a route set up from signal 10 to signal 12 and set up a conflicting route, such as a route from signal 11 to signal 12, he can cause the transmission of a code for restoring signal 10 to stop as heretofore described. The details of such restoration at the field stations will be hereinafter considered, but for the purpose of illustration in connection with the approach locking, assume signal 10 to be put to stop when the code is received, so as to cause the picking up of signal repeater relay 10M when the signal at stop contact 24 is closed. The picking up of relay 10M applies pick up energy to relay 10ALS upon closing a circuit from (+), through a circuit including front contact 25 of relay 10M (see Fig. 6), front contact 290 of relay 7T, and winding of relay 10ALS, to (−). The picking up of relay 10ALS, opens the stick circuits for relays 10XR¹ and 12XR¹ at back contact 291 (see Fig. 5).

The opening of those stick circuits by the picking up of relay 10ALS allows the setting up of a conflicting route, such as from signal 11 to signal 12.

If, however, a train had been approaching signal 10 at the time when the operator caused the restoration of that signal to stop, and if that train had occupied track section 7 (see Fig. 6) so as to cause the dropping away of relay 7T, the above described pick up circuit for relay 10ALS would be opened at front contact 290, and the picking up of that relay could be effected only after the associated thermal relay 10THR had completed its operation. When signal 10 is restored to stop, under such conditions, the picking up of relay 10M closes a circuit for the thermal relay 10THR, from (+), through a circuit including front contact 25 of relay 10M, winding of thermal relay 10THR, and back contact 26 of relay 10ALS, to (−). After the thermal relay has sufficiently heated its contact, a pick up circuit is closed for relay 10ALS, from (+), through a circuit including front contact 25 of relay 10M, contact 292 of thermal relay 10THR, and winding of relay 10ALS, to (−). The picking up of relay 10ALS opens the above described circuit for the winding of thermal relay at back contact 26, and closes its normal energized stick circuit at front contact 26. The picking up of approach locking relay 10ALS under such conditions of course releases relays 10XR¹ and 12XR¹ and allows the setting up of a conflicting route, such as from signal 11 to signal 12.

In order to prevent unnecessary operation of the thermal relay 10THR, the approach locking relay 10ALS is picked up as soon as the signal at stop repeater relay 10M is picked up when a train enters the interlocking plant to cause the dropping away of track relay 5T. Such a pick up circuit is closed from (+), through a circuit including front contact 25 of relay 10M, front contact 293 of relay 5T, and winding of relay 10ALS, to (−).

It is, of course, to be understood that other forms of approach and route locking can be used in accordance with the requirements of practice, all within the scope of the present invention with respect to the remote control of interlocking plants.

Restoration to Normal.—It has been pointed out how the operator can effect the transmission of a control code for causing the restoration of a signal to stop, and for causing the restoration of the parts of the network associated with that route, and it has also been pointed out how such a code is received at a field station and how a cancel relay CAR associated with the signal to be put to stop is picked up during the execution period. Consideration can now be given to the manner in which complete restoration of a route is effected in accordance with the picking up of a cancel relay CAR.

Assume, for example, that a code has been received for the restoration of signal 10 from a clear position to a stop position after a route has been set up from signal 10 to signal 12. Under such conditions relay 10CAR is picked up during execution period at the end of the control cycle,

and in picking up it opens the pick up circuit for relay 10NR[1] at back contact 217 (see Fig. 4) and it also opens the stick circuit for relay 10NR[1] at back contact 237 (see Fig. 5). Relay 10NR[1] is thus caused to drop away and open the circuits for relays 10XR[1] and 12XR[1] at front contact 235. Energy is still applied to the circuits for relays 10XR[1] and 12XR[1], however, at back contact 291 of approach locking relay 10ALS. The dropping away of relay 10NR[1] opens the circuit for signal 10 at front contact 276, and that signal in going to stop causes energization of relays 10M (see Fig. 6) and 10ALS respectively. The picking up of relay 10ALS opens the stick circuits heretofore described for relay 10XR[1] at back contact 291 and causes those relays to drop away. Relays 10XR[1] and 12XR[1] in dropping away cause the dropping away of relays 2AN and 3AN by opening their circuits at front contacts 243 and 246 of relays 10XR[1] and 12XR[1] respectively. The dropping away of relays 2AN and 3AN causes the picking up of relays 2L and 3L to complete the restoration of the signal and the relays associated with the route from signal 10 to signal 12.

Having thus described the means by which the system associated with a route is restored by the operator, it is obvious that a similar mode of operation is effected when relay 10NR[1] is dropped away when a train enters track section 5 upon accepting signal 10. The restoration of the exit relays 10XR[1] and 12XR[1] upon the passage of a train is delayed, as pointed out in considering the approach and route locking, but after such delay the network relays are restored as described above.

It is to be understood that each of the other signals can be restored, together with the route with which they are associated in a similar manner.

Communication of Indications.—In considering the communication of indications from the track layouts to the control office, the means provided for initiating the transmission of the indications, and the means provided at the control office for selecting and displaying such indications will be described in detail; but the communication of the indications from the field stations to the control office will be considered only in a general manner, because the details of such communication are similar to the details shown and described in the above mentioned Judge et al. Patent No. 2,082,544, dated June 1, 1937. Inasmuch as the relays illustrated in this disclosure have reference characters similar to corresponding parts of that patent, the description included in that patent can be readily applied to similar parts of this disclosure.

When a change occurs in the position of certain devices at a field station, such as at the field station illustrated in detail, the communication system is set into operation for the transmission of indications, provided that the system is available for the transmission of those indications. If the system is not available at the time the change occurs, the transmission of those indications is effected as soon as that station can gain control of the line circuit. The lockout relay LO[1] picks up at the field station illustrated in Fig. 3, when that station starts to transmit. That relay when picked up, locks out all more distant field stations that may have initiated the transmission of indications at the same time.

Relay LO[1], in picking up, closes the indication line circuit including line wires 22 and 23 illustrated in Figs. 2 and 3. The closing of the line circuit under such conditions, causes the picking up of relay MB (see Fig. 2) at the control office. Relay MB, when picked up, closes a circuit for relay FC (see Fig. 1B), and the picking up of relay FC causes the transmission of a series of impulses to operate the stepping during the indication cycle.

The indication line circuit is selectively opened or closed during each impulse and during each time space between impulses at the station transmitting. Relay PB[1] (see Fig. 3) selectively governs the indication line circuit during the "off" periods, and relay PF[1] selectively governs the indication line circuit during the "on" periods. At the control office, relay MB (see Fig. 2) responds to the closed indication line circuit during the "off" periods, and relay MF responds to the closed indication line circuit during the "on" periods.

As has heretofore been described when considering the normal conditions of the system, relay CH[1] is normally maintained picked up by its stick circuit. Ordinarily, in most coded centralized traffic controlling systems, a change in the position of any track switch interrupts that stick circuit and causes the start of an indication cycle. It is desirable, however, in an interlocking plant controlled over a code type communication system from a distant point, that the transmission of indications be delayed when setting up a route, until the entering signal for that route is cleared. Such delay provides that all of the indications for the route can be transmitted on one cycle of operation, and that the indication facilities are used to best advantage.

To consider an example of the above described mode of operation, assume the operator has caused the transmission of a control code defining signal 10 as an entrance point and signal 12 as an exit point. The picking up of relay 10XR[1] after the execution of such controls does not open the stick circuit for relay CH[1] (see Fig. 7) because a shunt circuit is closed around contact 47 of relay 10XR[1] in that stick circuit, from contact 46 of relay 11XR[1], through a circuit including back contact 294 of relay 2AN, back contact 295 of relay 2R, front contact 48 of relay CH[1], and upper winding of relay CH[1], to (—). Thus the picking up of relay 10XR[1] does not effect the dropping away of the change relay CH[1] to start the transmission of an indication cycle. In a similar manner that stick circuit is maintained during the picking up of relay 12XR[1] by a shunt circuit closed around contact 37 of relay 12XR[1] from (+), through a circuit including contact 36 of relay 13XR[1], back contact 296 of relay 3R, and back contact 297 of relay 3AN, to contact 38 of relay 12M. Such a shunt circuit provides that relay 12XR[1] in picking up does not cause the dropping away of relay CH[1].

In accordance with the picking up of relays 10XR[1] and 12XR[1], relays 2AN and 3AN are picked up (see Fig. 5) as heretofore described when considering the operation of the self-selecting network. In response to the picking up of relays 2AN and 3AN, relays 2WZ and 3WZ respectively are positioned in accordance with the typical switch control circuit illustrated in Fig. 6. The picking up of relays 2WZ and 3WZ cause the operation of switch machines 2CM and 3SM respectively, which in turn cause the respective dropping away of relays 2WP and 3WP. The dropping away of relays 2WP and 3WP, however, does not cause the dropping away of the change relay CH[1] (see Fig. 7) because a shunt

circuit is closed around contacts 41 and 40 of those relays in the stick circuit for relay CH¹, from contact 39 of relay 13M through a circuit including back contact 293 of relay WS to back contact 42 of relay 5T. Relay WS is in a dropped away position under such conditions, because that relay is picked up only during the reception of auxiliary track switch controls. Thus the operation of the track switches in setting up a route which has been defined by the picking up of relays for the opposite ends of that route, is not effective for dropping away relay CH¹ to start the transmission of indications.

