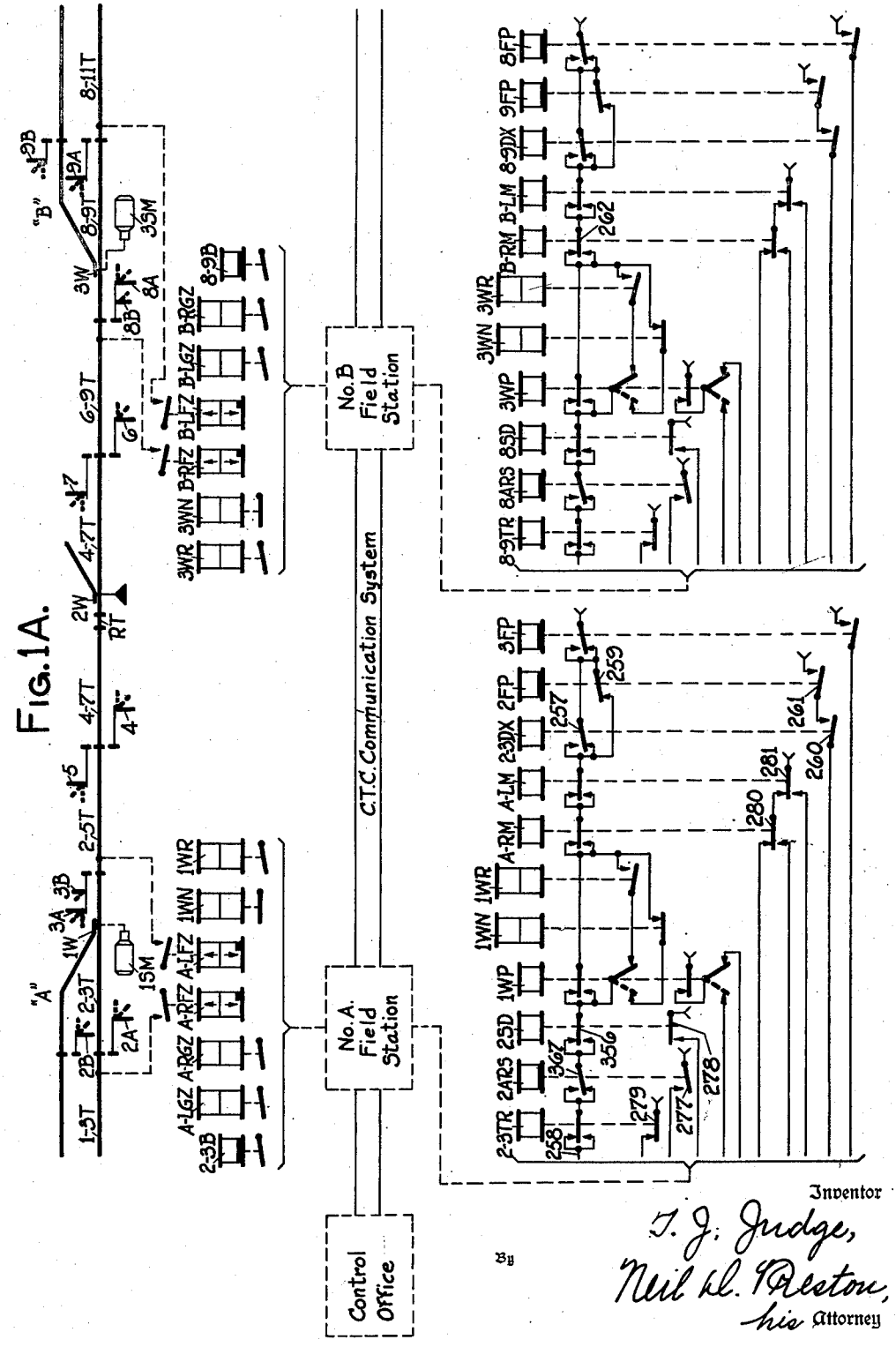
April 14, 1953 T. J. JUDGE 2,635,182

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 1



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April 14, 1953 T. J. JUDGE 2,635,182

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 2

FIG. 6.

CODE CHART

Use of Code	Code No	Code Character No.4.	No.5	No.6.	No.7.	No.8.
Switch Normal	1	(LS)				
Switch Reverse	2	(SL)				
Track circuit trans. active to Left	3		(LS)			
Track circuit trans. inactive to Left	4		(SL)			
Track circuit trans. active to right	5			(LS)		
Track circuit trans. inactive to right	6			(SL)		
Signal Right	7				(LS)	(SL)
Signal Left	8				(SL)	(LS)
Signal Stop	9				(SL)	(SL)
Phantom code for cycle having auto start	10				(LS)	(LS)

(LS) = Long followed by Short
(SL) = Short followed by Long

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 3

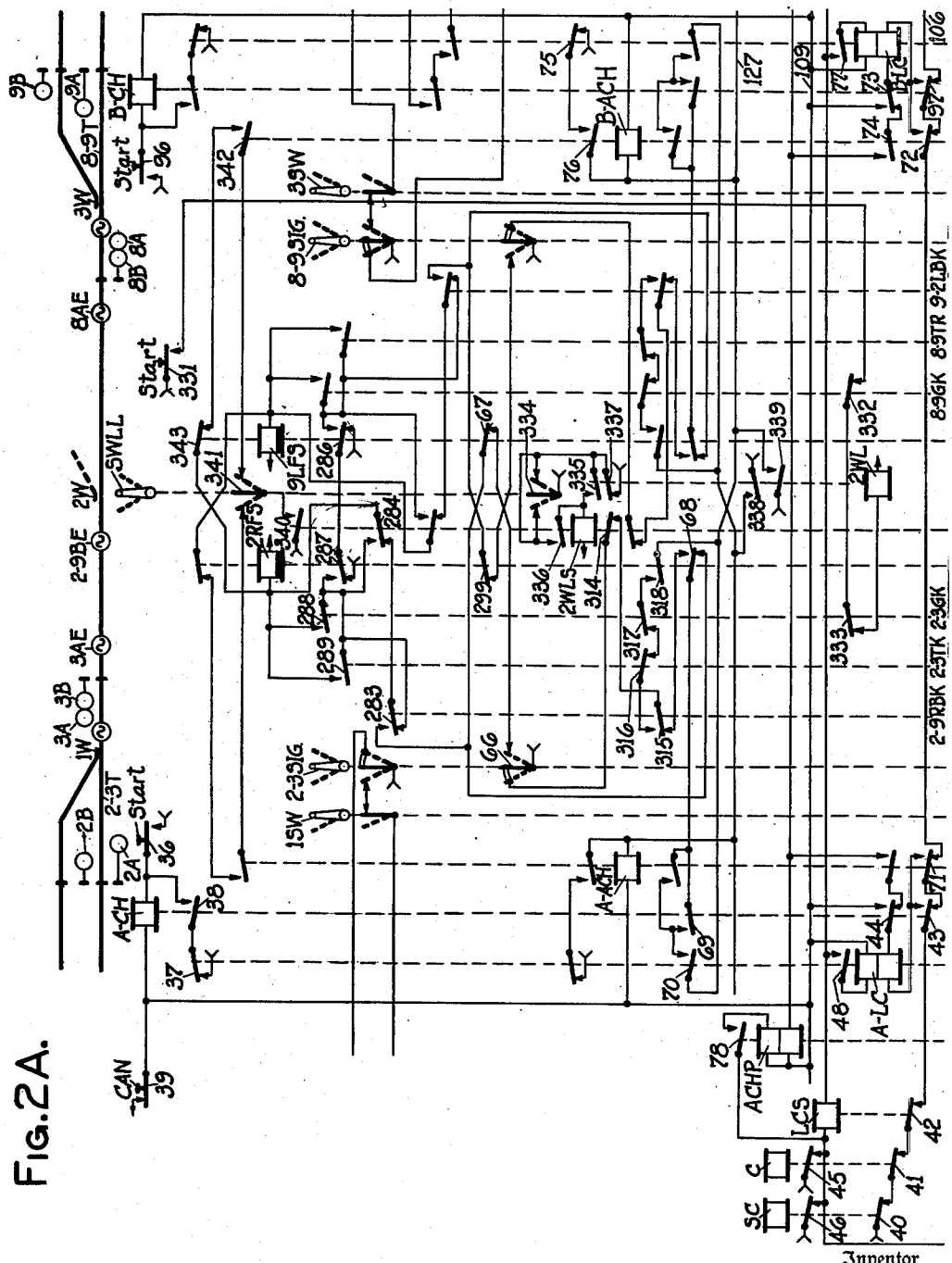


FIG. 2A.

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 4

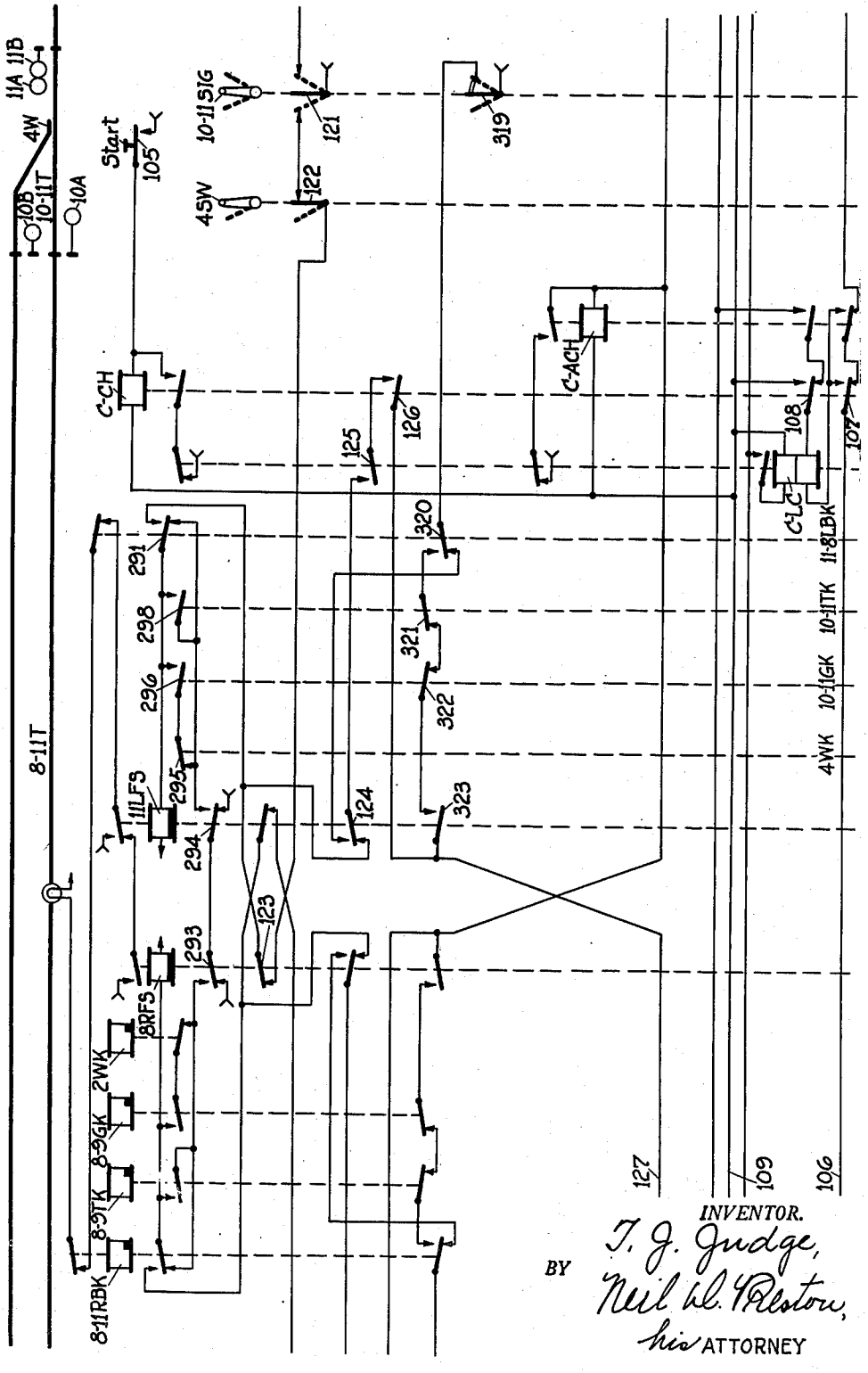


FIG. 2B.

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 5

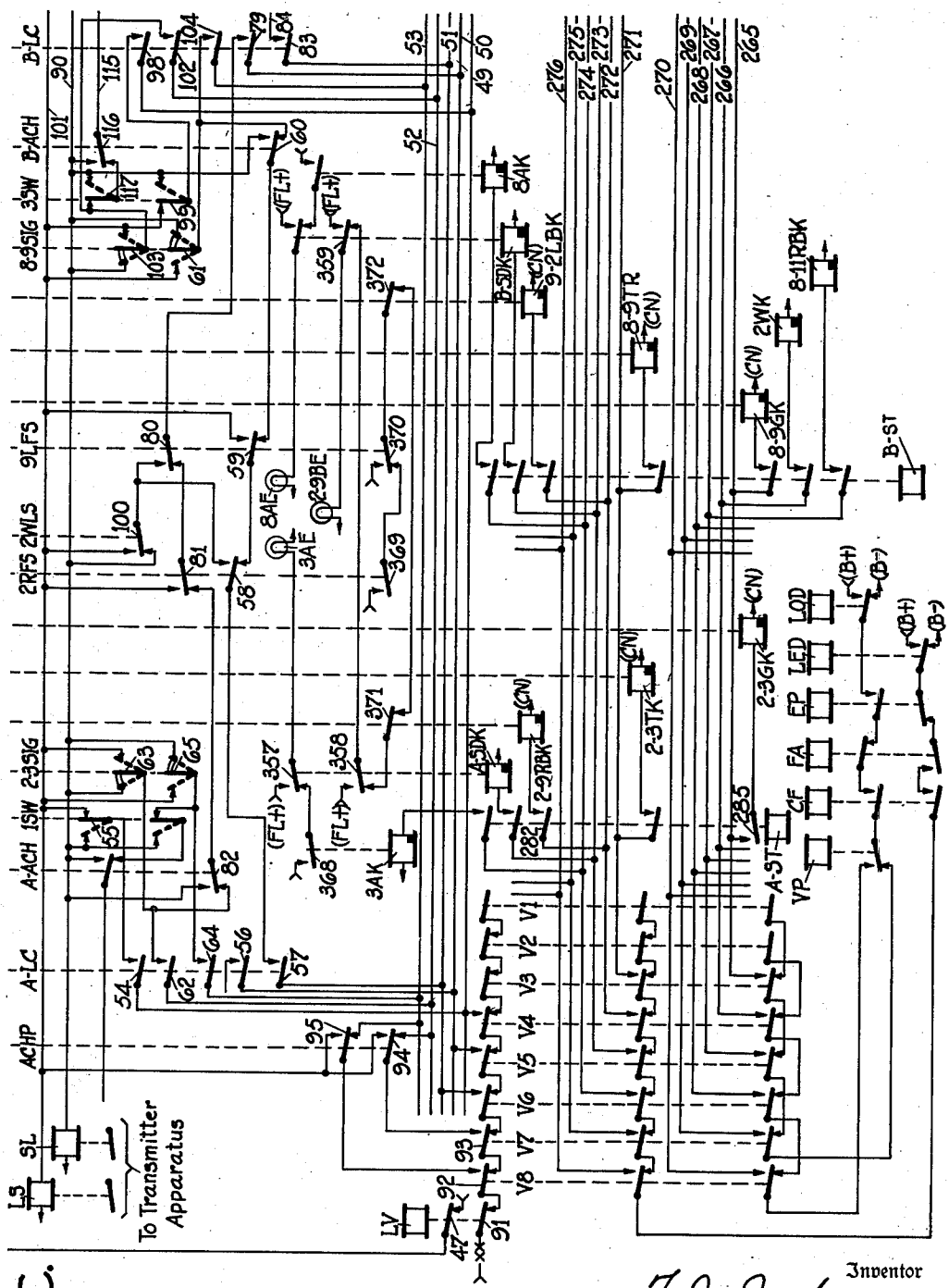


FIG. 2C.