After the route from signal 10 to signal 12 has been completely set up to cause the clearing of signal 10, the clearing of that signal causes the dropping away of signal repeater relay 10M, which, in dropping away, interrupts the stick circuit for relay CH¹ at contact 45. Relay CH¹ drops away under such conditions and initiates the transmission of an indication cycle.

As soon as the first of the stepping relays 1V¹ is picked up during the transmission of the indication cycle thus initiated, relay CH¹ is again picked up when its pick up circuit is energized from (+), through a circuit including back contact 398 of relay 2V¹, front contact 299 of relay 1V¹, front contact 300 of relay LO¹, and lower winding of relay CH¹, to (−). It is obvious that the pick up circuit for relay CH¹ is closed only momentarily, because it is opened at back contact 398 as soon as the second stepping relay 2V¹ is picked up.

Having thus described how the initiation of an indication cycle is effected after a route has been set up, by the clearing of the signal, assume an approaching train to accept signal 10, when a route is set up as described above. When that train enters track section 5 to cause the dropping away of relay 5T, the dropping away of that relay interrupts the stick circuit for relay CH¹ when front contact 43 of relay 5T is opened, to cause the initiation of an indication cycle. The dropping away of relay 5T also causes the dropping away of relay 10NR¹ (see Fig. 5) and the dropping away of relay 10NR¹ causes the restoration of signal 10 to stop by opening its circuit at front contact 276. When signal 10 is restored to stop, the signal repeater relay 10M is picked up. The restoration of signal 10 and the picking up of repeater relay 10M is effected prior to the end of the conditioning period of the communication system for the indication cycle initiated by the dropping away of relay 5T, thus providing that the indication cycle initiated when a train accepts the entering signal includes an indication of the restoration of that signal to stop.

When the train leaves the route, under the above assumed conditions, and track relay 5T is again picked up, relay CH¹ detects that change in the position of the contacts of relay 5T and initiates an indication cycle. Such an indication cycle describes the route from signal 10 to signal 12 as having been restored to normal.

To consider another condition under which the initiation of the transmission of indications is effected, consider a route to have been set up from signal 10 to signal 12 with the track sections within the interlocking plant unoccupied. Also consider a train to approach signal 10 and the operator to transmit, at that time, a control code to cause the restoration of signal 10 to stop. Under such conditions, the dropping away of relay 10M initiates the transmission of an indication cycle as heretofore described, and relay CH¹ is again picked up during the stepping for that indication cycle. The approach locking becomes effective under such assumed conditions to maintain the exit relays 10XR¹ and 12XR¹ picked up for a predetermined time after signal 10 has been restored to stop. When the approach locking relay 10ALS (see Fig. 6) is picked up, after the contact of the associated thermal relay has been closed, the stick circuit for the exit relays 10XR¹ and 12XR¹ is opened (see Fig. 5) at back contact 291 to cause the dropping away of those relays. Inasmuch as relay 2AN is maintained picked up when relays 10XR¹ and 12XR¹ are picked up, the stick circuit for relay CH¹ is momentarily interrupted upon the dropping away of relay 10XR¹ because of back contact 294 of relay 2AN being open, and because of the momentary opening of contact 47 of relay 10XR¹. Thus an indication cycle is initiated which will include indications that the route from signal 10 to signal 12 has been completely restored. Such indications are transmitted because the relays 2AN and 3AN have time to drop away before the end of the conditioning period for that indication cycle.

Having thus considered various means for initiating the transmission of indications with respect to a particular signal and a particular route, it is to be understood that other signals and other routes are indicated in a similar manner. It is also to be understood that a change in the position of any track relay included in a route initiates the transmission of indications, irrespective of the number of track circuits provided.

When a control code is received at a field station for the auxiliary positioning of a group of track switches, the system is set into operation for the transmission of indications after the track switches have completed their operation. Inasmuch as each of the track switches is operated at the same time, the picking up of the WP relay for the first of the track switches to complete its operation is used to initiate the indication cycle, because all of the other track switches will complete their operation at comparatively the same time, thus providing that one indication cycle will transmit the indications of the newly operated position of all of the track switches involved.

To provide that the initiation of an indication cycle is effected upon the picking up of relay WP for one of the track switches and not upon the dropping away of any of the WP relays, a shunt circuit is closed around the neutral WP contact in the change relay stick circuit whenever the switch control relay WZ and the WP relay for that track switch or crossover are out of correspondence. If that track switch becomes unlocked, due to some abnormal condition, with the polar contacts of its WP and switch control relay in correspondence, an indication cycle is not initiated because of the shunt circuit provided by relay WS (see Fig. 7) as heretofore described, but indications defining the track switch as being unlocked will of course be transmitted as soon as transmission of indications is effected by a change in the position of other devices, or by the means often provided whereby the operator can initiate the transmission of indications. It is of course to be understood that modifications of the change relay stick circuit from the specific form shown in this embodiment can be provided in accordance with conditions encountered in practice.

To consider an example of such mode of oper-

ation, assume a control code to be received for the auxiliary operation of track switches 2TSA, 2TSB, 3TSA and 3TSB to their reverse position, as heretofore described. Also assume that the normal conditions with respect to those track switches exist in which the track switches for both of the crossovers are locked in their normal position.

Upon receiving such a control code, relay WS is picked up (see Fig. 4), and is maintained picked up until all of the track switches have completed their operation, by the energization of a stick circuit (see Fig. 6) closed from (+), through a circuit including front contact **301** of relay 2WZ, front contact **302** of relay WS, and upper winding of relay WS, to (—), and by the energization of a stick circuit closed from (+), through a circuit including front contact **303** of relay 3WZ, front contact **302** of relay WS, and upper winding of relay WS, to (—). The picking up of relay WS opens the heretofore described shunt in the stick circuit for relay CH^1 (see Fig. 7) around the WP contacts, at back contact **298**. When the switch machines start to operate, the relays WP are dropped away, but they do not initiate the transmission of indications because stick energy is maintained for relay CH^1 by a shunt circuit around WP contacts **41** and **40** in that stick circuit from contact **39** of relay **13M**, through a circuit including front contact **326** of relay 3WZ, polar contact **327** of relay 3WZ in a left hand position, polar contact **328** of relay 3WP in a right hand position, polar contact **329** of relay 2WP in a right hand position, polar contact **330** of relay 2WZ in a left hand position, and front contact **331** of relay 2WZ, to contact **42** of relay 6T. After those track switches have completed their operation to the reverse locked position, polar contacts **329** and **328** of relays 2WP and 3WP respectively are operated to their left hand position before the picking up of the neutral armature of those relays, thus opening the shunt circuit just described at polar contacts **329** and **328** respectively. The neutral armatures of the relays WP now pick up, and interrupt the stick circuit for relay CH^1 at contacts **41** and **40** respectively. The dropping away of relay CH^1, under such conditions, initiates the transmission of indications describing the newly operated position of the track switches. If, due to some obstruction or other abnormal condition, one of the track switches does not complete its operation, the transmission of indications is initiated by the picking up of the other WP relay, and those indications will include the unlocked position of the track switch that could not complete its operation. If one of the track switches is already in its newly defined position when the controls are received, it is obvious that the WP relay for that track switch remains picked up, and that the completion of the operation of the other track switches initiates the transmission of indications.

In order to simplify the disclosure of the present invention only sufficient channels have been provided by means of the stepping relays to provide for the transmission of the necessary controls and to provide for the transmission of certain typical indications. It is to be understood, however, that additional steps provide sufficient channels for the transmission of all of the indications associated with each signal and each route. Thus the transmission of signal indications for signal **10** is illustrated as typical of the indications transmitted for each of the other signals, the transmission of indications for the locked position of the track switches 2TSA and 2TSB is to be considered as typical of the transmission of indications for other track switches, the transmission of a correspondence indication for crossover *2ts* is to be considered typical of the transmission of other correspondence indications, and the transmission of track occupancy indication for track section **5** is to be considered as typical of the transmission of other track occupancy indications.

After the system has been set into operation for the transmission of indications as a result of the dropping away of relay CH^1, a station identification code is transmitted to the control office in accordance with jumpers **332**, **333**, **334** and **335** respectively (see Fig. 3), which cause the transmission of the station identification code composed of the characters closed, closed, open, closed.

Following the transmission of the station identification code, when indications are to be transmitted from the station illustrated in detail, the picking up of relay FP^1 (see Fig. 7) during the third impulse, closes a circuit for relay PB^1, if the track switch 2TSA and 2TSB are locked in the normal position for a route set up from signal **10** to signal **12**, from (+), through a circuit including front contact **304** of relay 2NCR, front contact **305** of relay 2AN, front contact **306** of relay $2V^1$, back contacts **307**, **308**, **309**, **310** and **311** of relays $3V^1$, $4V^1$, $5V^1$, $6V^1$ and $7V^1$ respectively, front contact **312** of relay FP^1, winding of relay PB^1, and front contact **313** of relay LO^1, to (—). The picking up of relay PB^1, under such conditions, provides that the indication line circuit is closed during the next "off" period. If that circuit for relay PB^1 is opened during the reception of the third impulse by the dropped away position of relay 2AN at front contact **305**, or by the dropped away position of relay 2NCR at front contact **304**, that relay will remain dropped away during the next "off" period to provide that the indication line circuit will be open during that period.

In a similar manner relay PB^1 is picked up during the fourth impulse, if relays 2BN and 2 NCR are picked up for a route set up from signal **11** to signal **13**, when a circuit is closed from (+), through a circuit including front contact **304** of relay 2NCR, front contact **314** of relay 2BN, front contact **307** of relay $3V^1$, back contacts **308**, **309**, **310** and **311** of relays $4V^1$, $5V^1$, $6V^1$ and $7V^1$ respectively, front contact **312** of relay FP^1, winding of relay PB^1, and front contact **313** of relay LO^1, to (—). The picking up of relay PB^1 under such conditions provides that the indication line circuit is closed during the next "off" period. If relay 2BN is dropped away to open front contact **314** or if relay 2NCR is dropped away to open front contact **304** during the fourth impulse, relay PB^1 is not picked up, and the indication line circuit will be opened during the following "off" period.

Relay PB^1 is picked up, during the transmission of such an indication cycle, during the fifth impulse, if relay 2RCR is picked up to close a circuit from (+), through a circuit including front contact **315** of relay 2RCR, front contact **308** of relay $4V^1$, back contacts **309**, **310** and **311** of relays $5V^1$, $6V^1$ and $7V^1$ respectively, front contact **312** of relay FP^1, winding of relay PB^1, and front contact **313** of relay LO^1, to (—). The picking up of relay PB^1 under such conditions provides that the indication line circuit is closed

during the next "off" period. If relay 2RCR is dropped away during the fifth impulse, relay PB[1] is not picked up, and the indication line circuit will be open during the following "off" period.

If the track relay 5T is picked up during the transmission of such an indication cycle, during the third "off" period, relay PF[1] remains in a dropped away position to open the indication line circuit during the following "on" period. If, however, relay 5T is dropped away, during that third "off" period, a circuit is closed for relay PF[1] from (+), through a circuit including back contact 316 of relay 5T, front contact 317 of relay 2V[1], back contact 318 of relay 4V[1], back contact 319 of relay 6V[1], front contact 320 of relay VP[1], back contact 321 of relay FP[1], winding of relay PF[1], and front contact 313 of relay LO[1], to (—). The picking up of relay PF[1], under such conditions, provides that the indication line circuit is closed during the following impulse.

If signal 10 is at stop during the fourth "off" period, relay PF[1] remains dropped away to open the indication line circuit during the fifth impulse, but if relay 10M is dropped away during that "off" period, relay PF[1] is picked up when its pick up circuit is energized by a circuit closed from (+), through a circuit including back contact 322 of relay 10M, front contact 323 of relay 3V[1], back contact 324 of relay 5V[1], back contact 325 of relay 7V[1], back contact 326 of relay VP[1], back contact 321 of relay FP[1], winding of relay PF[1], and front contact 313 of relay LO[1], to (—). The picking up of relay PF[1] under such conditions provides that the indication line circuit is closed during the following impulse.

Relay PF[1] is picked up, during the transmission of such an indication cycle, during the fifth "off" period, if relay 2WP is picked up and the track switches 2TSA and 2TSB are in a normal position to close a circuit from (+), through a circuit including front contact 332 of relay 2WP, polar contact 333 of relay 2WP in a right hand position, front contact 318 of relay 4V[1], back contact 319 of relay 6V[1], front contact 320 of relay VP[1], back contact 321 of relay FP[1], winding of relay PF[1], and front contact 313 of relay LO[1], to (—). The picking up of relay PF[1] under such conditions provides that the indication line circuit is closed during the following impulse. If, however, the track switches 2TSA and 2TSB are either unlocked or in the reversed position during the fifth "off" period, the pick up circuit for relay PF[1] remains open to provide that the indication line circuit will be open during the following impulse.

Relay FP[1] is picked up, during the transmission of such an indication cycle, during the sixth "off" period, if relay 2WP is picked up with the track switches 2TSA and 2TSB in a reverse position to close a circuit for relay PF[1] from (+), through a circuit including front contact 332 of relay 2WP, polar contact 333 of relay 2WP in a left hand position, front contact 324 of relay 5V[1], back contact 325 of relay 7V[1], back contact 326 of relay VP[1], back contact 321 of relay FP[1], winding of relay PF[1] and front contact 313 of relay LO[1], to (—). The picking up of relay PF[1] under such conditions provides that the indication line circuit is closed during the following impulse. If, however, relay 2WP is dropped away during the sixth "off" period, or track switches 2TSA and 2TSB are in their normal position, the pick up circuit for relay PF[1] is held open to provide that the indication line circuit is open during the following impulse.

Registration of indications.—Having considered the transmission of typical indications during an indication cycle, consideration is now given to the registration of those indications at the control office, and to the means provided at the control office for the control of the indicator lamps located on the control panel.

When the setting up of a route is initiated by the operator, by the depression of the button provided for the entrance end to a route, and by the depression of the button provided for the exit end to that route, a flashing indicator lamp, included in each of the buttons depressed, clearly indicates the entrance and exit points defined, and indicates that the signal for that route has not yet been cleared. It is of course to be understood that a lamp having a distinctive color can as well be used, and that the lamps can be located at other suitable positions than within the buttons. As soon as the indication has been received that the route thus initiated has been set up and the signal for that route has been cleared, the lamp in the button for the entrance end to that route becomes steadily illuminated and the lamp in the button for the exit end to that route is extinguished.

At the time when the indication that the signal is cleared is received, indicator lamps are illuminated on the track diagram to clearly define the route set up and to define the condition of occupancy of the track sections. Such route indications are provided by indicator lamps located at relative positions on the track diagram, but it is to be understood that means can as well be provided to display such indications by strips of light along the track diagram representative of the route set up.

To consider an example of how indications are provided, assume the operator to initiate the setting up of a route from signal 10 to signal 12 as heretofore described. The picking up of relay 10NR, as a result of the depression of button 10B, closes a circuit for the route and indicator relay 10NXS (see Fig. 8), from (+), through a circuit including contact 334 of button FLB in a normal position, front contact 335 of relay 10NR, and winding of relay 10NXS, to (—). The picking up of relay 10NXS closes a circuit for the intermittent energization of the indicator lamp 10GE contained in button 10B, from (+), through a circuit including back contact 336 of flasher relay FL, front contact 337 of relay 10NXS, polar contact 338 of relay 10GK in a left hand position, and lamp 10GE, to (—).

After the button for the exit end of that route is depressed, the route end repeater relay 12NXS (not shown) is picked up when its pick up circuit is closed by the picking up of relay 12XR. The picking up of relay 12NXS causes the intermittent energization of lamp 12GK (not shown) in button 12B. The circuit for lamp 12GK is similar to the circuit shown and described for lamp 10GK. The pick up circuit for relay 12NXS corresponds to the pick up circuit for relay 10NXS, which is closed when signal 10 is an exit point and relay 10XR is picked up to close a circuit from (+), through a circuit including contact 334 of button FLB in a normal position, front contact 339 of relay 10XR, and winding of relay 10NXS, to (—).

After the designated route from signal 10 to signal 12 has been transmitted, relays 10NR and 12XR are dropped away, but the indicator lamps contained in the buttons for the ends of that route continue to flash because relay 10NXS is

maintained picked up by a stick circuit closed from (+), through a circuit including contact 334 of button FLB in a normal position, polar contact 357 of relay 2ANK in a left hand position, polar contact 358 of relay 2RK in a left hand position, polar contact 340 of relay 10GK in a left hand position, front contact 341 of relay 10NXS and winding of relay 10NXS, to (—), and relay 12NXS (not shown) is maintained picked up by a stick circuit similar in character.

When that route has been completely set up in the field, an indication cycle is transmitted as heretofore described, and the identity of the station transmitting is registered at the control office, after the station identification code has been completely received. Such registration is effected by the picking up of a station relay ST responsive to that particular identification code.

After the station relay ST has been picked up, the polar relay 2ANK is positioned during the impulse following the identification code. Relay 2ANK is energized, by a circuit closed from (B+), through a circuit including front contact 381 of relay MB, front contact 342 of relay FP, back contacts 343, 344, 345 and 346 of relays 7V, 6V, 5V and 4V respectively, front contact 347 of relay 3V, front contact 348 of relay ST and winding of relay 2ANK, to (CN). Relay 2ANK operates its polar contact 349 to a right hand position, due to such energization, and closes an obvious circuit for the energization of indicator lamp 2ANE.