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 6

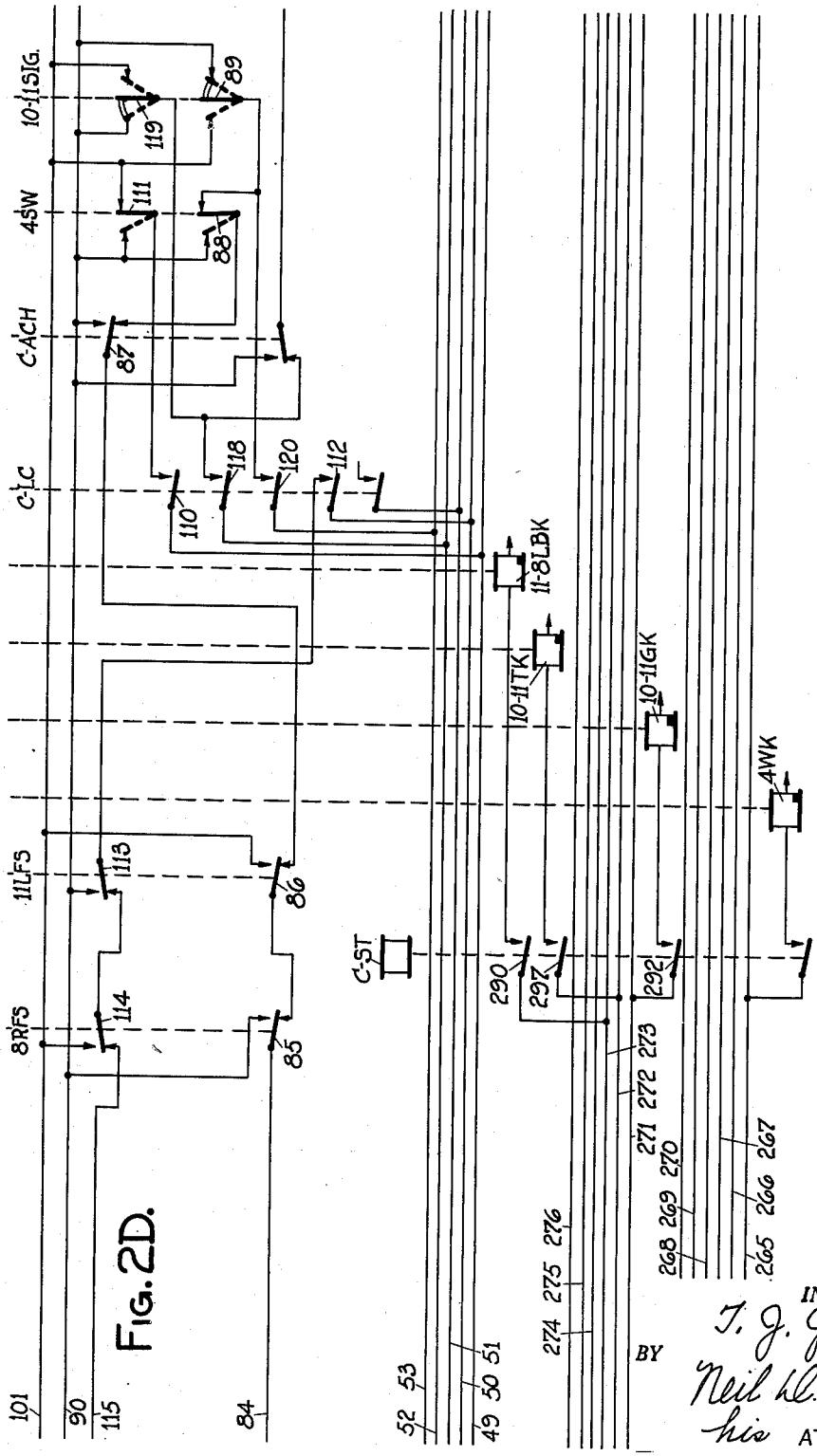


FIG. 2D.

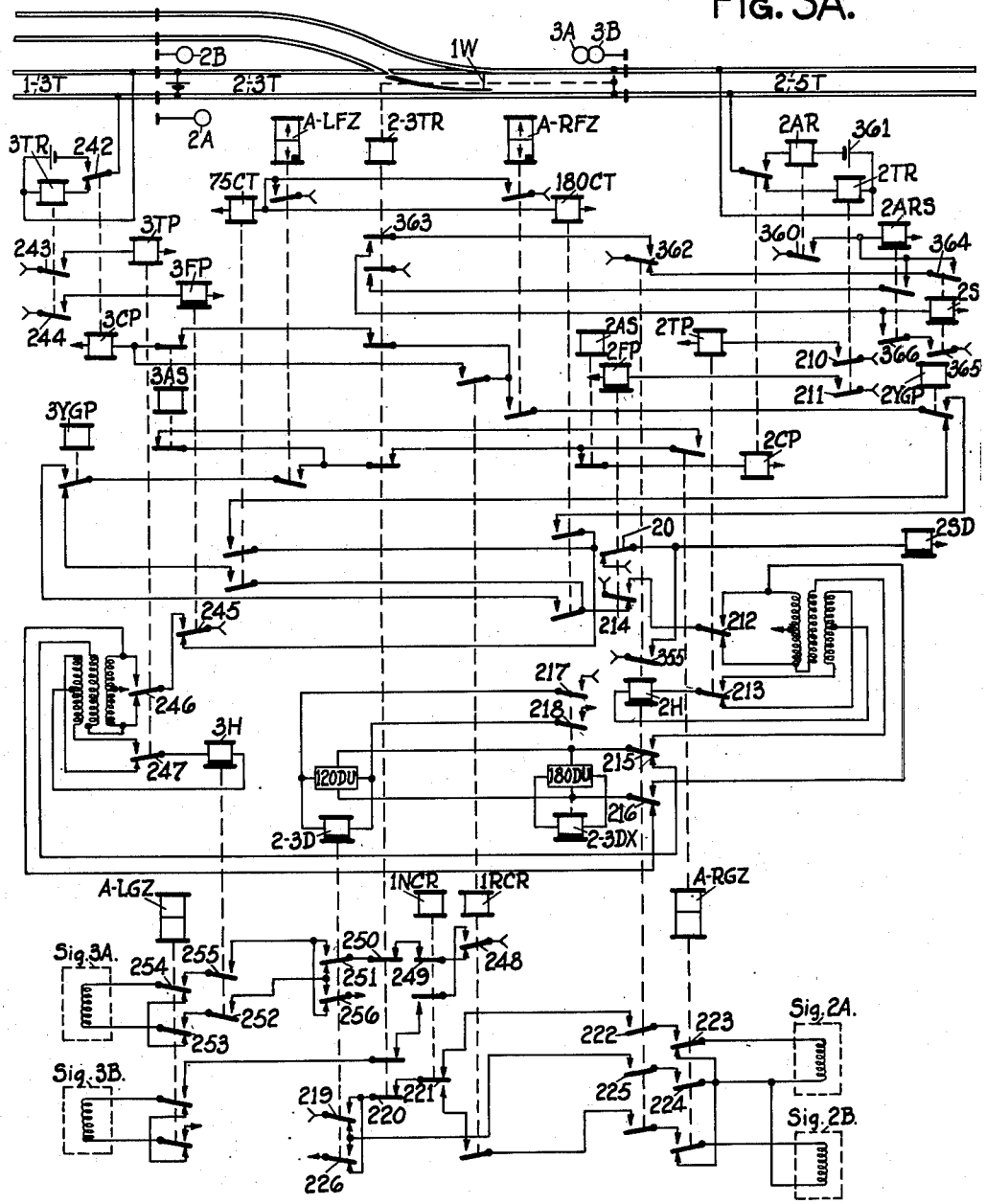
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 7

FIG. 3A.



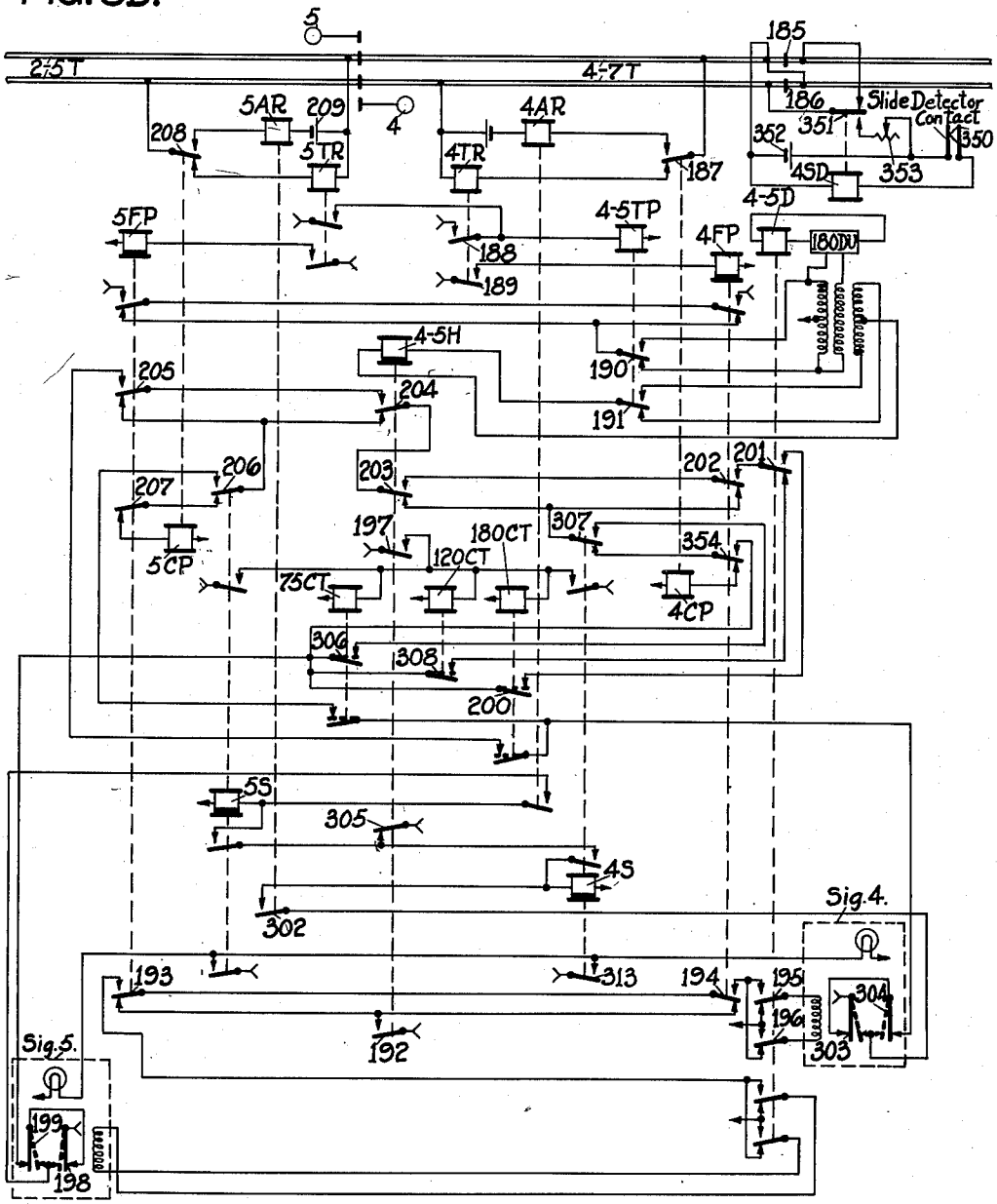
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

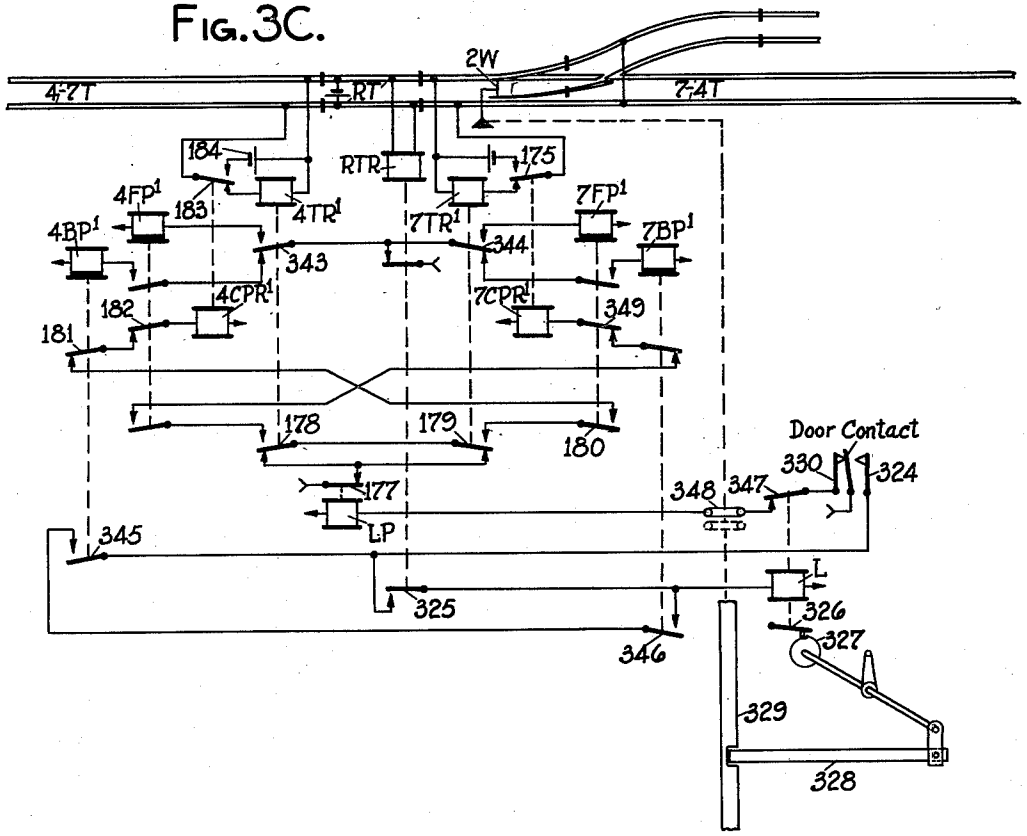
Filed March 19, 1946 13 Sheets-Sheet 8

FIG. 3B.