In a similar manner a relay 3ANK (not shown) is energized during the indication cycle to operate its polar contacts to a right hand position and cause the illumination of the associated indicator lamp.

Relay 10NXS is dropped away upon the position of the polar contacts of relay 2ANK because its stick circuit is opened at polar contact 357 of relay 2ANK, in a left hand position. In a similar manner, the position of the polar contacts of relay 3ANK (not shown) opens the stick circuit for relay 12NXS (not shown) and causes that relay to drop away. The dropping away of relay 10NXS, causes the extinguishing of the indicator lamp 10GE included in button 10B by opening the circuit for that lamp at front contact 337, and in a similar manner the dropping away of relay 12NXS (not shown) causes the extinguishing of the indicator lamp 12GE (not shown), included in button 12B.

During the fifth "off" period a circuit is closed for the energization of relay 10GK, from (B+), through a circuit including front contact 350 of relay MF, front contact 351 of relay SA, back contact 352 of relay FP, front contact 353 of relay VP, back contact 354 of relay 6V, front contact 355 of relay 4V, front contact 356 of relay ST, and winding of relay 10GK, to (CN). As a result of such energization the polar contacts of relay 10GK are operated to a right hand position, thus closing a circuit at polar contact 338 in a right hand position for the steady energization of the signal indicator lamp 10GE contained in button 10B. The steady energization of the lamp 10GE indicates to the operator that signal 10 has been cleared, and the energization of the lamps 2ANE and 3ANE clearly indicate the route which has been established.

When the train accepts the signal and enters track section 5, another indication cycle is transmitted from the field station as heretofore described. During that indication cycle track indicator relay 5TK is energized when its circuit is closed during the fourth "off" period from (B+), through a circuit including front contact 350 of relay MF, front contact 351 of relay SA, back contact 352 of relay FP, back contact 353 of relay VP, back contact 354 of relay 7V, back contact 355 of relay 5V, front contact 356 of relay 3V, front contact 357 of relay ST, and winding of relay 5TK, to (CN). Relay 5TK operates its polar contact 368 to a right hand position in accordance with such energization and closes an obvious circuit to cause the illumination of lamp 5TE.

During the same indication cycle, relay 10GK is energized during the fifth "off" period by the same circuit as heretofore described for the previous indication cycle, except that it is energized with the opposite polarity to the energization heretofore described, as a result of relay MF being dropped away during that period to apply (B—) to that circuit at back contact 350. As a result of such energization the polar contact 338 of relay 10GK is operated to a left hand position, thus causing the extinguishing of the signal indicator lamp 10GE to indicate to the operator that the signal has been restored to stop upon the passage of the train.

When the train leaves the route, under the above assumed conditions, the picking up of relay 5T in the field causes the transmission of an indication cycle during which relay 2ANK is energized with the opposite polarity to that heretofore described when the route was first set up and during which relay 5TK is energized with reverse polarity to that described when an indication was received that track section 5 was occupied by a train. Such energization of relays 2ANK and 5TK causes the extinguishing of lamps 2ANE and 5TE respectively to indicate to the operator that the train has left the interlocking plant and released the route which had been set up. It is of course to be understood that indicator lamp 3ANE (not shown) is extinguished during the same indication cycle.

If the operator initiates the setting up of a route which cannot be completed in the field, it is obvious that the indicator lamps in the route end buttons for that route will continue to flash, thus attracting the attention of the operator to the condition that exists. To extinguish the indicator lamps under such condition, the operator has only to acknowledge the condition by depressing the flashing light cancel button FLB and opening the circuit for the route end repeater relay 10NXS. It is contemplated that such a flashing light cancel button is provided for the section of the diagram associated with each station, so that the indications for stored controls of other stations will not be effected when the cancel button is operated for a particular route initiated.

It has been pointed out in considering the transmission of indications, that an indication cycle is initiated whenever a signal is put to stop by the transmission of a control code for such a purpose from the control office, and it has been pointed out that an indication cycle is initiated by the field station when a route is restored after that route has been released by the approach locking. To consider an example of how the indications are provided at the control office during such a mode of operation, assume the operator

to have set up a route from signal 10 to signal 12, and to have received the indications that the route has been completely set up and that signal 10 has been cleared. If, for some reason, under such conditions, the operator decides to restore signal 10 to stop, he causes the transmission of a control code for putting that signal to stop. The restoration of signal 10 causes the transmission of an indication cycle from the field station to the control office which causes signal indicator lamp 10GE on the control panel to be extinguished. If, at that time, a train is approaching signal 10 to provide that the approach locking is effective to lock the route set up for a predetermined time after the signal is restored to stop, the route indicator lamps for that route at the control office remain illuminated after signal indicator lamp 10GE has been extinguished. Such a mode of operation indicates to the operator that the approach locking is effective for holding the route because a track indicator lamp 5TE is extinguished, thus indicating that the route locking is not effective. The operator knows he must wait, therefore, until the route for which he has initiated the restoration has been completely restored until he can cause the setting up of a conflicting route. Upon the release of the approach locking at the field station by the picking up of relay 10ALS, the dropping away of the relays 10XR[1] and 12XR[1] for that route initiates the transmission of an indication cycle to cause the extinguishing of the route indicator lamps 2ANE and 3ANE (not shown). The extinguishing of such lamps indicates to the operator that he is free to set up a conflicting route, and that the approaching train did not enter the route previously set up.

Having thus considered how the various indications are displayed in accordance with the setting up and restoration of a particular route, it is to be understood that such indications are provided for each of the other routes and signals included in the system.

When the operator effects the transmission of controls for the auxiliary positioning of a group of track switches, an out of correspondence lamp CE (see Fig. 8) associated with each of the auxiliary levers is illuminated for the levers that are in an operating position, provided that the track switch is out of correspondence with that operated position. The control of the lamps CE are so provided that they become illuminated only after the transmission of the auxiliary controls has been initiated by the depression of the start button SB provided for that particular station. As soon as the track switches are operated to a position corresponding with the position of the auxiliary levers, an indication cycle is transmitted from the field station which causes the extinguishing of the associated out of correspondence lamps.

Each of the out of correspondence lamps also indicates an unlocked position of the associated track switch, if that switch is unlocked due to an abnormal condition any time during the transmission of indications from that station.

To consider an example of how such out of correspondence indications are provided, assume the auxiliary levers 2SML and 3SML to be operated to a reverse position when the corresponding track switches in the field are in a normal position. Upon depression of the send button SB, following such positioning of the auxiliary levers a circuit is closed for the energization of relay 2WNK from (B—), through a circuit including contact 369 of button SB in a depressed position, contact 370 of lever 2SML in a downward reverse operating position, polar contact 371 of relay 2WNK in a right hand position, and winding of relay 2WNK, to (CN). As a result of such energization the polar contacts of relay 2WNK are operated to a left hand position, thus closing a circuit for the out of correspondence lamp 2CE, from (+), through a circuit including polar contact 372 of relay 2WRK in a left hand position, polar contact 373 of relay 2WNK in a left hand position, and lamp 2CE, to (—).

After the track switches 2TSA and 2TSB have completed their operation to a reverse locked position in accordance with the transmission of such controls, the transmission of an indication cycle is initiated, during which relay 2WNK is energized when its circuit is closed during the sixth "off" period from (B—), through a circuit including, back contact 350 of relay MF, front contact 351 of relay SA, back contact 352 of relay FP, back contact 353 of relay VP, back contact 364 of relay 7V, front contact 365 of relay 5V, front contact 374 of relay ST, and winding of relay 2WNK, to (CN). As a result of such energization relay 2WNK maintains its polar contacts in a left hand position, because the polarity of such energization is the same as the polarity last applied to that relay.

During the seventh "off" period of that indication cycle, relay 2WRK is energized when its circuit is closed from (B+), through a circuit including front contact 350 of relay MF, front contact 351 of relay SA, back contact 352 of relay FP, front contact 353 of relay VP, front contact 354 of relay 6V, front contact 375 of relay ST, and winding of relay 2WRK, to (CN). As a result of such energization the polar contacts of relays 2WRK are operated to a right hand position, thus causing the extinguishing of lamp 2CE by opening its control circuit at polar contact 372 of relay 2WRK in a left hand position.

The mode of operation has thus been described in detail whereby the out of correspondence lamp 2CE associated with a particular switch control lever 2SML is illuminated upon the transmission of auxiliary controls for the positioning of the track switches, and whereby that indicator lamp is extinguished as soon as an indication has been received that the initiated positioning of the associated track switch has been completed. Such a mode of operation is to be considered as typical of that provided in connection with an indicator lamp provided for each crossover or track switch, and it is of course obvious that a similar mode of operation is employed when track switches are operated from a reverse to a normal position.

To consider an example of how the indicator lamp CE is illuminated when its associated track switches become unlocked, due to some abnormal condition, consider the relays 2WNK and 2WRK to have their polar contacts in the normal position illustrated in Fig. 8, and assume a condition to exist at the associated field station whereby relay 2WP is dropped away, due to some abnormal condition. As soon as an indication cycle is transmitted from that field station, relays 2WNK and 2WRK are both energized with the same polarity, to provide that a circuit is closed for the out of correspondence lamp 2CE as heretofore described. During such an indication cycle relay 2WNK is energized by a circuit closed from

(B—) to (CN) as has heretofore been described. As a result of such energization the polar contacts of that relay are operated to a left hand position. Also, during that indication cycle relay 2WRK is energized when its circuit is closed as heretofore described except that the circuit is closed from (B—) to (CN) to effect the maintenance of the polar contacts of that relay in a left hand position. Thus the lamp 2CE becomes illuminated as a result of the closing of its circuit at polar contact 373 in a left hand position, to inform the operator of the condition existing in the field; and it is extinguished only when the associated track switches are operated to a normal or a reverse locked position.

Summary

In considering the mode of operation of different parts of the system, various novel features have been described as applied to this embodiment of the present invention that are believed to be broad in scope and applicable to a number of other types of NX control systems. For example, the means provided at the control office by which the various codes are selected in accordance with the levers and buttons operated, can readily be applied to a system employing a different type of code communication system, such, for example, as the two wire code communication system shown in a prior application of Hailes and Brixner, Ser. No. 197,404, filed March 22, 1938.

The present system provides that, at the end of a control cycle for setting up a route, a relay for the entrance point to that route and a relay for the exit point to that route at the field station is momentarily energized. In accordance with such energization, relays for the ends to that route are picked up and are maintained picked up by stick circuits. Thus, it is readily apparent that other types of self-selecting networks can as well be substituted for the self-selecting network illustrated; for example, the self-selecting network shown in a prior application of Langdon, Ser. No. 176,466, filed November 26, 1937, could be controlled from a remote point in accordance with the present invention.

The interlock between conflicting routes is established, in accordance with the present invention, in such a manner that it is unnecessary to maintain a route selecting network in the control office for interlock purposes. That is, once route end controls have been transmitted, the control relays associated with those route ends at the control office are automatically restored to normal, because the self-selecting network at the field station provides interlock protection against setting up contemporaneously two conflicting routes. Such an arrangement reduces to a minimum the control apparatus required at the control office, and yet maintains the desirable features required in an interlocking system.

It is obvious that the system provided by this invention by which the transmission of indications is delayed in setting up a route until the signal for that route is cleared, can as well be applied to other control systems of the remote code communication type, and that the novel features with respect to the display of the indications received at the control office can as well be applied to other NX systems.

Having described an entrance-exit type interlocking system provided for a particular track layout 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, it is to be further understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What I claim is:

1. In an interlocking system for railroads; a track layout at a field station connected to a control office by a code type communication system, said track layout having a plurality of power operated track switches to set up different routes; manually operable means at the control office for designating, when operated, the opposite ends of each of said routes; code transmitting means responsive to the designation of the particular ends of any given route by said manually operable means to transmit over said communication system codes characteristic of the opposite ends of that route, and route establishing means at the field station responsive to the route end codes transmitted over said communication system for controlling the power operation of said track switches to set up a given route when the route end codes for the opposite ends of that route are received over said communication system.

2. In an interlocking system for railroads; a distant field station having a track layout including a plurality of power operated track switches to set up different routes through such track layout; a code type communication system of the multiple impulse type connecting said field station with a control office; a manually operable means at the control office for each of the several route ends of said plurality of different routes; code transmitting means at the control office responsive to the operation of the manually operable means for the opposite ends of any particular route to transmit a code for each route end of said particular route; code receiving means at the field station responsive to the route end codes transmitted over said communication system; route establishing means at the field station controlled by said code receiving means in response to the reception of the route end codes for the opposite ends of any particular route to control the power operated track switches of said track layout to set up that particular route.

3. In an interlocking system in which a track layout, having a plurality of conflicting routes between entrance and exit points at a field station, is controlled from a control office by means of a code type communication system; an entrance relay at the control office for each entrance point; an exit relay at the control office for each exit point; manually governed means for selectively energizing any desired entrance relay and any desired exit relay, said means allowing only one entrance relay and only one exit relay to be energized at any one time; circuit means for transmitting a control code, such code being made up of impulses of distinctive character, from the control office to the field station when one of said entrance relays and one of said exit relays are picked up, such control code being selected in accordance with the entrance relay then energized and in accordance with the exit relay then energized; and route establishing

means at the field station responsive to said control code for setting up a route by controlling track switches and signals between entrance and exit points described in that code.

4. In an interlocking system for railroads of the entrance-exit type; a track layout at a remote point having a plurality of power operated track switches to set up different routes through the track layout and signals for governing traffic over such routes; a control machine at a control office having a miniature track diagram of said track layout; manually operable control buttons at points on said track diagram corresponding to the locations of said signals in the actual track layout; an entrance relay and an exit relay for each route end; interlocking control circuit means associated with said entrance and exit relays so as to pick up an entrance relay in response to the operation of a control button for its route end and so as to pick up an exit relay for another route end in response to the operation of a control button for such another route end following the picking up of an entrance relay, said means being so organized as to allow only one entrance relay and one exit relay to be picked up at the same time; code transmitting means at the control office governed by said entrance and exit relays for transmitting the route end codes for the route ends having an entrance or an exit relay picked up; code receiving means at the field station responsive to the route end codes transmitted over said communication system; route establishing means at the field station controlled by said code receiving means in response to the reception of the route end codes for the opposite ends of any particular route to control the power operated track switches of said track layout to set up that particular route and clear the signal at the entrance end of such route.

5. In a centralized traffic controlling system of the character described for transmitting controls from a control office to a field station; a track layout at the field station providing a plurality of conflicting routes between entrance and exit points; manually operable means at the control office for designating, when operated, each of said entrance and exit points; a transmitter rendered effective in response to the designation of an entrance point and an exit point for transmitting a control code from the control office to the field station, such code being characteristic of each route end designated; code receiving means at the field station responsive to the transmission of said control code; and route establishing means at the field station operable in response to the reception of said control code to set up a route between the entrance and exit points described by that code.

6. In a remote control interlocking system of the character described for transmitting controls from a control office to a field station, a track layout at the field station providing a plurality of conflicting routes between route ends, a single manually operable contactor at the control office for each route end, an entrance relay for each route end, an exit relay for each route end, a circuit for energizing each of said entrance relays when the contactor for that route end is actuated only if no other entrance relay or exit relay is picked up at that time, a circuit for energizing each of said exit relays when and only when the contactor for that route end is actuated following the picking up of an entrance relay and then only if no other exit relay is picked up at that time, a transmitter initiated in response to the picking up of an exit relay for transmitting a control code message from the control office to the field station including a particular route end code selected by the entrance relay picked up and a particular route end code selected by the exit relay picked up, such route end codes being made up of impulses of distinctive characters, circuit means for maintaining each of said entrance relays and each of said exit relays picked up until said transmitter has completed its operation, means at the field station for receiving said code message, and route establishing means for setting up a route at the field station between the entrance and exit points described in the codes received.

7. In a centralized traffic controlling system for railroads; a track layout at a field station having track switches to form a plurality of routes between signal locations governing traffic over such routes; a control machine at a control office having a miniature track diagram of said track layout; manually operable means at each point on said miniature track diagram corresponding to a signal location, each of said manually operable means being capable of designating that location as an entrance point or as an exit point; a normally-at-rest code transmitter effective, when initiated into operation, to transmit control codes; means effective, upon the designation of one signal location as an entrance point and another signal location as an exit point by said manually operable means, to initiate said transmitter into operation and cause it to transmit a control code comprising a portion of code elements characteristic of the route end for the entrance point and another portion of code elements characteristic of the route end for the exit point; code receiving means at the field station responsive to the control codes transmitted by said transmitter; storing means at the field station for each of the route ends, each such storing means being rendered active in response to the reception of a code characteristic of its route end; and route establishing means at the field station operable in response to the active condition of said storing means for the opposite ends of any given route to cause the operation of the track switches of said track layout to set up that route and clear the signal at the entrance end to such route.

8. In a remote control interlocking system of the entrance-exit type in which a track layout, having conflicting routes between route ends at a field station, is controlled from a control office by a code type communication system; an entrance relay at the control office for each route end; an exit relay at the control office for each route end; manually governed means for selectively picking up each entrance relay and each exit relay, only one entrance and only one exit relay being picked up at any one time; circuit means dependent upon the picked up position of an entrance relay or an exit relay for each route end for selecting for transmission a particular code made up of distinctive impulses for that route end; a code transmitter for transmitting a composite concontrol code, composed of the route end code selected by the picked up position of one of said entrance relays followed by the route end code selected by the picked up position of one of said exit relays, from the control office to the field station during one cycle of operation of the communication system; means at the field station responsive to said composite control code for identifying the route ends designated by said selected route end codes transmitted from the control office, circuit means at the field station for setting up a route by controlling track switch-

es and signals in accordance with the route ends designated by the selected route end codes, and circuit means at the field station for defining the entrance point for the route set up in accordance with the order in which said route end codes are transmitted in the composite code during a cycle of operation.