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FIG. 3C.



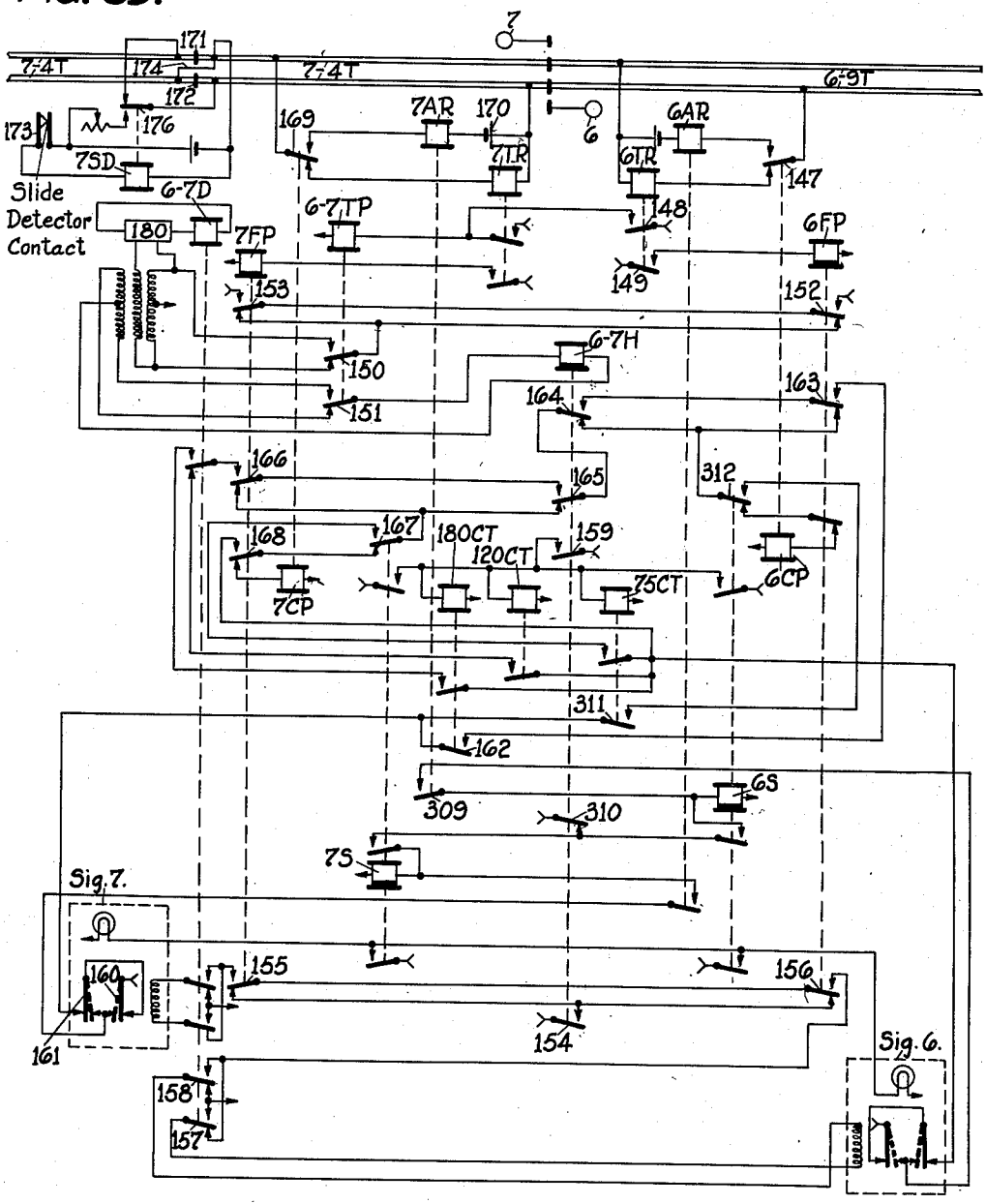
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April 14, 1953 T. J. JUDGE 2,635,182

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 10

FIG. 3D.



INVENTOR.

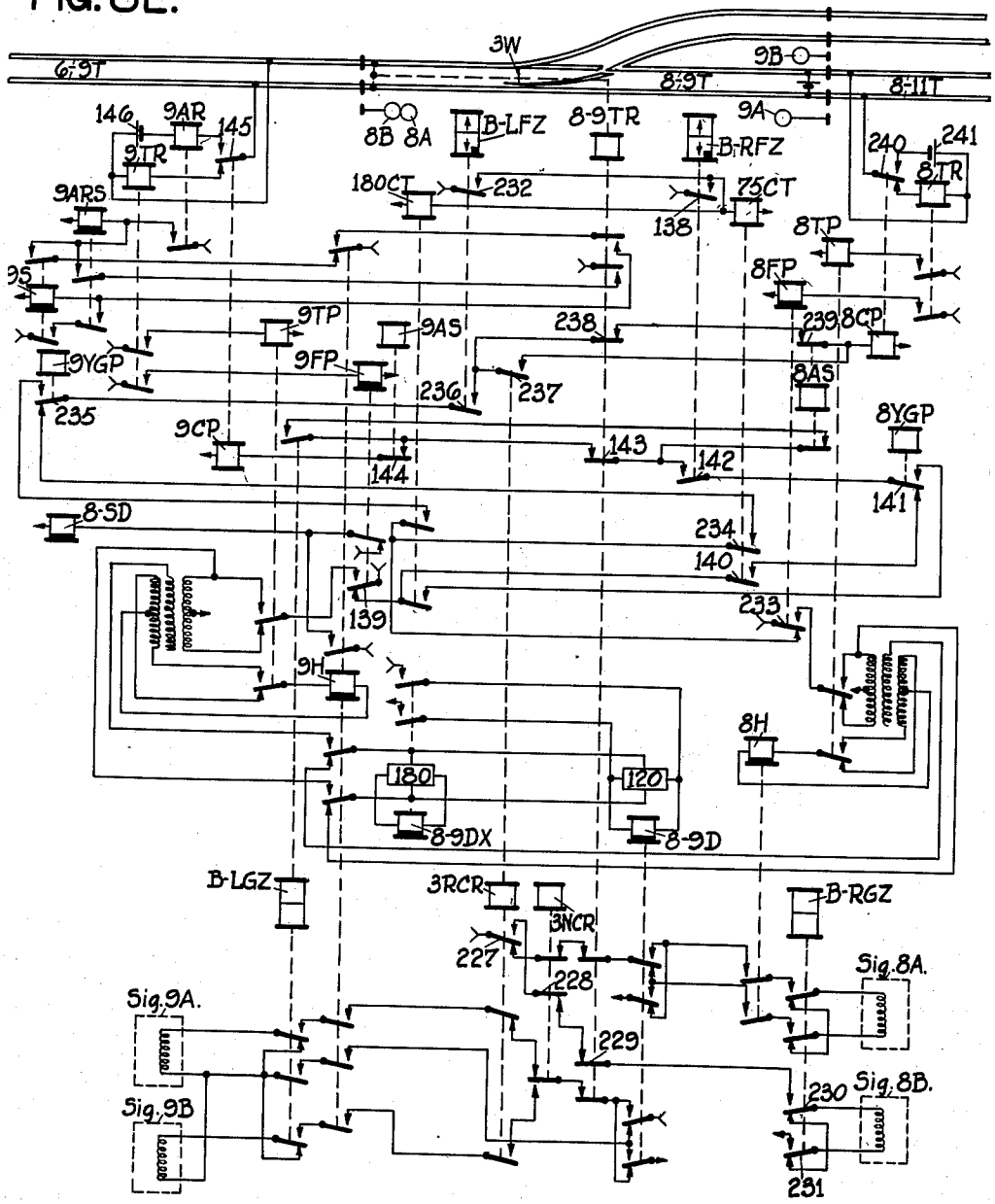
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 11

FIG. 3E.



INVENTOR.

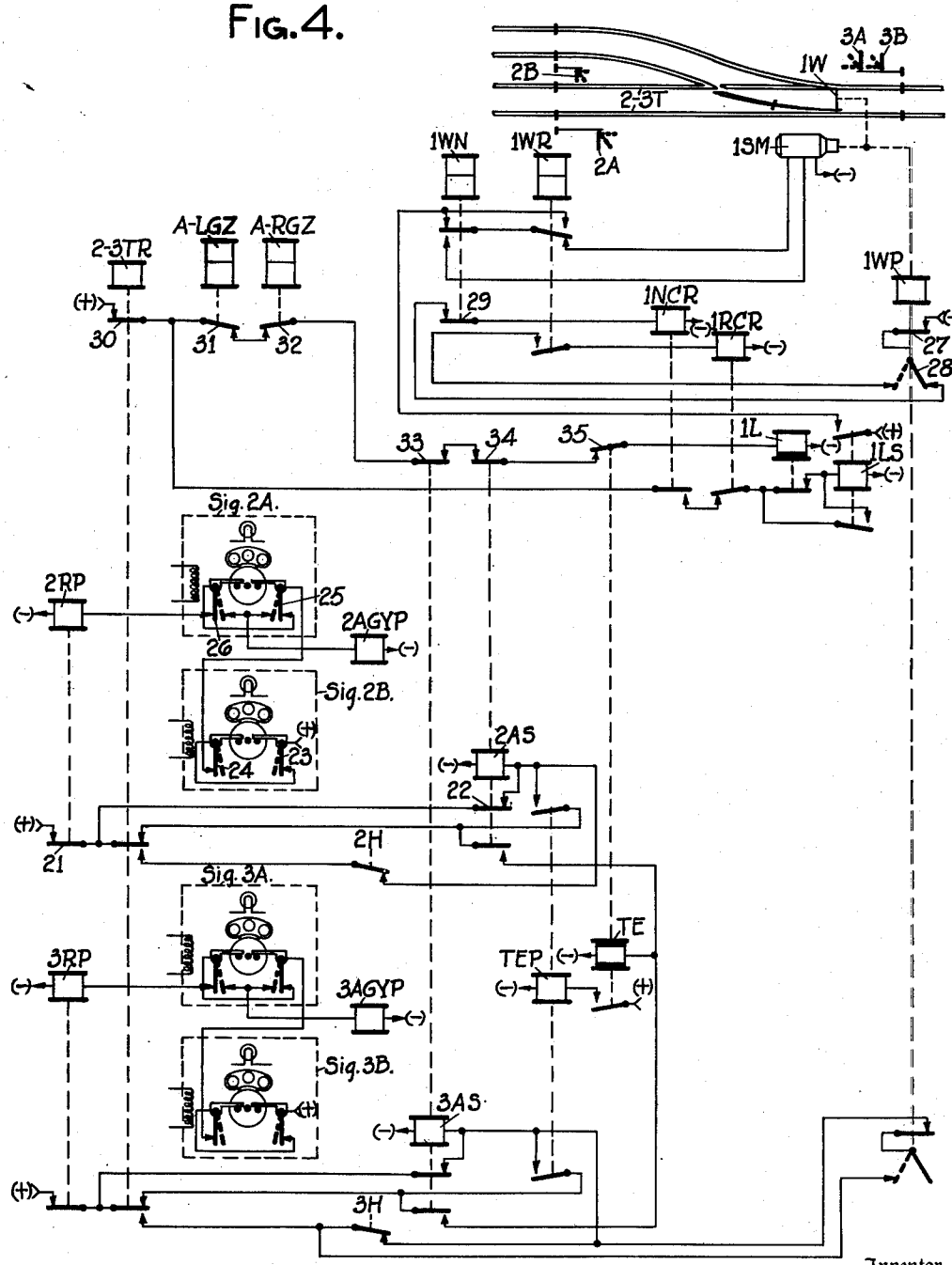
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 12

FIG. 4.