9. In a remote control interlocking system of the character described for controlling over a line circuit extending from a control office to a field station, a track layout having several tracks connected by track switches at various points to form several conflicting routes between entrance and exit points; an entrance relay at the control office for each entrance point; an exit relay at the control office for each exit point; manually operable contact means at the control office for each of said entrance and exit relays; means for picking up each entrance relay and each exit relay when the contactor for that relay is actuated, only one entrance relay and only one exit relay being picked up at any one time; lever contact means at the control office for selecting control codes for positioning each of the track switches; a station relay at the control office; a start button at the control office; circuit means for picking up said station relay when said start button is actuated; circuit means for so interlocking said station relay with said entrance and exit relays that said station relay can be picked up only when all entrance and exit relays for that field station are dropped away, and that said entrance and exit relays can be picked up only when said station relay for that station is dropped away; a transmitter operable when said station relay or an entrance and exit relay are picked up, to impress upon the line circuit an impulse of a particular distinctive character selected in accordance with the position of said station relay, and operable to impress upon the line circuit following impulses in accordance with the position of said entrance and exit relays if said station relay is dropped away, or in accordance with said lever contact means if said station relay is picked up, and means at the field station for receiving the impulses transmitted and determining the purpose of the control code in accordance with the distinctive character of the impulse selected by said station relay.

10. In a centralized traffic controlling system in which impulses forming control codes are received at a field station through channels provided by a bank of stepping relays, decoding relays for each step, circuit means for positioning said decoding relays for each step in accordance with the distinctive character of the control code impulse received during that step, route establishing means responsive when rendered effective to the positioning of said decoding relays for several of the steps for setting up a route by controlling track switches and signals in accordance with the control code received, auxiliary switch control means responsive, when rendered effective, to the positioning of said decoding relays for said several of the steps for positioning a particular group of track switches alone in accordance with the control code received, and circuit means responsive to the positioning of said decoding relays for a step preceding said several steps for rendering said route establishing means effective if the impulse for that preceding step is of a particular character, or for rendering said auxiliary switch control means effective if the impulse for that preceding step is of another character.

11. In an interlocking system of the character described for transmitting controls from a control office over a line circuit to a field station; a track layout having a plurality of tracks interconnected by a plurality of crossovers to provide a plurality of routes between entrance and exit points; an entrance relay at the control office for each entrance point; an exit relay at the control office for each exit point; a manually operable contactor at the control office for controlling each of said entrance relays and each of said exit relays; a control lever at the control office for governing the track switches for each crossover; a start button at the control office; a station relay at the control office; a change relay at the control office; circuit means for picking up each entrance and each exit relay when the contactor for that relay is actuated, only if said change relay is dropped away, only one entrance relay and only one exit relay being picked up at any one time; circuit means for picking up said change relay when an entrance and an exit relay have been picked up; circuit means for picking up said station relay when said start button is actuated after any of said levers have been positioned, only if said change relay is dropped away; circuit means for picking up said change relay when said station relay has been picked up; a transmitter operable when a change relay is picked up to transmit from the control office to the field station over the line circuit, a control code made up of distinctive impulses selected in accordance with the entrance and exit relays picked up, or in accordance with the position of the switch control levers if said station relay is picked up; and circuit means for maintaining each of said entrance relays and exit relays, said station relay, and said change relay energized until the transmission of the selected control code has been completed, whereby an interlock is maintained between the means provided for selecting a control code for the setting up of a route and the means provided for selecting a control code for the auxiliary positioning of the track switches, so that only one of the two types of control codes can be selected for transmission at any one time.

12. In a remote control interlocking system of the character described for controlling from a control office a track layout at a field station having a plurality of conflicting routes between entrance and exit points; manually operable contact means at the control office for each entrance and each exit point; an entrance relay at the control office for each entrance point; an exit relay at the control office for each exit point; circuit means for picking up each of said entrance relays when the contact means for that entrance point is actuated, only one entrance relay being picked up at any one time; circuit means for picking up each of said exit relays when and only when the contact means for that exit point is actuated following the picking up of an entrance relay and when there is a possible route between that exit point and the designated entrance point, only one exit relay being picked up at any one time; a transmitter effective after one of said entrance relays and one of said exit relays have been picked up for transmitting a composite control code of distinctive impulses from the control office to the field station, such composite control code including a code selected

in accordance with the entrance relay picked up and a code selected in accordance with the exit relay picked up; whereby only entrance and exit control codes for possible routes can be transmitted; means for maintaining each of said entrance and exit relays picked up until transmission of the code selected by those relays has been completed, means at the field station for receiving the control code transmitted from the control office; and route establishing means at the field station for setting up a route between the entrance and exit points described in the composite control code received.

13. In a centralized traffic controlling system for railroads; a track layout at a field station having track switches to form a plurality of conflicting routes between different route ends; a code type communication system operable through cycles of operation to transmit control codes from a control office to a field station; a single control button in said control office for each of said different route ends; an entrance relay at the control office for each of said control buttons; an exit relay at the control office for each of said control buttons; a circuit organization effective upon the operation of any control button to pick up its entrance relay when all of said entrance and exit relays are deenergized, said circuit organization being effective upon the operation of any control button to pick up its exit relay if an entrance relay is already picked up, said circuit organization also being effective to prevent more than the energization of one entrance relay and one exit relay for said control buttons, whereby an entrance relay for one end of a route and an exit relay for the opposite end of that route can be picked up or an entrance relay and an exit relay can be picked up for the same route end; transmitting means rendered effective upon the picking up of an entrance relay and an exit relay to transmit a control code comprising a group of impulses characteristic of a route end designated as an entrance point and another group of impulses characteristic of a route end designated as an exit point by the entrance and exit relays picked up for that cycle of operation; code receiving means at the field station responsive to the codes transmitted over said communication system; storing means at the field station for each of said different route ends, said storing means being responsive to a control code designating that route end as an entrance point to be rendered active until cancelled, said storing means also being responsive to a control code designating that route end as an exit point to be rendered active only if there is an available route between that point and another route and designated as an entrance point, and said storing means for each route end also being so organized that the designation of such route end as both an entrance and an exit point causes the cancellation of any storage at that point; and route establishing means at the field station controlled by said storing means for the different route ends so as to establish a route between a point designated as an entrance point and a route end designated as an exit point, said route establishing means being so organized as to prevent a route from being set up in conflict with a route already established, and said route establishing means maintaining any given route establishing only so long as said storing means at the entrance end to that route is maintained active.

14. In a centralized traffic controlling system of the character described for controlling from a control office a track layout at a field station having a plurality of conflicting routes between route ends and having signals for governing traffic thereover; a single manually operable contactor at the control office for each route end, having a normal position and an operating position; an entrance relay at the control office for each route end; an exit relay at the control office for each route end; circuit means for picking up each of said entrance relays when the contactor for that route end is actuated, only one entrance relay being picked up at any one time; circuit means for picking up each of said exit relays when and only when the contactor for that route end is actuated following the picking up of an entrance relay and the restoration to normal of the contactor for that entrance relay; circuit means dependent upon the picked up position of an entrance or an exit relay for each route end for selecting for transmission a particular control code for that route end, such code being composed of selected distinctive impulses; a transmitter for transmitting a complete control code composed of a control code for a particular route end selected by the picking up of an entrance relay, followed by a control code for a particular route end selected by the picking up of an exit relay; circuit means for maintaining each of said entrance relays and each of said exit relays picked up until the code selected by the picking up of those relays is transmitted; circuit means at the field station for receiving each code transmitted from the control office, route establishing means at the field station responsive to the composite code received for setting up a route between route ends designated in that composite code if there is an available route between those route ends; and circuit means responsive to the composite code received at the field station for causing the restoration of each of said signals to stop if the two control codes included in that composite code are identical and are provided for the route end with which that signal is associated.