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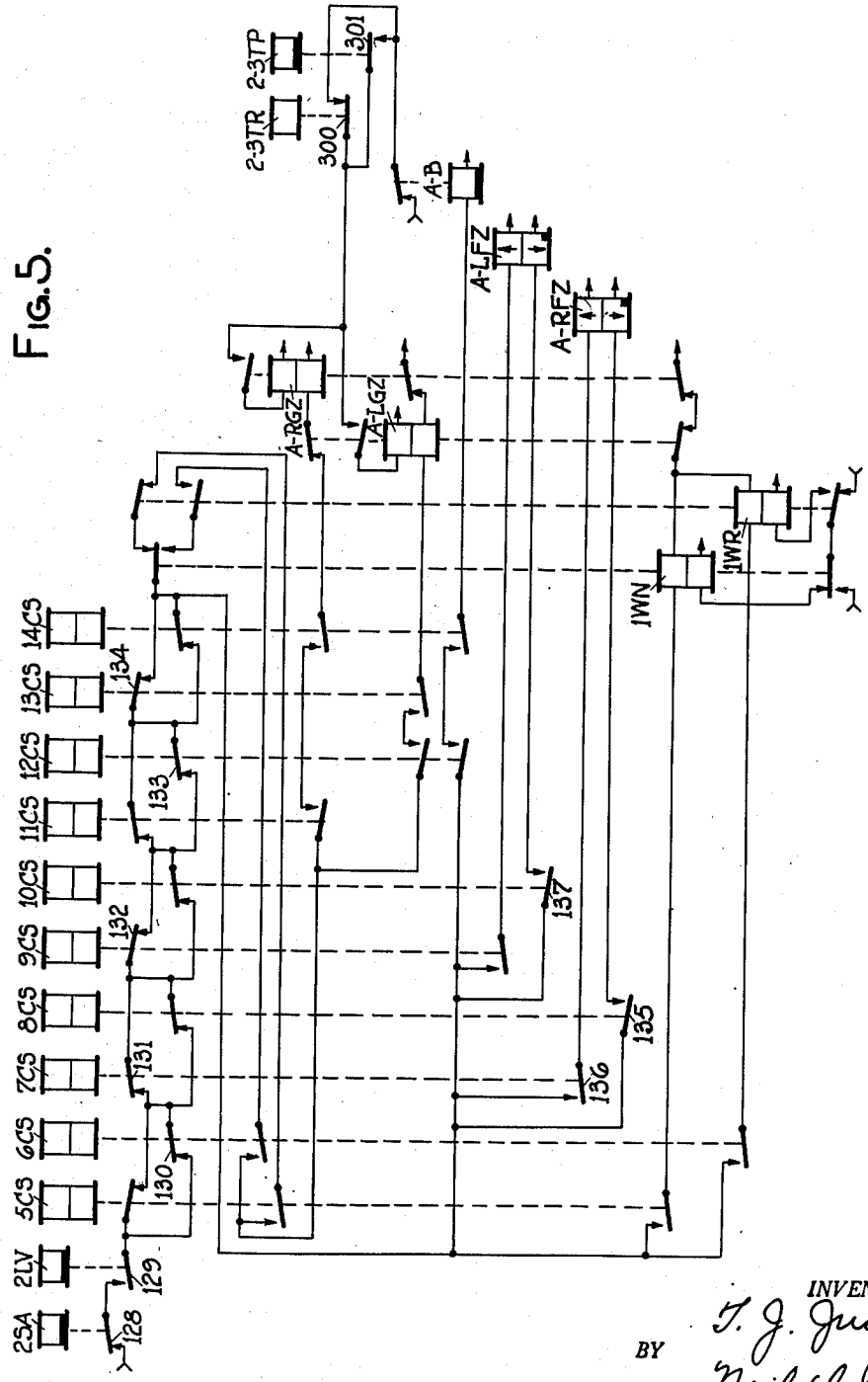
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April 14, 1953 T. J. JUDGE 2,635,182

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Filed March 19, 1946 13 Sheets-Sheet 13

FIG. 5.



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Patented Apr. 14, 1953

2,635,182

UNITED STATES PATENT OFFICE

2,635,182

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS HAVING TRACK OBSTRUCTION DETECTING MEANS

Thomas J. Judge, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

Application March 19, 1946, Serial No. 655,622

6 Claims. (Cl. 246—121)

1

This invention relates to centralized traffic controlling systems for railroads, and it more particularly pertains to a centralized traffic controlling system employing coded track circuits for controlling the signals in accordance with railway traffic conditions.

In a centralized traffic controlling system for single track railroads in which coded track circuits are employed for the portion of the control of the wayside signals in the field which is automatic, a problem is encountered to provide coordination between the direction of traffic designated by a dispatcher in a control office and the direction of track circuit code transmission through the track rails for the control of signals over a corresponding stretch of track. A means for providing such coordination is shown, for example, in my prior Patent No. 2,357,518, and in another prior Patent No. 2,357,519, both patents being dated September 5, 1944. This invention is to be considered as an improvement over the systems disclosed in such patents.

In systems of this particular character, switch and signal control codes are transmitted by a selector system from the central control office to the signal locations at the respective ends of the passing sidings in accordance with switch and signal operational designations by a dispatcher in the usual manner, and the designation by a dispatcher of a signal desired to be cleared is effective automatically to cause the transmission to the next field station in advance of that signal of a code to render effective the transmission of track circuit codes as required for the control of that signal and the intervening automatic signals between that signal and the next centralized traffic controlled signal location in advance.

An object of the present invention is to provide a centralized traffic controlling system having coded track circuits in which the code transmitters for transmitting the track circuit code pulses are normally inactive, but such code transmitters can be rendered active in response to the respective designation at the control office of the signals desired to be cleared. The transmission of track circuit codes thus established is maintained active for a particular direction of code transmission until automatically rendered inactive after passage of a train, or after the established route has been restored by action of the dispatcher at the control office. It will be readily apparent that if a dispatcher could transmit a control from the control office that would call for a direction of traffic contrary to that established through a stretch of track occupied by a train between passing sidings, the track circuit code upon which the train is dependent could be taken away, and thus cause delay because of removal of track circuit code required for clearing the intermediate signals between passing sidings.

2

Another object of the present invention is therefore to provide an interlocking means at the control office for permitting the transmission of signal control codes for the establishment of traffic in a direction opposite to the direction last established in a stretch of single track only subsequent to the reception of an indication at the control office communicated from the field that such stretch of track is unoccupied by a train.

Another object of the present invention is to indicate over the track rails and by code communication to the control office dangerous conditions along the trackway such as land slides, washed out bridges, and the like at any time that such conditions may occur even though the coded track circuit apparatus may be normally inactive at that time.

Another object of the present invention is to provide adequate means for governing an electric lock associated with an outlying track switch in a stretch of track between passing sidings so as to allow the release of such lock for the passage of a train out of the outling switch, dependent upon a required act of the dispatcher at the control office, and dependent upon a check of occupancy of the particular block with which such outlying track switch is associated, such control being accomplished by the use of coded track circuits with their code transmitters controlled at the ends of the block by the centralized traffic controlling communication system associated with such ends.

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

In describing the invention in detail, reference will be made to the accompanying drawings in which those parts having similar features and functions are designated throughout the several illustrations by like letter reference characters which are generally made distinctive by reason of preceding numerals indicative of the location of the signals or track switch with which such parts are associated, and in which—

Figs. 1A and 1B, when placed end to end re-

spectively, illustrate the general organization of the system provided by the present invention for the code communication of controls from a control office to various field stations, and the communication of indications from such field stations to the control office as to the conditions of the apparatus associated with such field stations;

Figs. 2A and 2B, when placed end to end above the Figs. 2C and 2D respectively, illustrate the apparatus and circuit organization at the control office required for the operation of the system provided by the present invention;

Figs. 3A, 3B, 3C, 3D and 3E, when placed side by side respectively, illustrate the stretch of trackway between two passing sidings for this embodiment of the present invention together with coded track circuit means for controlling the switches and signals, and under certain conditions Fig. 3A will be considered as being placed at the right of Fig. 3E to show a stretch of main track with its associated passing siding;

Fig. 4 shows certain circuits typical to the centralized traffic control of switches and signals at a given field station;

Fig. 5 illustrates a typical manner of controlling application relays at a given field station in accordance with code impulses communicated by the communication system to that field station; and

Fig. 6 shows a code chart indicating how various control codes are assigned to the respective channels of a control cycle.

The illustrations employed in the disclosure of this embodiment of the present invention have been arranged to facilitate the disclosure of the invention as to the mode of operation and the principles involved rather than for the purpose of illustrating the construction and arrangement of parts that would be employed in practice. Thus the relays and the contacts are shown in a conventional manner, certain relay contacts being shown in written circuit form and identified as of particular relays by corresponding reference characters appearing above such contacts.

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 these symbols are used always have current flowing in the same direction. The symbols (B+) and (B−) are used to indicate the respective positive and negative terminals of a center tap battery or other suitable source of direct current, and the center tap of such source is indicated by the symbol (CN). The symbol (FL+) is used to indicate connection to the positive terminal of a suitable source of direct current through a suitable intermittently actuated contact to provide intermittent energization. The symbols (LS) and (SL) are used to indicate code characters transmitted over the communication system, each character comprising a combination of a long and short period, the symbol (LS) representing a code character having long and short periods respectively, and the symbol (SL) representing a code character having short and long periods respectively.

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

The trackway for which this embodiment of the present invention is provided, comprises a main stretch of track having passing sidings associated therewith, such stretch of track being divided into the usual track sections to provide several track sections constituting a block between passing sidings. With reference to Fig. 3A, a passing siding is illustrated as being connected at its right-hand end to the main track by the track switch 1W, and similarly in Fig. 3E, the left-hand end of a passing siding is illustrated as being connected to the main track by a track switch 3W. An outlying switch 2W is shown in Fig. 3C as being connected to the main track, and it is to be understood that such track switch is provided for hand-throw operation in the usual manner with the hand operation of the track switch limited by the usual type of an electric lock. It will be readily apparent as the description progresses that the track switch 2W and the control apparatus associated with the main track as illustrated in Fig. 3C can be provided when required in practice, but the system is operative without the apparatus disclosed in Fig. 3C under conditions where such outlying switch is not required in practice.

The arrangement of the signals at the ends of the passing sidings is provided in the usual manner to provide a short detector or OS track section for the track switch at each end of the passing siding. The detector track section 2—3T is provided for the right-hand end of the passing siding illustrated in Fig. 3A, for example. Such detector track section has a steadily energized track circuit provided in the usual manner. The power operation of the track switches at the respective ends of the passing sidings can be provided, for example, by a suitable power switch machine controlled as shown in Fig. 4.

The signals at the respective ends of the passing sidings are provided for governing traffic in each direction over the detector track section at such passing siding such signals being normally at stop, and subject to manual control by an operator at the control office in accordance with the communication of controls for such signals to respective field stations by a code communication system such as disclosed in detail, for example, in the prior application of Hailes, et al., Ser. No. 484,728, dated April 27, 1943, which has resulted in Pat. No. 2,399,734, dated May 7, 1946.

Although this embodiment of the present invention has been particularly adapted to employ the centralized traffic controlling code communication system disclosed in the above mentioned Hailes et al. application, it is to be understood that other types of code communication systems could be readily employed by those skilled in the art, such, for example, as the code communication system disclosed in the patent to Judge, et al., No. 2,032,544, dated June 1, 1937.

The entering signals 3A and 3B at the right-hand end of the passing siding illustrated in Fig. 3A are provided for governing westbound traffic over the track switch 1W through the track section 2—3T, and the head-block signals 2A and 2B are provided for governing eastbound traffic through that track section. At the left-hand end of the passing siding illustrated in Fig. 3E, the signals 8A and 8B are provided for governing eastbound traffic through the OS track section 8—9T and the signals 9A and 9B are provided for controlling westbound traffic through such section.

Intermediate signals, which are controlled only

in accordance with coded track circuits transmitted through the track rails of the respective track sections of the block illustrated between passing sidings, are provided at double intermediate signal locations, but it will be readily apparent as the description progresses that the present arrangement can be modified to provide control for staggered automatic signal locations in accordance with the requirements of practice. The intermediate signals 4 and 6 are automatic signals provided for governing eastbound traffic in the block between the passing sidings illustrated, and the signals 5 and 7 are provided for governing westbound traffic in such block.

Although the signals illustrated are of the searchlight type, it is to be understood that other types of signals such as the color light type having individual color lamp units, semaphore, or position light signals could as well be employed.

Each of the track sections in the stretch of track between the passing sidings, except for the short release track section RT associated with the outlying track switch 2W, has a coded track circuit which comprises a track battery and a code following track relay TR at each end of the track section. For the purpose of obtaining the best operating conditions of the code following track relays, it is desired that each relay have a polar structure so arranged as to cause the relay contacts to be biased to a deenergized position from which they can be moved upon energization of the relay windings with a particular polarity only. Also associated with several of the coded track circuits is a series approach control relay AR which can be of a similar character to the track relays, and certain of the approach relays AR have slow acting repeater relays ARS associated therewith.

At the ends of each of the track sections having a coded track circuit, is a code transmitter relay CP or CPR, which is operated when rendered active to apply a code of pulses at that end of the track circuit at a selected rate. For the purpose of obtaining the most desired operating characteristics of each of the relays CP, such relay is also provided with a polar structure to provide the operating characteristics above described as being preferable for the code following relay TR.

Relays TP and FP at each end of each coded track circuit are provided as front contact repeaters of the track relay TR at such end, the relay TP being quick acting to follow the codes received, while the relay FP is made to be sufficiently slow acting as to be maintained picked up whenever a code of either of the code rates employed is received. Also at certain switch or signal locations a slow acting back contact repeater relay BP is provided that is energized through a back contact of the associated track relay TR, provided that the associated front contact repeater relay FP is picked up.

East and west directional stick relays S are provided for the intermediate signals for controlling the application of track circuit code to the track sections in the rear of a train for governing the clearing of signals for the passage of a following train.

Relays H and D are provided for the respective ends of the coded track circuits for use in the control of the signals, and such relays are energized in accordance with track circuit codes transmitted through the track circuits with which they are associated. The relays H and D are sufficiently slow acting to cause them to be

maintained steadily picked up during the time when a track circuit code is being received. Each of the relays D is energized through the medium of a decoding transformer and a tuned circuit in a manner generally employed in coded track circuits so as to cause such relay to be picked up only in response to a particular code rate employed for the clearing of signals. In this embodiment of the present invention the code rate for energizing the relays D is at times a 120 rate and at other times a 180 rate. At the ends of the block, relays DX are provided so as to be tuned to a 180 rate, and the purpose of such relays is to provide by their response an indication that the entire block is unoccupied by a train.

Suitable code forming means is provided at the respective signal locations such, for example, as code oscillators or motor driven coders to form the different code rates employed. For this embodiment of the present invention, an oscillator 180CT is provided for each of the signal locations for forming a 180 code, an oscillator 120CT is provided at each of the intermediate signal locations for forming a 120 code, and an oscillator 75CT is provided at each of the signal locations for forming a 75 code.

Each of the field stations has office controlled application relays as shown in Figs. 1A and 1B, the relays LGZ and RGZ being provided for governing the signals for westbound and eastbound directions of traffic respectively, and a relay B being provided at each of the field stations for use in the manual restoration to stop of signals by the dispatcher at the control office. Relays WN and WR are provided at each of the field stations for causing the power operation of the switch machine SM at such station to its respective normal and reverse positions.

The initiation of the track circuit code transmitter relays CP for the ends of the coded track sections adjacent the respective field stations is provided at each station in accordance with the control from the control office of eastbound and westbound traffic direction relays RFZ and LFZ respectively. These relays are of the magnetic stick type, and are therefore maintained in their picked up or dropped away position as last operated over the code communication system from the control office.

At the control office (see Figs. 2A to 2C inclusive) various switch and signal control levers, and relays are provided for purposes specifically set forth in the above mentioned application of Hailes, et al., Ser. No. 484,728, filed April 27, 1943, which has resulted in Pat. No. 2,399,734, dated May 7, 1946, to which reference is to be made for a description in detail of such apparatus. For convenience in readily identifying the apparatus employed in this embodiment of the present invention with that shown in the above mentioned Hailes, et al. application, corresponding letter reference characters for the various relays and control switches have been employed to facilitate the reference to such application for a more detailed description of their mode of operation. This communication system includes relays SA, LV, B, and CS. The relay SA is steadily picked up during a cycle of operation; relay LV is picked up at the end of a cycle; relay B is a signal stop control relay; and relays CS are decoding relays.

In addition to the relays generally employed in the code communication system, the present embodiment employs relays ACH which are used

in effecting automatic starts of the system for the transmission of control cycles of operation used in transmitting controls for the initiation of the track circuit code transmitters at the respective field stations. Associated with the relays ACH is a repeater relay ACHP which is picked up each time an automatic start is initiated for the transmission of a control cycle of operation for the starting of any particular track circuit code transmitter. The function of such relay ACHP will be more apparent as the description progresses, it generally being employed to render the transmission of a control cycle for the starting or shutting down of a track circuit code transmitter ineffective for controlling signals at that particular field station.

The code communication system also includes code determining relays LC for selecting respective codes for transmission to the respective stations, and a stick relay LCS, the principal function of which is to prevent the changing of the condition of the relays LC during a communication cycle.

The relays RFS and LFS are provided for each block and for each siding section for maintaining an interlock in the traffic direction set up within such track portion. That is, the purpose of such relays is to prevent the transmission of control codes to the field for changing the direction of code transmission in the coded track circuits, provided such controls should be inadvertently designated for transmission by an operator of the control machine. It is therefore provided that the relays RFS and LFS are controlled in accordance with conditions of track circuit code transmission in the field, indication of such conditions being communicated to the office to condition the indication responsive relays at the office such as the relays WK, GK, TK and BK. Relays of this type are magnetic stick relays so as to be maintained in their picked up or dropped away respective positions in accordance with the particular character of energization last applied to such relays. Relays 2WL and 2WLS are provided at the control office as part of the apparatus governing the transmission of controls for a switch lock in the field.

Having thus considered the general organization of the apparatus employed in this embodiment of the present invention it is believed that the specific circuit organization can best be understood when considered in connection with specific typical conditions of operation of the system.

Operation

General.—Before considering specifically the circuit organization provided for establishing various routes through the track layout, some consideration will be given as to the general mode of operation of the system without attempting to describe specifically the circuits employed to accomplish such operation.

In accordance with the general manipulation of the control machine according to the usual practice, the machine operator positions the respective switch and signal control levers according to routes desired to be established, and effects the transmission of controls to the respective field stations with which such levers are associated by the actuation of start buttons associated with such field stations. In this manner a number of different controls can be designated for transmission, and the circuit organization of the code communication apparatus is such as to cause the transmission of control cycles to such field stations, one cycle of operation at a time and one cycle of operation for each station, such cycles being transmitted in a particular predetermined order, and such order being established by the circuit organization for the relay LCS in which the relays LC have their respective contacts inserted in series in the circuit for the relay LCS.

Thus the designation of the controls for transmission to a field station by the positioning of switch and signal control levers SW and SIG, and the actuation of the start button for causing the transmission of these controls, is effective to first pick up the relay CH associated with the initiation of the control cycle start for that field station, and the picking up of such relay is effective to pick up the associated relay LC. The picking up of the relay LC for that field station is in accordance with the actual setting into operation of the code communication system for the transmission of the control cycle to that particular field station, and in accordance with the picking up of such LC relay, a circuit is closed to cause the picking up of the relay ACH associated with the next field station in advance of the signal desired to be cleared for causing an automatic start for the transmission of controls to that field station. Thus, in general terms, the initiation of the system for the transmission of a control for clearing a signal, is effective to pick up a relay ACH for the next field station in advance of the signal desired to be cleared to thereby cause the initiation of a subsequent cycle of operation for the transmission of a control to the next field station in advance to start the transmission of track circuit codes through the track rails in the direction of the signal desired to be cleared.

As soon as the track circuit code has been transmitted through the track rails to the signal desired to be cleared, a relay FP is picked up in the field, and the picking up of such relay is effective to transmit an indication to the control office that the code transmitters have been properly conditioned in accordance with the route desired to be established. Upon the reception at the control office of such indication, the relays LFS and RFS for the particular stretch of track between field stations involved are conditioned to establish an interlock and prevent the inadvertent removal of the track circuit codes thus established, as by an inadvertent attempt at transmission of the controls from the control office for a direction of traffic contrary to that already established through that particular stretch of track.

Having therefore established a route for a train in the field, and having established an interlock in the control office to prevent the taking away of that route or any portion thereof, it will be assumed that the passage of a train is effective in the field over such route, and subsequent to the passage of such train, an indication is transmitted to the office that the particular stretch of track involved is unoccupied, and in accordance with the reception of such indication, a relay ACH is picked up to initiate an automatic start for the transmission of a control cycle to the same field station to which a control cycle was initially transmitted for the setting into operation of the track circuit code transmitter. However, the character of the code communicated from the control office to that field station under such conditions is such as to cause the dropping away of a relay FZ at that field station to render the track circuit code transmitter inactive at that station and therefore restore the conditions to

normal for the stretch of track under consideration above.

Normal conditions.—Normally, with no routes established, and with the trackway unoccupied by trains, the transmitters and receivers of track circuit codes are inactive, and therefore the wayside signals are at stop, and the only relays that are energized under such conditions are the track relays TR that are controlled by steadily energized track circuits, and such other redays as are provided for repeating normal conditions of the system.

The slide detector relays SD (see Figs. 3A and 3E) at the respective ends of the block between passing sidings are normally energized so as to provide a means responsive to a condition of slide detection which may be desired to be established at a time when the system is normally inactive or at rest. The slide detector relay 2SD, for example, is maintained picked up under normal conditions by the energization of an obvious circuit closed at back contact 20 of relay 2FP.

The approach locking relays AS (see Fig. 4) are normally energized by circuits provided in accordance with the usual practice for the control of time or approach release locking. The relay 2AS, for example, is normally energized by a circuit extending from (+), including front contact 21 of relay 2RP, front contact 22 of relay 2AS, and winding of relay 2AS to (—). It will be noted that energy for this circuit is applied through front contact 21 of relay 2RP, such relay being normally energized in accordance with the signals 2A and 2B being at stop by a circuit extending from (+), including normally closed contacts 23 and 24 of signal 2B and contacts 25 and 26 of signal 2A, and winding of relay 2RP, to (—).

The normal correspondence relay INCR for the track switch IW is normally energized in accordance with the closure of a circuit extending from (+), including front contact 27 of relay IWP, polar contact 28 of relay IWP in its right-hand position, front contact 29 of relay IWN, and winding of relay INCR, to (—). The lock relay IL for the track switch IW is energized normally by a circuit extending from (+), including front contact 30 of relay 2—3TR, back contact 31 of relay A—LGZ, back contact 32 of relay A—RGZ, front contact 33 of relay 3AS, front contact 34 of relay 2AS, back contact 35 of the thermal relay TE, and winding of relay IL, to (—). The relays IL and ILS are used in providing for the safe operation of the track switch IW in a well known manner generally employed in practice.

The magnetic stick relays, under normal conditions when the system is at rest, of course assume their last operated positions, and it is to be considered that the last conditions established as by the passage of a train and the restoration of all the switch and signal control levers to their center positions has provided that the magnetic stock relays have been operated to their dropped-away position as indiacted in the drawings.

Transmission of controls at the control office.—With reference to Fig. 6, a code chart is shown showing the manner in which a control cycle of operation comprises all of the switch and signal and traffic direction control codes required for transmission to any particular field station. It will be noted that the composition of the cycle is such as to allocate the first group of pulses for control station selection, the next pulse for switch control, the next fololwing pulse for the rendering active or inactive of a track circuit code transmitter in connection with the transmission of track circuit codes through the track rails to the left of that field station, the next following pulse for the rendering active or inactive of a code transmitter in connection with the transmission of track circuit codes through the track rails to the right of that field station, and the last two pulses for the control of the signals at that field station. It will be noted that the signal control code characters(LS) for both of the signal code pulses is an additional code to that usually provided for the control of the signals, and such code is merely used as a phantom code during the transmission of a cycle of operation which has been automatically initiated. It will be readily apparent that it is desirable under such conditions of automatic initiation of transmission to leave the control of the signals as last established by the dispatcher.

To consider further the manner of transmission of control cycles of operation for the establishment of routes, it will be assumed, for the purpose of illustration, that it is desired to establish a route at a time when normal conditions of the system exist for the clearing of signal 2A for the passage of an eastbound train to the next passing siding.

To establish this route, the dispatcher operates the signal control lever 2—3SIG (see Fig. 2A) to its right-hand position, and checks that the switch control lever ISW is in its normal position and then depresses the start button associated with such control levers to initiate the cycle of operation.

In accordance with the closure of the start button contact 36, an obvious circuit is closed to pick up relay A—CH, and a stick circuit is established to maintain such relay picked up until a control cycle has been initiated, extending from (+), including back contact 37 of relay A—LC, front contact 38 of relay A—CH, winding of relay A—CH, and normally closed contact 39 of the cancel button CAN, to (—).

Upon the picking up of relay A—CH a circuit is closed to cause the picking up of relay A—LC extending from (+), including back contact 40 of relay SC, back contact 41 of relay C, back contact 42 of relay LCS, front contact 43 of relay A—CH, lower winding of relay A—LC, front contact 44 of relay A—CH, and normally closed contact 39 of the cancel button CAN, to (—).

The relay LCS is picked up to further initiate the starting of a control cycle, in accordance with the picking up of relay A—LC, by the energization of a circuit extending from (+), including back contacts 45, 46 and 47 of relays C, SC and LV (see Fig. 2C) respectively connected in multiple, winding of relay LCS, front contact 48 of relay A—LC, upper winding of relay A—LC, and the normally closed contact 39 of the cancel button CAN, to (—). Upon the picking up of relay LCS by the energization of the circuit just described, a circuit (not shown) is closed to cause the picking up of the relay C for starting the communication of the control cycle. The manner in which the relay C is controlled to provide such mode of operation, and the manner in which the relay LCS is maintained energized throughout the control cycle, is fully described in the above mentioned application of Hailes, et al., Ser. No. 484,728, dated April 27, 1943.

Assuming the control cycle to be started, the stepping relays V (see Fig. 2C) are picked up in order according to the numerical order defined by their numerical reference characters, the first

three steps being assumed as provided for the transmission of a station selecting code in a manner fully described in the above mentioned Hailes, et al. application. The transmission of code characters subsequent to the transmission of the station selecting code is provided by successive energization of the respective channel wires 49, 50, 51, 52 and 53 which are connected respectively to channels provided by stepping relays V4, V5, V6, V7 and V8.

The respective code characters transmitted are selected for transmission by the relay LS and SL. As it has been heretofore pointed out, the energization of the relay LS causes the transmission of a character comprising a long period followed by a short period, and the energization of a relay SL causes the transmission of a short period followed by a long period. Thus, in accordance with the assumed transmission of a switch control code for operating the track switch 1W to its normal position, the picking up of the relay V4 is effective to close a circuit to apply energy to the channel wire 49, and in accordance with the energization of such wire, a circuit is closed to cause the picking up of the relay LS, extending from such channel wire 49, including front contact 54 of relay A—LC, contact 55 of switch lever 1SW in its right-hand position, and winding of relay LS, to (—).

The following character of the code is an (LS) or (SL) character in accordance with the direction of traffic established in the track section 1—3T in the rear of signal 2. The circuit for selecting such character is not shown, but it corresponds to a circuit shown in Fig. 2D which will be hereinafter described. The wire for this particular character of the code is shown in Fig. 2C as being connected to its channel wire 50 through front contact 56 of relay A—LC.

The transmission of the next following code character is effective to govern the code transmitter at the left-hand end of the track section 2—5T in advance of the signal 2A, and inasmuch as it is desired that such track circuit code transmitter be inactive for the establishment of a route for signal 2A, the character transmitted for this particular control is transmitted in accordance with the energization of the relay SL, as called for in the code chart shown in Fig. 6, for rendering such code transmitter inactive. Of course such code transmitter is inactive under normal conditions, and the transmission of the (SL) character at this time is effective only in that it is in accordance with the conditions desired to be established for the establishment of the route. The relay SL is connected to the channel wire 51 under these conditions by a circuit extending from the channel wire 51 including front contact 57 of relay A—LC, back contact 58 of relay 2RFS, back contact 59 of relay 9LFS, back contact 60 of relay B—ACH, contact 61 of signal lever 8—9SIG in its right-hand position, and winding of relay SL, to (—).

In accordance with the right-hand position of the signal lever 2—3SIG, the next character of the code is an (LS) character, and therefore the relay LS is energized upon the energization of the channel wire 52 by a circuit extending from such channel wire 52, including front contact 62 of relay A—LC, contact 63 of signal lever 2—3SIG in its right-hand position, and winding of relay LS, to (—). The next following character which completes the signal control portion of the control cycle requires the picking of the relay SL in accordance with the control code required for the designation of the clearing of the signal 2A according to the code chart shown in Fig. 6. Thus, the application of energy to the channel wire 53 for the transmission of the next character of the control code is effective to cause the picking up of relay SL by the energization of a circuit extending from such channel wire 53, including front contact 64 of relay A—LC, contact 65 of signal control lever 2—3SGL in its right-hand position, and winding of relay SL, to (—). The transmission of this code character completes the transmission of the control cycle to the field station A.

It is also necessary, in order to clear signal 2A, to cause the transmission of a control cycle to the field station B for picking up relay B—RFZ (see Fig. 3E) at such field station. The picking up of such relay is effective to cause the transmission of a track circuit code through the track rails in the direction of signal 2A. The transmission of such code in the track section adjacent and to the left of field station B is effective to cause the code transmitters to be active for the intermediate track sections between field stations A and B to provide track circuit code for the control of the intermediate signals in that block as well as to provide track circuit code for the clearing of signal 2A.