15. In a centralized traffic controlling system for railroads; a track layout having track switches to form a plurality of routes between signal locations at the different route ends, some of said routes being conflicting and others being non-conflicting; a code type multiple impulse communication system connecting the track layout with a control office and operable when initiated into operation to transmit control codes from a control office to the track layout; an entrance relay and an exit relay at the control office for each route end; manually governed means for energizing any desired entrance relay and any desired exit relay, said means allowing only one entrance relay and only one exit relay to be energized during any one operating cycle of said communication system; transmitting means at the control office effective to initiate said communication system into operation upon the energization of an entrance relay and an exit relay for transmitting a control code comprising an entrance route end group of impulses characteristic of the route end corresponding to the entrance relay then picked up and comprising an exit end group of impulses characteristic of the route end corresponding to the exit relay then picked up, said transmitting means being effective at the end of a cycle of operation to cause the deenergization of the entrance and exit relays picked up during such

cycle of operation; code receiving means at the track layout responsive to the control codes transmitted over said communication system; code storing means at the track layout for each of said different route ends, said code storing means for any particular route end being rendered active at any time in response to an entrance route end code for that route end but being capable of being rendered active in response to an exit route end code for that route end only if there is an available route between such route end and another route end where an entrance route end code has been stored; and route establishing means at the track layout controlled by the storing means for the different route ends so as to set up the different routes through said track layout, said route establishing means operating to set up a given route in response to the storage of an entrance route end code and the storage of an exit route end code in said code storing means for the route ends at the opposite ends of that given route, said route establishing means being so organized as to prevent the establishment of a route in conflict with any particular route already established.

16. In an interlocking system of the entrance-exit type in which a control office is connected to a plurality of field stations by a code type communication system, a track layout at each field station forming a plurality of conflicting routes between entrance and exit points, manually operable contact means at the control office for each of the entrance and exit points, a transmitter operable to transmit from the control office to the field stations, a control code when said contact means is actuated for an entrance and for an exit point, a single code determining relay at the control office for each track layout, circuit means for picking up said code determining relay whenever a control code for that track layout is being transmitted, circuit interlock means dependent upon each of said code determining relays for rendering said transmitter effective for transmitting only control codes selected for transmission to the field station associated with the code determining relay picked up, irrespective of the actuation of said manually operable contact means for other entrance and exit points.

17. In a centralized traffic controlling system in which a track switch at a field station is remotely controlled over a normally at rest code type communication system from a control office and its condition is also indicated in the control office over such communication system, a plurality of different switch control means at the control office responsive to manual actuation to respectively effect the transmission of controls over said communication system to govern the operation of said track switch, a normally energized change relay at the field station for initiating the transmission of indications from that station to the control office over said code type communication system, a stick circuit for normally maintaining said change relay energized, and means for interrupting said stick circuit to cause said change relay to drop away when a change occurs in the position of the track switch, said means acting only if that track switch is positioned in accordance with a predetermined one of said different switch control means, whereby the positioning of a track switch causes the initiation of the transmission of indications only when that track switch is positioned in accordance with said predetermined switch control means and the positioning of such track switch by any other switch control means fails to interrupt said stick circuit.

18. In a centralized traffic controlling system of the character described in which indications are provided on a control panel at a control office in accordance with operation of control contactors for the entrance and exit ends of routes and in accordance with indication codes transmitted over a line circuit from a field station, an indicator lamp for each route end, an indication relay for each route end, circuit means for energizing said indication relay for each route end when the contactor for that route end is actuated, circuit means for energizing each of said indicator lamps when said indication relay for that route end is energized, stick circuit means for maintaining each of said indication relays energized when energization has become effective, only until an indication code is received from the field station describing a route as being set up between route ends for which the indicator lamps are illuminated, means for energizing each of said indicator lamps upon the reception of an indication code received from the field station describing that route end as the entrance end of a set up route, said means acting independently of said indication relay for that indicator lamp, whereby indicator lamps for the route ends are illuminated when the setting up of a route is initiated, but when indications are received from the field station that the route has been set up only the indicator lamp at the entrance to the route is maintained illuminated.

19. In an interlocking system for railroads, a distant field station having a track layout including a plurality of power-operated track switches to set up different routes through such track layout between signal locations constituting entrance and exit points, a code type communication system of the multiple impulse type connecting said field station with a control office, a track diagram of said track layout, manually operable means on said track diagram at each of the points corresponding to the entrance and exit ends of the different routes, code transmitting means at the control office responsive to the actuation of the manually operable means for the entrance and exit ends of any desired route for transmitting the two codes corresponding to such entrance and exit ends of the desired route over said communication system to the field station, code receiving means at the field station responsive to the route end codes transmitted over said communication system for storing such codes, and route establishing means at the field station controlled by said code receiving means in response to the reception and storage of the route end codes for the opposite ends of any particular route to control the power-operated track switches of said track layout to set up that particular route.

20. In an interlocking system for railroads, a distant field station having a track layout including a plurality of power-operated track switches to set up different routes through such track layout with signals located at the entrances to such routes, an entrance relay and an exit relay at the field station for ends of the different routes, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel having thereon a track diagram of said track layout, a single manually operable control button

on said diagram at each of the points corresponding to the locations of said signals and constituting the ends of the various routes, code transmitting means at the control office responsive to the sequential manual actuation of said control buttons for the entrance and exit ends of any desired route in the order named for transmitting a distinctive entrance control code corresponding to the entrance end for such route and a distinctive exit control code corresponding to the exit end of that route, code receiving means at the field station responsive to the entrance and exit control codes transmitted over said communication system for actuating entrance and exit relays for the respective entrance and exit ends of the corresponding route, route establishing means at the field station controlled by said entrance and exit relays when actuated at the opposite ends of any particular route for controlling the power-operated track switches of said track layout to set up that route and to clear the signal at the entrance end of such route.

21. In an interlocking system for railroads, a distant field station having a track layout including a plurality of power operated track switches to set up different routes through such track layout, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel in the control office having thereon a track diagram of said track layout, a single manually operable control button on said diagram at each of the points corresponding to the points of the actual track layout constituting the entrance and exit ends of the various routes, code transmitting means at the control office responsive to the sequential actuation of the manually operable control buttons for the entrance and exit ends of any given route for transmitting control codes corresponding to the entrance and exit ends of that route, and code receiving means at the field station responsive to the entrance and exit route end codes transmitted over said communication system for controlling the power operated track switches of said track layout to establish that given route.

22. In an interlocking system for railroads, a distant field station having a track layout including a plurality of power operated track switches to set up different routes through such track layout, a normally-at-rest code type communication system of the multiple impulse type connecting said field station with a control office, a control panel having thereon a diagram of said track layout, manually operable means on said control panel at points on the diagram corresponding to the ends of the different routes, means responsive to the actuation of the manually operable means for the opposite ends of any given route for setting said code type communication system into operation to transmit the two codes characteristic of the opposite ends of said given route, code receiving means at the field station responsive to the two codes characteristic of the opposite ends of any given route transmitted over said communication system for controlling the power operation of said track switches to establish said given route, whereby a normally-at-rest code communication system will be initiated into operation and transmit the required route end codes to establish a given route in response to the designation of merely the opposite ends of such given route.

23. In an interlocking system for railroads, a distant field station having a track layout including a plurality of power operated track switches to set up different routes through such track layout, an entrance relay and an exit relay at the field station for the ends of the different routes, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel having thereon a track diagram of said track layout, a single manually operable control button on said diagram at each of the points corresponding to the points of the actual track layout constituting the ends of the various routes, an auxiliary switch control lever on the control panel for each of said power-operated track switches, an auxiliary control start button, code transmitting means at the control office responsive to the actuation of the manually operable control buttons for the entrance and exit ends of any desired route for transmitting a control code corresponding to the entrance end for such route and a control code corresponding to the exit end of that route, said code transmitting means also being responsive to the actuation of said auxiliary control start button for transmitting switch control codes for said track switches in accordance with the positions of said auxiliary switch control levers, code receiving means at the field station responsive to the entrance and exit route end codes transmitted over said communication systm for actuating the corresponding enrance and exit relays for the respective entrance and exit ends of the desired route, said code receiving means also being responsive to the auxiliary switch control codes, and route establishing means at the field station jointly controlled by said entrance and exit relays at the opposite ends of any given route for governing the power operation of the track switches to establish that route, said route establishing means also being responsive to said code receiving means upon the reception of switch control codes for operating the individual track switches to positions in accordance with their corresponding auxiliary switch control levers, said route establishing means including circuit interlocking means for preventing the control of any track switch by an auxiliary switch control code if such track switch is already controlled by said entrance and exit route end codes and also preventing the control of any track switch by route end code if such track switch is already controlled by an auxiliary switch control code.

24. In an interlocking system for railroads, a track layout including a plurality of power operated track switches to set up different routes through such track layout with signals located at the entrances to such routes, an entrance relay and an exit relay for the ends of the different routes, route establishing means jointly controlled by an actuated entrance relay at one end of a particular route and an actuated exit relay at the opposite end of that route for controlling the power operation of the track switches to set up that route and to clear the signal at the end having the actuated entrance relay, a control office connected with said track layout by a communication system of the multiple impulse code type, a control panel at the control office having a track diagram of said track layout, manually operable control means on said diagram for each of the locations constituting the ends of the various routes, auxiliary switch control levers located on said control panel for each of said power operated track switches, code transmitting means at the control office responsive to the actuation of the manually operable control means for the

entrance and exit ends of any desired route for transmitting a control code corresponding to the entrance end of such route and a control code corresponding to the exit end of that route, said code transmitting means also being responsive to manual actuation of a start button for transmitting auxiliary switch control codes in accordance with the positions of said auxliiary switch control levers, code receiving means at the field station responsive to the entrance and exit route end codes transmitted over said communication system for actuating the corresponding entrance and exit relays, said code receiving means also being responsive to the auxiliary switch control codes for causing the individual power operation of said track switches only if such track switches are not at that time under the control of said route esablishing means and the associated entrance and exit relays.