In accordance with the picking up of relay A—LC for the transmission of a control cycle as has just been described, a circuit is closed at that time to cause the picking up of the relay B—ACH which, in turn, is effective to provide an automatic start of the system for the subsequent transmission of a cycle of operation to the field station B for picking up the relay B—RFZ at such station. The relay B—ACH (see Fig. 2A) is picked up under such conditions by the energization of a circuit extending from (+), including contact 66 of signal control lever 2—3SIG in its right-hand position, back contact 67 of relay 9LFS, back contact 68 of relay 2RFS, front contact 69 of relay A—CH, front contact 70 of relay A—LC, winding of relay B—ACH, and normally closed contact 39 of cancel button CAN, to (—). Upon the picking up of the relay B—ACH, a stick circuit is established for such relay to maintain that relay picked up until the relay B—LC has been picked up at the beginning of the transmission of a control cycle to the field station B. The stick circuit by which relay B—ACH is maintained picked up under such conditions extends from (+), including back contact 75 of relay B—LC, front contact 76 of relay B—ACH, winding of relay B—ACH, and normally closed contact 39 of the cancel button CAN, to (—).

It is therefore provided that after the control cycle has been transmitted for the communication of switch and signal controls to the field station A, the relay B—LC is allowed to be picked up upon the closure of back contact 42 of relay LCS. This is provided by the energization of a circuit extending from (+), including back contact 40 to relay SC, back contact 41 of relay C, back contact 42 of relay LCS, back contact 43 of relay A—CH, back contact 71 of relay A—ACH, front contact 72 of relay B—ACH, lower winding of relay B—LC, back contact 73 of relay B—CH, front contact 74 of relay B—ACH, lower winding of relay ACHP, and normally closed contact 39 of cancel button CAN, to (—). It will be noted from the circuit just described that the picking up of relay B—LC by an automatic start, as has been effected by the picking up of relay B—ACH, is also effective to cause the picking up of the

relay ACHP, such relay ACHP being common to the automatic starts for all field stations and having a purpose to be hereinafter described. In accordance with the picking up of the relay B—LC, under the above described conditions, the relay LCS is picked up, upon the establishment of the stick circuit for relay B—LC, by the energization of a circuit extending from (+), including back contacts 47, 46 and 45 of relays LV, SC and C respectively, connected in multiple, winding of relay LCS, front contact 77 of relay B—LC, upper winding of relay B—LC, and normally closed contact 39 of the cancel button CAN, to (—). It will be noted that a stick circuit is also closed to maintain the relay ACHP picked up throughout the control cycle by the energization of a circuit extending from (+), including back contacts 47, 46 and 45 of relays LV, SC and C respectively, connected in multiple, front contact 78 of relay ACHP, upper winding of relay ACHP, and normally closed contact 39 of the cancel button CAN, to (—).

In accordance with the picking up of relay B—LC, the station code for selecting field station B is transmitted, and subsequent to the transmission of that code, the relay LS is picked up for the transmission of a switch control character in accordance with the normal position of the switch control lever 3SW in a manner similar to that described above for the transmission of a similar character in accordance with the normal position of the switch control lever 1SW.

The code character following the switch control character will be required to be the character (LS) in order to cause the picking up of the relay B—RFZ (see Fig. 3E) at field station B, thus the relay LS is energized upon application of energy to the channel wire 50 by a circuit extending from such channel wire 50 including, front contact 79 of relay B—LC, back contact 80 of relay 9LFS, back contact 81 of relay 2RFS, back contact 82 of relay A—ACH, contact 63 of signal control lever 2—3SIG in its right-hand position, and winding of relay LS, to (—).

The following character of the code, for governing the track circuit code transmitter at the right of the field station B, will be an (SL) character because it is not desired to start the transmission of driven codes in the coded track circuit 8—11T at the end adjacent field station B. The energization of relay SL for such character is effective upon the application of energy to the channel wire 51 by the closure of a circuit extending from such channel wire 51, including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 8RFS, back contact 86 of relay 11LFS, back contact 87 of relay C—ACH, contact 88 of the switch control lever 4SW in its right-hand position, contact 89 of signal control lever 10—1'SIG in its center position, wire 90, and winding of relay SL, to (—).

Inasmuch as no controls for the switches and signals in field station B have been designated by the operator, according to the code chart shown in Fig. 6, the signal control code characters to be transmitted will be respectively both (LS) characters so as not to affect the control of the signals at field station B. It will be readily apparent as the description progresses that the transmission of this code is ineffective to control the signals at field station B, even though such signals may be clear for one direction of traffic or the other.

The relay ACHP (see Fig. 2A) is picked up each time an automatic start is initiated for the transmission of a control cycle to select that the characters of the signal control portion of the control cycle are such as to apply both characters as (LS) characters. This arrangement is provided as shown in Fig. 2C by the closure of a circuit for the relay LS for the first signal control character extending from (+), including code communication contacts (not shown), back contact 91 of relay LV, back contact 92 of relay V8, front contact 93 of relay V7, front contact 94 of relay ACHP, and winding of relay LS, to (—). It will be noted from the circuit just described that the closure of back contact 94 of relay ACHP during a control cycle provides a connection to the regular signal control channel wire 52 for the transmission of all cycles of operation except those that are automatically initiated.

In a similar manner, the second character of the signal control portion of the control code is selected by the picking up of the relay LS, in accordance with the picking up of relay V8, by the energization of a circuit extending from (+), including code communication contacts (not shown), back contact 91 of relay LV, front contact 92 of relay V8, front contact 95 of relay ACHP, and winding of relay LS, to (—). It will be noted that the closure of back contact 95 of the relay ACHP applies energy to the channel wire 53 in the usual manner for all cycles of operation other than those automatically initiated.

Having thus considered in detail the mode of operation and specific circuits involved in transmitting the control codes required for the clearing of a particular signal, it is believed that it will be readily apparent to those skilled in the art how a similar mode of operation is followed in the clearing of other signals as required for the proper dispatching of trains through the track layout. Inasmuch as some of the apparatus associated with the transmission of controls to the respective field stations is common to both directions of traffic, some consideration will be given to the clearing of another signal for the opposite direction of traffic.

It will therefore be assumed, that the route which has been described as desired to be established from signal 2A to signal 8A is to be used by a train which will enter the passing siding at field station B for meeting a westbound train for which a route will be established from signal 11A to signal 9A. In accordance with this proposed traffic condition, it will first be assumed that an operator operates the signal control lever 8—9SIG (see Fig. 2A) to its right-hand position and the switch control lever 3SW to its reverse position for causing the clearing of signal 8B.

In accordance with the positioning of these switch and signal control levers, the subsequent closure of the start button contact 96 causes the picking up of the relay B—CH by the energization of a circuit corresponding to the circuit described by which the relay A—CH is controlled.

In accordance with the picking up of the relay B—CH, the relay B—LC is picked up by the energization of a circuit extending from (+), including back contact 40 of relay SC, back contact 41 of relay C, back contact 42 of relay LCS, back contact 43 of relay A—CH, back contact 71 of relay A—ACH, back contact 72 of relay B—ACH, front contact 97 of relay B—CH, lower winding of relay B—LC, front contact 73 of relay B—CH, and normally closed contact 39 of the cancel button CAN, to (—). Upon the picking

up of relay B—LC, a stick circuit is closed for the upper winding of such relay including the winding of relay LCS in a manner similar to that which has been heretofore described when considering the transmission of a control cycle to field station B.

The first code character following the station selecting code under the above assumed conditions is an (SL) character because the track switch 3W is to be operated to its reverse position, such character is selected by a circuit closed from the channel wire 49, including front contact 98 of relay B—LC, contact 99 of the switch control lever 3SW in its right-hand position, and winding of relay SL, to (—).

The next character of the code is an (LS) character because the traffic direction is established for eastbound trains and it is desired to maintain the direction of transmission of track circuit codes in the track sections of the block between the field stations A and B for the passage of eastbound trains. Therefore, such character must be an (LS) character to allow the relay B—RFZ at field station B to remain energized to maintain the direction of code transmission in the block between passing sidings A and B as established for the clearing of signal 2A. Therefore, the character of the code following the character used for controlling the operation of the track switch 3W is provided by the energization of the relay LS upon the closure of a circuit for such relay extending from the channel wire 50, including front contact 79 of relay B—LC, back contact 80 of relay 9LFS, back contact 81 of relay 2RFS, back contact 82 of relay A—ACH, contact 63 of signal control lever 2—3SIG in its right-hand position, and winding of relay LS, to (—). If it is assumed that there has been time for the establishment of the route in the field for the clearing of signal 2A, and an indication has been transmitted back to the office that the establishment of track circuit code in the particular block involved has been effected, the relay 2RFS has been picked up in accordance with the transmission of such indication to the office; and this being the case, the character of the next code element, following the element used for the positioning of the track switch 3W, would be provided by the energization of the relay LS by a circuit extending from the channel wire 50, including front contact 79 of relay B—LC, back contact 80 of relay 9LFS, front contact 81 of relay 2RFS, and winding of relay LS, to (—). It will be readily apparent that such circuit would be used for determining the character of that particular code element if a train had already accepted the signal 2A and entered the block between the field stations A and B. Under such conditions the operator at the control office could have restored the signal control lever 2—3SIG, but the relay LS, under such conditions would be picked up by the energization of the circuit last described.

Assuming as yet that no effort has been made to establish a route through the track section 8—11T, the next following character in the control code is selected to be an (SL) character because of the energization of a circuit extending from the channel wire 51, including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 8RFS, back contact 86 of relay 11LFS, back contact 87 of relay C—ACH, contact 88 of switch control lever 4SW in its normal position, contact 89 of the signal control lever 10—11SIG in its normal position, wire 90, and winding of relay SL, to (—). It will be noted that the nature of the circuit just described is such that if the signal control lever 10—11SIG were in its left-hand operated position, as for the clearing of a signal for a westbound train, assuming the switch control lever 4SW to be in its normal position, the relay LS would be picked up to provide a code character that would cause the code transmitter for the left-hand end of the track section 8—11T at field station B to become active for the transmission of track circuit codes for the clearing of the signal 11A. Under such conditions the relay LS would be energized by a circuit extending from the channel wire 51, including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 8RFS, back contact 86 of relay 11LFS, back contact 87 of relay C—ACH, normally closed contact 88 of the switch control lever 4SW, contact 89 of the signal control lever 10—11SIG in its left-hand position, wire 101, and winding of relay LS, to (—).

The portion of the control code for the control of the signal 8B will comprise the characters (LS) and (SL) respectively. The (LS) character is provided by the energization of the channel wire 52 upon the closure of a circuit extending from that channel wire 52, including front contact 102 of relay B—LC, contact 103 of signal control lever 8—9SIG in its right-hand position, and winding of relay LS, to (—). The (SL) character is provided upon the energization of the channel wire 53 by the closure of a circuit extending from such channel wire 53 including front contact 104 of relay B—LC, contact 61 of signal control lever 8—9SIG in its right-hand position, and winding of relay SL, to (—). The transmission of this code character completes the cycle of operation for the control of the track switch 3W to its reverse position and for the control of the signal 8B for the passage of a train into the passing siding.

It will now be assumed that the operator positions the signal control lever 10—11SIG (see Fig. 2B) to its left-hand position, with the switch control lever 4SW in its normal position, for the establishment of the route governed by the signal 11A.

The closure of the start button contact 105 by the operator, subsequent to such positioning of the switch and signal control levers picks up the relay C—CH for initiating the start of a control cycle in a manner corresponding to that which has been described for the picking up of the relay A—CH in the initiation of a control cycle for transmission to the field station A. In accordance with the picking up of the relay C—CH, the relay C—LC is picked up by the energization of a circuit extending from (+), including back contact 40 of relay SC (see Fig. 2A), back contact 41 of relay C, back contact 42 of relay LCS, back contact 43 of relay A—CH, back contact 71 of relay A—ACH, back contact 72 of relay B—ACH, back contact 97 of relay B—CH, wire 106, front contact 107 of relay C—CH, lower winding of relay C—LC, front contact 108 of relay C—CH, wire 109, and normally closed contact 39 of the cancel button CAN, to (—). The picking up of the relay LCS in accordance with the establishment of the stick circuit for relay C—LC is provided in a manner corresponding to that which has been specifically described upon considering the establishment of the stick circuit for the relay A—LC.

In accordance with the start of a control cycle with the relay C—LC energized, a station select-

ing code is transmitted for selecting the field station C; and the first code character following the station selecting code is an (LS) character in accordance with the energization of a circuit extending from the channel wire 49, including front contact 110 of relay C—LC, contact 111 of switch control lever 4SW in its right-hand position, wire 101, and winding of relay LS, to (—).

The following character of the control code must necessarily be an (SL) character because such character is used for controlling the track circuit code transmitter at the right-hand end of the track section 8—11T, and it is desired that such code transmitter remain inactive for the route desired to be established. Thus, the relay SL is energized under such conditions by a circuit extending from the channel wire 50, including front contact 112 of relay C—LC, back contact 113 of relay 11LFS, back contact 114 of relay 8RFS, wire 115, back contact 116 of relay B—ACH, contact 117 of switch control lever 3SW in its right-hand position, and winding of relay SL, to (—). If the switch control lever 3SW were in its normal rather than its reverse position, and the signal control lever 8—9SIG were in its normal position, the relay SL would have been energized for such character by a circuit extending from the channel wire 50, including front contact 112 of relay C—LC, back contact 113 of relay 11LFS, back contact 114 of relay 8RFS, wire 115, back contact 116 of relay B—ACH, contact 117 of switch control lever 3SW in its normal position, contact 103 of signal control lever 8—9SIG in its center position, and winding of relay SL, to (—).

Inasmuch as the control of transmission of track circuit codes in the rear of signal 11 is of no particular consequence to the control of signal 11, the second character of the control code, which is used for the control of the transmission of controls for the coded track circuit transmitter for the track section in the rear of signal 11, is either an (SL) or an (LS) character in accordance with the selection on the switch and signal control levers (not shown) for the next field station in the rear of signal 11. In accordance with the assumed approach of a westbound train to the signal 11A, however, it would necessarily be established that the direction of track circuit code transmission in the block at the right of the field station C would be for a westbound train, and thus the character selected for transmission to field station C for the control of track circuit code transmission in the track section at the right of the field station C would necessarily be selected as an (LS) character for rendering the code transmitter active for transmitting a track circuit code for controlling signals used in governing westbound traffic.

In accordance with the code chart shown in Fig. 6, the characters (SL) and (LS) are respectively required to be transmitted for the clearing of the signal 11A for governing traffic to the left, and the relay SL is picked up under such conditions by the energization of a circuit extending from the channel wire 52, including front contact 118 of relay C—LC, contact 119 of lever 10—11SIG in its left-hand position, wire 90, and winding of relay SL, to (—). The relay LS is picked up for the last character of the control cycle upon energization of the channel wire 53 by a circuit extending from that channel wire 53, including front contact 120 of relay C—LC, contact 89 of signal control lever 10—11SIG in its left-hand position, wire 101, and winding of relay LS, to (—).

Inasmuch as the transmission of track circuit code in the track section 8—11T from left to right is required for the control of signal 11A, the picking up of the relay C—LC for the transmission of a control cycle to the field station C is effective to cause the picking up of the relay B—ACH for the automatic initiation of a control cycle for transmission to field station B for initiating the transmission of track circuit code in the track section 8—11T. Thus, the picking up of relay C—LC is effective to cause the picking up of relay B—ACH by the closure of a circuit extending from (+), including contact 121 of signal control lever 10—11SIG in its left-hand position, contact 122 of switch control lever 4SW in its normal position, back contact 123 of relay 8RFS, back contact 124 of relay 11LFS, front contact 125 of relay C—LC, front contact 126 of relay C—CH, wire 127, winding of relay B—ACH, and normally closed contact 39 of cancel button CAN, to (—).

Upon the picking up of relay B—ACH, it is provided that such relay will initiate the transmission of a control cycle, when the communication system is available for the transmission of such cycle, by causing the picking up of the relays B—LC, LCS and ACHP in a manner that has been heretofore described. It is believed unnecessary to describe specifically the circuits involved in the selection of the control code for transmission to the field station B under conditions as such circuits have already been described.

Establishment of routes in field.—The transmission of the various control cycles of operation from the control office, according to the selection of code character as has been described, is effective to select the respective field stations for which such controls are intended and provide the general decoding of such codes in a suitable manner, such, for example, as the system specifically disclosed in the above mentioned Hailes, et al., application, Ser. No. 484,728, dated April 27, 1943, which has resulted in Pat. No. 2,399,734, dated May 7, 1946, and reference is to be made to such application for a specific description of the manner in which the decoding is accomplished in this embodiment of the present invention.

Therefore, for the purposes of simplifying the disclosure of the present invention, it has been assumed that the application relays at the respective field stations are energized in accordance with the decoding of the control codes, during an execution period, as this is the particular means disclosed in the above mentioned Hailes, et al. application. With reference to Fig. 5 the specific control circuits are shown for the switch and signal and traffic direction control relays associated with field station A, and it is believed to be unnecessary to describe specifically these circuits as such circuits will be readily identified as corresponding to those fully described in the above mentioned Hailes, et al. application, except for the circuits for the relays A—LFZ and A—RFZ which are traffic direction control relays not shown in such application. It will be readily apparent, however, that the control of such relays is merely provided by the use of extra channels in the control cycle, and does not disturb the circuit organization or general mode of operation of the switch and signal control application relays. Inasmuch as the application circuits are similar for the respective field stations, the circuits shown in Fig. 5 for field sta-

tion A are to be considered as typical of the application circuits provided but not specifically shown for the field stations B and C.

Assuming a control cycle to be transmitted from the control office in a manner which has been described for clearing the signal 2A, the reception of such control cycle at the field station A is effective to pick up the relay 1WN for providing that the track switch 1W is operated to its normal position.

If the code character following the character used for the control of the track switch 1W is an (SL) character, the relay A—RFZ is energized during the execution period of the cycle with a polarity to operate its contacts to their dropped away positions in accordance with the closure of a circuit extending from (+), including back contact 128 of relay 2SA, front contact 129 of relay 2LV, back contact 130 of relay 6CS, back contact 131 of relay 7CS, back contact 132 of relay 9CS, back contact 133 of relay 12CS, back contact 134 of relay 13CS, front contact 135 of relay 8CS, and lower winding of relay A—RFZ, to (—).

If, however, it is assumed that a route has been set up for the approach of an eastbound train to the signal 2A, it is selected that the code character following the code character used for the control of the track switch 1W is an (LS) character, and therefore the relay A—RFZ is energized with a polarity to pick it up. Thus, under these conditions, the relay A—RFZ is energized by a circuit similar to the circuit just described for that relay except that the circuit is closed for the upper winding of that relay, rather than the lower winding, as selected by front contact 136 of relay 7CS, such relay 7CS being picked up in accordance with the reception of an (LS) character as compared to the picking up of the relay 8CS in accordance with the reception of an (SL) character.

It will be noted that the relay A—LFZ, which is controlled in accordance with the second code character following the code character used for the control of the track switch 1W, is controlled in a similar manner to the manner of control provided for the relay A—RFZ. It has been described that the code character (SL) is selected at the control office for the control of the relay A—LFZ for the establishment of a route for an eastbound train because it is desirable that the code transmitter at the left-hand end of the track section 2—5T be inactive. Thus, during the execution period at the end of the control cycle, the lower winding of the relay A—LFZ is energized with a polarity to cause the contacts of that relay to be dropped away, the circuit for such lower winding including the checking contacts of the decoding relays CS, and the front contact 137 of relay 10CS, to correspond with the (SL) code character received.

The relay A—RGZ is picked up during the execution period under consideration because the signal control code which has been transmitted for that particular cycle of operation has the code characters (LS) and (SL) respectively selected for the control of the signals at field station A.

The picking up of relay A—RGZ (see Fig. 3A) is effective to close a portion of the signal control circuit for signal 2A, but it can be ineffective to cause the clearing of that signal unless track circuit code is received at the left-hand section of the track 2–5T.

To consider the manner in which the track circuit code is established through the respective track sections to provide for the feeding of such code through track section 2–5T, it will be assumed that the cycle of operation for the initiation of the track circuit code transmitter at field station B is transmitted in a manner which has been described, and that the reception of such cycle of operation has been effective at field station B to cause the picking up of the track circuit code control relay B—RFZ (see Fig. 3E). Such relay is picked up by the reception of an (LS) character immediately following the character used for the control of the track switch. Although it is not specifically shown as to how such relay is controlled during the execution period, it is to be understood that it is controlled in a manner similar to that shown in Fig. 5 for the control of a similar relay A—RFZ at field station A. The relay A—RFZ would be picked up under similar conditions in accordance with the closure of front contact 136 of relay 7CS to provided for energization of the upper winding of such relay with a polarity to cause the contacts of such relay to be picked up.

With reference to Fig. 3E, the picking up of the relay B—RFZ is effective to render the code oscillators 180CT and 75CT active in accordance with the closure of front contact 138. Assuming the relay 8YGP to be dropped away because of the signal 8 being at stop, a circuit is closed by which the relay 9CP becomes active for the transmission of a 75 code by its energization for each pulse of such code by a circuit extending from (+), including back contact 139 of relay 9FP, contact 140 of code oscillator 75CT, back contact 141 of relay 8YGP, front contact 142 of relay B—RFZ, front contact 143 of the OS track relay 8—9TR, front contact 144 of relay 9AS, and winding of relay 9CP, to (—).

Each time the relay 9CP is picked up, it is effective to close an obvious circuit at front contact 145 to connect the battery 146 across the track rails of the track section 6–9T, through the winding of the series relay 9AR.

At the left-hand end of the track section 6—9T (see Fig. 3D), the track relay 6TR becomes active in response to the 75 code applied at the right-hand end of the track section, such relay being connected across the track rails in an obvious manner through back contact 147 of the code transmitter relay 6CP. In accordance with the pulsing of the contact 148 of the track relay 6TR, the track repeater relay 6—7TP is effective to follow the operation of the track relay 6TR, and the relay 6FP is picked up because of the energization of its circuit by the closure of front contact 149 of relay 6TR, relay 6FP is sufficiently slow acting to be maintained steadily picked up as long as the code pulses are received.

The relay 6—7H is picked up because of the pulsing of contacts 150 and 151 of relay 6—7TP by the energization of the usual type of decoding circuit through the decoding transformer. Energy is applied to such transformer through front contact 152 of relay 6FP, back contact 153 of relay 7FP, and contact 150 of relay 6—7TP. The contact 151 of relay 6—7TP is effective to rectify the output of the transformer to provide for the energization of the relay 6—7H with direct current.

Upon the picking up of the relay 6—7H, a circuit is closed for the energization of the winding of signal 6 with a polarity to operate such signal to its caution position. Such circuit extends from (+), including front contact 154 of relay 6—7H, back contact 155 of relay 7FP, front contact 156

of relay 6FP, back contact 157 of relay 6—7D, winding of signal 6, and back contact 158 of relay 6—7D, to (—). The picking up of relay 6—7H is also effective to render the code oscillators active in accordance with the closure of their circuit at front contact 159.

The code transmitter relay 7CP becomes active in accordance with the picking up of relay 6—7H by the energization of a circuit extending from (+), including normally closed contacts 160 and 161 of signal 7, contact 162 of oscillator 180CT, front contact 163 of relay 6FP, front contact 164 of relay 6—7H, front contact 165 of relay 6—7H, back contact 166 of relay 7FP, back contact 167 of relay 7S, back contact 168 of relay 7FP, and winding of relay 7CP, to (—). The pulsing of contact 169 of relay 7CP is effective to intermittently connect the track battery 170 across the track rails through the winding of the series relay 7AR.

The track circuit code is transmitted around the insulated rail joints 171 and 172 provided for the slide detector as long as the slide detector relay 7SD is maintained in its normal position by the energization of its circuit including slide detector contact 173 associated with a slide detector fence or other slide detecting means. Thus, each time the relay 7CP is picked up, a track circuit is closed extending from the positive terminal of the track battery 170, including winding of relay 7AR, front contact 169 of relay 7CP, upper rail of track section 7—4T at the right of the slide detector insulated rail joints 171 and 172, jumper 174, lower rail of the portion of the track section extending to the left of the slide detector insulated joints 171 and 172, back contact 175 of relay 7CPR[1], winding of track relay 7TR[1], upper rail of track section 7—4T at the left of the slide detector joints 171 and 172, front contact 176 of relay 7SD, and lower rail of the track section 7—4T to the right of the insulated joints 171 and 172, to the negative terminal of the track battery 170.

The code received at the left-hand end of the track section 7—4T is merely repeated into the right-hand end of the track section 4—7T by the relay 4CPR[1] (see Fig. 3C). Such relay is energized for each pulse received by the track relay 7TR[1] by the energization of the circuit extending from (+), including front contact 177 of the switch lock relay LP, back contact 178 of relay 4TR[1], front contact 179 of relay 7TR[1], front contact 180 of relay 7FP[1], back contact 181 of relay 4BP[1], back contact 182 of relay 4FP[1], and winding of relay 4CPR[1], to (—).

In accordance with the pulsing of contact 183 of the relay 4CPR[1] at the right-hand end of the track section 4—7T, the track battery 184 is connected across the track rails intermittently to transmit a track circuit code in the track section 4—7T corresponding to the code impressed upon the track section 7—4T.

The connection of the track circuit for the track section 4—7T around the insulated joints 185 and 186 of the slide detector associated with such track section is provided in a manner similar to that which has been specifically described above in connection with the slide detector associated with the track section 7—4T. The connection of the track relay 4TR (see Fig. 3B) across the track rails at the left-hand end of the track section 4—7T, through back contact 187 of the relay 4CP, provides that such track relay is effective to follow the code impressed upon the track rails at the right-hand end of that track section, and in accordance therewith the relay 4—5TP is active to follow the code in accordance with the pulsing of front contact 188 of relay 4TR. The relay 4FP is maintained steadily picked up in accordance with the pulsing of the contact 189 of relay 4TR.

The pulsing of contacts 190 and 191 of relay 4—5TP is effective to provide for the energization of relay 4—5H, and the picking up of such relay is effective to close a circuit for the energization of the signal 4, such signal being energized to provide a clear indication because of the energization of the relay 4—5D in accordance with the 180 rate of the track circuit code received. Relay 4—5D is energized in an obvious manner from the decoding transformer through the tuned circuit 180DU. The signal 4 is energized under such conditions by a circuit extending from (+), including front contact 192 of relay 4—5H, back contact 193 of relay 5FP, front contact 194 of relay 4FP, front contact 195 of relay 4—5D, winding of signal 4, and front contact 196 of relay 4—5D, to (—).

The code oscillators 75CT, 120CT and 180CT become active upon the picking up of the relay 4—5H in accordance with the closure of front contact 197. The relay 5CP then becomes active to transmit a 180 code because of its energization for each pulse by a circuit extending from (+), including normally closed contacts 198 and 199 of signal 5, contact 200 of oscillator 180CT, front contact 201 of relay 4—5D, front contact 202 of relay 4FP, front contact 203 of relay 4—5H, front contact 204 of relay 4—5H, back contact 205 of relay 5FP, back contact 206 of relay 5S, back contact 207 of relay 5FP, and winding of relay 5CP, to (—).

The pulsing of contact 208 of relay 5CP at a 180 rate is effective to intermittently connect the track battery 209 across the track rails at the right-hand end of the track section 2—5T, through the winding of the series relay 5AR, to provide for the transmission of a 180 code.

The reception at the left-hand end of the track section 2—5T of the 180 code causes the pulsing of the contacts 210 and 211 of the track relay 2TR (see Fig. 3A) which is connected across the track rails at that end of the track section. The pulsing of contacts 210 and 211 of such relay causes the relay 2TP to follow the code and the relay 2FP to be steadily picked up. In accordance with the pulsing of contacts 212 and 213 of relay 2TP, the relay 2H is energized through the decoding transformer, energy being applied to such transformer through the front contact 214 of relay 2FP. Inasmuch as the code is at a 180 rate, the relay 2—3DX is picked up because its tuned circuit 180DU is tuned to this rate, the tuned circuit 180DU for such relay being connected to the decoding transformer through front contacts 215 and 216 of the relay 2H. Because of the picking up of the relay 2—3DX, the relay 2—3D is picked up by the closure of an obvious circuit for such relay at front contacts 217 and 218 of relay 2—3DX.

Assuming the relay A—RGZ to have been previously picked up in accordance with the reception of a control code for clearing the signal 2A, a circuit is now closed for the signal 2A for energization of that signal with a polarity to cause such signal to display a clear indication selected in accordance with the picking up of relay 2—3D. Such circuit extends from (+), including front contact 219 of relay 2—3D, front contact 220 of

relay 2—3TR, front contact 221 of relay 1NCR, front contact 222 of relay 2H, front contact 223 of relay A—RGZ, winding of signal 2A, front contact 224 of relay A—RGZ, front contact 225 of relay 2H, and front contact 226 of relay 2—3D, to (—).

To consider further the establishment of routes, it will be assumed that the control cycle is received at the field station B for the power operation of the track switch 3W (see Fig. 3E) to its reverse position and for the control of the signal 8B for governing traffic into the passing siding at that field station. In accordance with the reception of such cycle of operation at the field station B, the relay B—RGZ is picked up and the circuit for the signal 8B is completed after the track switch 3W has been operated to its reverse position so as to pick up the reverse correspondence relay 3RCR. The winding of signal 8B is then energized to cause such signal to be operated to its caution position by a circuit extending from (+), including front contact 227 of relay 3RCR, back contact 228 of relay 3NCR, front contact 229 of relay 8—9TR, front contact 230 of relay B—RGZ, winding of signal 8B, and front contact 231 of relay B—RGZ, to (—).