25. In a centralized traffic controlling system of the character described in which indications are provided on a control panel at a control office in accordance with the operation of control contactors for the entrance and exit ends of routes and in accordance with indication codes transmitted over a line circuit from a field station, an indicator lamp for each route end, an indication relay for each route end, circuit means for energizing said indication relay for each route end when the contactor for that route end is actuated, circuit means for energizing any given one of said indicator lamps when said indication relay for the corresponding route end is energized, stick circuit means for maintaining each of said indication relays energized irrespective of the actuated condition of its said contactor until the reception of an indication code from the field station describing a route as being set up between its route end and another route end for which an indicator lamp is illuminated, and circuit means for each of said indicator lamps for distinctively energizing that lamp upon the reception of an indication code received from the field station describing its route end as the entrance end of a set up route, said means acting independently of said indication relay for that indicator lamp.

26. In a centralized traffic controlling system of the character described in which indications are provided on a control panel at a control office in accordance with the operation of control contactors for the entrance and exit ends of and in accordance with indication codes transmitted over a line circuit from a field station, an indicator lamp for each route end, an indication relay for each route end, circuit means for energizing said indication relay for each route end when the contactor for that route end is actuated, circuit means for intermittently energizing each of said indicator lamps when said indication relay for that route end is energized to thereby cause such indicator lamp to intermittently flash, stick circuit means for maintaining each of said indication relays energized independently of the non-actuated condition of its said contactor until the reception of an indication code from the field station describing a route as being set up between route ends including that route end for which such indicator lamp is illuminated, and means for steadily energizing each of said indicator lamps upon the reception of an indication code received from the field station describing that route end as the entrance end of a set up route, whereby the indicator lamps at the opposite ends of a route designated by the actuation of the control contactors for the entrance and exit ends of such route are initially illuminated on the control panel in a flashing manner but upon the completion of that route the flashing indication of the indicator lamp at the entrance end is changed to a steady indication and the indicator lamp at the exit end is extinguished.

27. In a switch and signal control system for railroads, a distant field station having a track layout including a plurality of power operated track switches to set up different routes through such track layout between signal locations, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel in the control office having thereon a track diagram of said track layout, a single manually operable control button on said diagram at each of the points corresponding to the signal locations of the actual track layout constituting the entrance and exit ends of the various routes, code transmitting means at the control office responsive to the sequential actuation of the manually operable control buttons for the entrance and exit ends of any given route for transmitting entrance and exit control codes for the corresponding ends of that route, code receiving and storing means at the field station responsive to the entrance and exit control codes transmitted over said communication system, and route establishing means controlled by said code receiving and storing means in response to the storage of an entrance and exit control code for the opposite ends of any route then available for use for causing the power operation of the track switches to set up that route and clear the signal at the end of such route for which the entrance control code was received.

28. In a switch and signal control system for railroads, a distant field station having a track layout including a plurality of power-operated track switches to set up different routes through such track layout between entrance and/or exit points, signals at the entrance points for governing traffic thereover, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel in the office having a track diagram of said track layout, manually operable control devices on said track diagram at the points corresponding to the entrance and exit points of the different routes, an entrance relay in the control office for each of the entrance points, an exit relay in the control office for each of the exit points, circuit means in the control office responsive to the sequential manual actuation of the control devices for the entrance and exit ends of any particular route in that order to cause the energization of the respective entrance and exit relays for the corresponding points and thereafter prevent energization of other entrance and exit relays until those for said particular route are again deenergized, code transmitting means at the control office initiated into operation by the energization of the exit relay for said particular route to transmit over said communication system an entrance code having code elements determined by said energized entrance relay and an exit code having code elements determined by said energized exit relay, said code transmitting means also being effective to maintain energized said energized entrance relay and said energized exit relay for said particular route until and only until both codes have been transmitted, code receiving and storing means at the field station responsive to the entrance and exit

codes transmitted over said communication system for separately storing such codes, and route establishing means at the field station controlled by said code receiving and storing means in response to the storage of the entrance and exit codes for the opposite ends of any particular route to control the power-operated track switches of said track layout to set up that particular route and clear the signal at the entrance to such route.

29. In a switch and signal control system for railroads, a distant field station having a track layout including a plurality of power-operated track switches to set up different routes through such track layout between entrance and/or exit points, signals at the entrance points for governing traffic thereover, a code type communication system of the multiple impulse type connecting said field station with a control office, a control panel in the office having a track diagram of said track layout, manually operable control devices on said track diagram at the points corresponding to the entrance and exit points of the different routes, code transmitting means at the control office responsive to the actuation of the control devices for the entrance and exit ends of any desired route for transmitting an entrance code and an exit code for the respective ends of the route over said comunication system to the field station, an entrance relay at the field station for the entrance ends of the different routes, an exit relay at the field station for the exit ends of the different routes, code receiving means at the field station responsive to an entrance code for the entrance point to a route to energize said entrance relay for that point and responsive to an exit code for the exit point to a route to energize said exit relay for that point, route establishing means at the field station controlled by said entrance and exit relays to cause the power operation of the track switches to set up any particular route when an entrance relay and an exit relay are energized for the entrance and exit points of such route, and signal circuits controlled by said entrance relays and said route establishing means to clear the signal at the entrance to any particular route when its associated entrance relay is energized after said track switches have operated to positions to correspond with said route establishing means.

30. In a switch and signal control system for railroads, a distant field station having a track layout including a plurality of power-operated track switches to set up different routes through such track layout between signal locations constituting entrance and exit points, a code type communication system of the multiple impulse type connecting said field station with a control office, a track diagram of said track layout, manually operable means on said track diagram at each of the points corresponding to the entrance and exit ends of the different routes, code transmitting means at the control office responsive to the actuation of the manually operable means for the entrance and exit ends of any desired route for transmitting two codes corresponding to such entrance and exit ends of the desired route over said communication system to the field station, code receiving and storing means at the field station including entrance and exit code responsive relay means for the entrance and exit ends of said different routes, and route establishing means at the field station controlled by said code receiving and storing means to cause the power operation of the track switches to set up a particular route and clear the signal at the entrance end of such route in response to the storage of an entrance code in the code responsive relay means for the entrance end of that route and the storage of an exit code in the code responsive relay means for the exit end of such route.

31. In a switch and signal control system for railroads, a track layout divided into a plurality of interlocked groups located end to end with signals located at points where the interlocked groups join, said track layout having a plurality of power-operated track switches to set up different routes between signal locations constituting entrance and exit points, a code type communication system of the multiple impulse type connecting a control office with several field stations each being respectively associated with a particular interlocked group of said track layout, a track diagram on a control panel in said control office, manually operable control devices on said track diagram at each of the points corresponding to the entrance and exit points in the track layout, code transmitting means at the control office responsive to the actuation of a manually operable control device to designate an exit point following the operation of a manually operable control device to designate an entrance point in the same interlocked group for transmitting two codes respectively corresponding to such entrance and exit points over said communication system to the corresponding field station, said code transmitting means at the control office also being effective to prevent the remaining manual control devices for that interlocked group from being effective until after the transmission of such codes, code receiving and storing means at each of the field stations including entrance and exit code responsive relay means for entrance and exit points in its associated interlocked group, and route establishing means at the track layout for each of the interlocked groups controlled by the code receiving and storing means for its interlocked group to cause the power operation of the track switches to set up any particular route and clear the signal at the entrance end of such route in response to the storage of an entrance code in the entrance code responsive relay means for the entrance end of that route and the storage of an exit code in the exit code responsive relay means for the exit end of such route.

32. In a centralized traffic controlling system in which a track switch at a field station is controlled from a central office over a normally at rest code type communication system either in accordance with a code determined by an individual control lever or in accordance with the operation of a route establishing means controlled by codes determined by entrance-exit route designation, and in which the code type communication system can be initiated into operation to transmit indications to the central office, a normally energized change relay at the field station for initiating the transmission of indications from that station to the control office, a stick circuit for normally maintaining said change relay energized, circuit means acting when rendered effective to interrupt said stick circuit to cause said change relay to drop away when a change occurs in the position of the track switch, means for rendering said circuit means effective only when that track switch is positioned in ac-

cordance with a control code determined by the individual control lever, and other means for interrupting said stick circuit dependent upon the condition of routes including that track switch, whereby the individual positioning of a track switch causes the transmission of indications and the positioning of such track switch by entrance-exit route establishing means fails to interrupt said stick circuit except dependent upon route conditions.

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