It will be noted that the code character of the control cycle immediately following the character used for the control of the track switch 3W is an (LS) character which calls for the picking up of the relay B—RFZ, but it has been pointed out that the relay B—RFZ is already picked up in accordance with the establishment of the route through the block between the two passing sidings. It has also been pointed out that the selection of the code character for governing the transmission of track circuit codes from left to right in the track section 8—11T is dependent upon the position of the switch and signal control levers at the control office for the field station C at the right-hand end of the track section 8—11T. That is, if the switch and signal control levers at the control office for field station C are in their normal positions, the code character transmitted for the control of the relay B—LFZ is such as to cause such relay to be dropped away and thus render the code transmitter inactive at the left-hand end of the track section 8—11T. It will therefore be assumed that such is the condition of the relay B—LFZ at this time, and it will be hereinafter described how such relay is picked up in accordance with the establishment of a route through the siding section 8—11T for a westbound train.

To further consider the establishment of routes in the field, an arrangement of the drawings will be considered in which the Fig. 3A is placed at the right of the Fig. 3E. By this arrangement, the circuits shown in Fig. 3A for the field station A are considered as identical with the circuits that would be provided for the field station C at the right-hand end of the siding section 8—11T.

Assuming this arrangement of the drawings, the transmission from the control office of a control cycle for the clearing of the signal 11A (see Fig. 1B) in a manner which has been described is effective to cause the picking up of a relay at field station C comparable to the relay A—LGZ of Fig. 3A, and the picking up of such relay is effective to close a portion of the signal control circuit, but the energization of the signal 11A cannot be effected until track circuit code is received at the right-hand end of the track section 8—11T.

It has been pointed out that in accordance with the transmission of a control cycle to the field station C for the clearing of signal 11A, the code communication system is automatically initiated into a cycle of operation for transmission to field station B for starting the transmission of track circuit codes at the left-hand end of the track section 8—11T. In accordance with the reception of such control cycle at the field station B, the relay B—LFZ (see Fig. 3E) is picked up during the execution period at the end of the cycle, and the picking up of such relay is effective to render the code oscillators 180CT and 75CT active at that field station in accordance with the closure of front contact 232.

The relay 8CP then becomes active to transmit a 75 code (because the signal 9A is at stop) by the energization of a circuit closed for each pulse of such relay from (+), including back contact 233 of relay 8FT, contact 234 of the code oscillator 75CT, back contact 235 of relay 9YGP, front contact 236 of relay B—LFZ, front contact 237 of relay 3RCR, and winding of relay 8CP, to (—). It will be noted that the relay 3RCR is picked up at that time because it is assumed that a route has been established over the track switch 3 in its reverse position. If this route has not been established, the relay 8CP would have been energized in accordance with the closure of the branch of the circuit including contacts 238 and 239 of relays 8—9TR and 8AS connected in multiple with the front contact 237 of relay 3RCR.

The pulsing of the contact 240 to relay 8CP is effective to connect the track battery across the track rails at the left-hand end of the track section 8—11T for each pulse of the 75 code in an obvious manner. The reception of such code at the right-hand end of the track section 8—11T is provided by means comparable to the code receiving means provided in Fig. 3A by the relays 3TR, 3TP, 3FP and 3H. The relay 3TR in that figure is connected across the track rails of track section 1—3T through the back contact 242 of relay 3CP, and the pulsing of the contacts 243 and 244 of such relay causes the relay 3TP to follow the code and causes the relay 3FP to be steadily picked up as long as the code is being received. The closure of front contact 245 of relay 3FP applies energy to the decoding transformer for the energization of the relay 3H, and the pulsing of the contacts 246 and 247 of relay 3TP is effective to cause the picking up of the relay 3H to close a circuit for the energization of the signal 3A. A circuit for signal 3A is closed under such conditions from (+), including back contact 248 of relay 1RCR, front contact 249 of relay 1NCR, front contact 250 of relay 2—3TR, back contact 251 of relay 2—3D, front contact 252 of relay 3H, front contact 253 of relay A—LGZ, winding of signal 3A, front contact 254 of relay A—LGZ, front contact 255 of relay 3H, and back contact 256 of relay 2—3D, to (—). It is to be understood that the signal 11A at field station C is energized to its caution indicating position upon the reception of a 75 code in the track section 8—11T by the energization of circuits similar to those just described for the energization of signal 3A.

Interlock at the control office.—Having described specifically the manner in which the various routes are established in accordance with the transmission from the control office of control cycles of operation for the establishment of such routes, consideration will now be given to the means provided at the control office for pro-

viding an interlock to prevent the inadvertent transmission of controls for rendering inactive the track circuit code transmitters that are required to be active for routes previously established.

In general, the interlock is provided in the control office by LFS and RFS stick relays (see Figs. 2A and 2B), and the control of such relays is generally provided in accordance with the reception of indications at the control office transmitted from the respective field stations.

Thus, assuming routes to have been established in a manner which has been described, with reference to Fig. 1A, the reception of a track circuit code at the left-hand end of the track section 2—5T is effective to cause the picking up of the relay 2FP, and the shifting of contact 257 of the relay 2—3DX upon the reception of a 180 code is effective to cause the start of an indication cycle at the field station A because of the momentary opening of the stick circuit for the change relay CH (not shown) for such field station. For the purpose of simplification of the disclosure of the present invention, the complete circuit for the relay CH has not been shown, but it is to be understood that the wire 258 of the present disclosure is connected to a stick circuit of a change relay CH such as the connection of such wire to the front contact 47 of the relay 2CH shown in Fig. 3A of the above mentioned Hailes, et al. application, Ser. No. 484,728, dated April 27, 1943. Reference is to be made to that application for details in connection with the communication of the indications to the control office. For the purpose of the present disclosure, however, it is believed sufficient to assume that the start of an indication cycle is provided by the shifting of a contact of a relay in the stick circuit for the relay CH, and in accordance with the initiation of such indication cycle, the indications transmitted are selected as indicated in Figs. 1A and 1B by the indication contacts shown below the stick circuits for the CH relays at the respective field stations. It is assumed that such indication contacts are connected to respective channels for communication of the respective indications to the control office during the transmission of an indication cycle.

To consider more specifically the communication of an indication to the control office that the track circuit codes are transmitted in the block between the field stations A and B, it will be noted that the picking up of the relay 2FP (see Fig. 1A) to open back contact 259 does not start the transmission of an indication cycle, but it merely removes the shunt around contact 257 of relay 2—3DX so that the shifting of that contact can cause the start of an indication cycle. It will be noted that the sequence of operation of these two relays, upon reception of a 180 code at the left-hand end of the track section 2—5T, is that the relay 2FP must be picked up prior to the energization of the decoding transformer from which the relay 2—3DX is energized.

Thus, in accordance with the reception at the left-hand end of the track section 2—5T of a 180 code during the establishment of the route, an indication cycle is initiated, and an indication is transmitted that the track circuit code has been transmitted through the respective track section of the block. Such indication is in accordance with the closure of front contacts

260 and 261 of relays 2—3DX and 2FP respectively.

Under the assumed conditions of establishment of routes, the relays 8FP and 9FP at field station B both remain de-energized because it has been described that the direction of track circuit code transmission at field station B is away from such station both to the left and to the right. The operation of the signal 8B to its caution position as has been described is, however, effective to initiate an indication cycle by the shifting of contact 262 in the stick circuit for the relay CH (not shown) at that field station, unless the picking up of relay 3WP after operation of the track switch has already started the cycle, all in a manner well known to those skilled in the art.

At the field station C, the picking up of the relay 11FP in accordance with the reception of a track circuit code at the right-hand end of the track section 8—11T, is effective to start the transmission of an indication cycle from that field station. In accordance with the shifting of contact 263 of relay 11FP upon the picking up of that relay, the indication cycle is initiated, and an indication is transmitted that the track circuit code is received at that end of the track section 8—11T in accordance with the closure of front contact 264 of relay 11FP in a circuit connected to a channel of the communication system.

In accordance with the reception at the control office of the indication cycle transmitted from the field station A, the relay A—ST (see Fig. 2C) is responsive at the control office to the indication station identification code transmitted during the first part of the cycle of operation, and in accordance with the reception of the indications, energy of selected polarity is applied to the respective channel wires 265 to 276 inclusive.

Thus, the reception of the indication cycle from field station A causes the conditioning of the approach indication relay 3AK (see Fig. 2C) in accordance with the position of the contact 277 of the approach track relay 2ARS as shown in Fig. 1A. Similarly, the slide indicator relay A—SDK (see Fig. 2C) is positioned in accordance with contact 278 of the relay 3SD shown in Fig. 1A. The block indication relay 2—9RBK (see Fig. 2C) is positioned in accordance with the contacts 260 and 261 of relays 2—3DX and 2FP respectively as shown in Fig. 1A. The OS track indicator relay 2—3TK (see Fig. 2C) is positioned during an indication cycle in accordance with the contact 279 of the relay 2—3TR as shown in Fig. 1A. The signal indication relay 2—3GK is positioned during an indication cycle transmitted from the field station A to correspond with the indication selected for transmission at the field station A by the contacts 280 and 281 of relays A—RM and A—LM respectively. Such relays when energized repeat the stop position of the signals at field station A in the usual manner.

The block indicator relay 2—9RBK (see Fig. 2C) is picked up upon reception of the indication cycle under consideration upon the closure of front contact 282 of the indication station relay A—ST, and the picking up of that relay closes a circuit to cause the picking up of the relay 2RFS to establish an interlock in the control office for the block between the passing sidings A and B to correspond with the direction of traffic established through such block in ac-

cordance with the setting up of the route for the clearing of the signal 2A. The relay 2RFS is picked up under such conditions by the energization of a circuit extending from (+), including contact 66 of lever 2—3SIG in its right-hand position, back contact 67 of relay 9LFS, front contact 283 of relay 2—9RBK, back contact 284 of relay 2WLS, and winding of relay 2RFS, to (—).

The reception of an indication at the control office that the signal 2 has been cleared causes the picking up of the signal indicator relay 2—3GK through front contact 285 of relay A—ST, and the picking up of such relay provides a stick circuit for the relay 2RFS to maintain such relay picked up as long as the signal 2 is clear. Such stick circuit extends from (+), including back contact 286 of relay 9LFS, front contact 287 of relay 2RFS, front contact 288 of relay 2—3GK, and winding of relay 2RFS, to (—).

It will be apparent from the circuits that have been described for the relay 2RFS that the picking up of such relay and the establishment of its stick circuit can be accomplished only when the relay 9LFS for the opposite direction of traffic is deenergized, and, inasmuch as the circuits for the relay 9LFS and 2RFS are similar except that the relays are provided for opposite directions of traffic, the relay 9LFS cannot be picked up at a time when the relay 2RFS is energized.

It is also provided that the relay 2RFS is maintained picked up, whenever the OS track section 2—3T is occupied by a train, by the energization of a stick circuit extending from (+), including back contact 286 of relay 9LFS, front contact 287 of relay 2RFS, front contact 289 of the OS track indication relay 2—3TK, and winding of relay 2RFS, to (—). It is therefore provided that the relay 2RFS is maintained picked up after a train has accepted the signal 2A and caused the signal 2A to be restored to stop, such operation being effective to open the stick circuit described for the relay 2RFS at front contact 288 of relay 2—3GK. The front contact 289 of relay 2—3TK is connected in multiple with the front contact 286 of relay 2—3GK to provide that the relay 2RFS is maintained steadily picked up under these conditions. The relay 2RFS is sufficiently slow acting to be maintained picked up during the shifting of these contacts even though the respective track and signal indications are received during the same indication cycle. It is desirable from the standpoint of maintaining continuity of the circuit for relay 2RFS that the channels for the communication of the OS track and signal indications be provided relatively close together, or that the signal indication relay 2—3GK be conditioned in a channel prior to the conditioning of the track relay 2—3TK.

It is further provided that the relay 2RFS is maintained picked up whenever a train is in the block between the field stations A and B because such relay is also maintained picked up by a stick circuit when the block indicator relay 2—9RBK is dropped away. Such block indicator relay is dropped away when the train enters the track section 2—5T because of the transmission of an indication cycle to the control office upon the dropping away of the relays 2—3DX and 2FP (see Fig. 1A). Because of the relative timing of such relays, the relay 2—3DX is dropped away prior to the dropping away of the relay 2FP, and thus, with reference to Fig. 1A, the shifting of contact 257 of relay 2—3DX is effective to initiate the transmission of an indication cycle because the back contact 259 of relay 2FP is open at that time. The transmission of this indication cycle, with the front contacts 260 and 261 of relays 2—3DX and 2FP respectively open, provides a means at the control office for energizing the relay 2—9RBK with a polarity to cause that relay to be dropped away.

The back contact 259 of the relay 2FP is connected in multiple with contact 257 of the relay 2—3DX for the purpose of shunting out contact 257 of relay 2—3DX when that relay is energized in connection with the transmission of a code from left to right in the track section 1—3T at times when the direction of traffic is established for westbound trains. In other words, the relay 2—3DX at field station A is used selectively for both directions of traffic, and the shunting of the contact 257 of the ralay 2—3DX by contact 259 of relay 2FP in the indication start circuit provides that the relay 2—3DX is effective in that circuit only when that relay is employed in accordance with the establishment of eastbound traffic. The inclusion of contact 261 of relay 2FP in series with contact 260 of relay 2—3DX provides that that indication channel will be open at all times when a westbound traffic direction is established through the block.

The reception at the control office of an indication that the block between the field stations A and B is occupied, provides another stick circuit for maintaining the relay 2RFS (see Fig. 2A) picked up. Such stick circuit extends from (+), including back contact 286 of relay 9LFS, front contact 287 of relay 2RFS, back contact 283 of relay 2—9RBK, back contact 284 of relay 2WLS, and winding of relay 2RFS, to (—). By the closure of this stick circuit it is provided that the relay 2RFS is maintained picked up as long as a train is in the block between the field stations A and B, irrespective of any attempt the dispatcher may make to set up traffic through the block for the opposite direction of traffic, or to provide for the shutting down of the code transmitters which are essential for controlling the intermediate signals in the block used for governing traffic of the eastbound train.

In a similar manner, the relay 11LFS, associated with the interlock for the direction of code transmission in the track section 8—11T, is picked up in accordance with the energization of the relay 11—8LBK after the route has been established for the clearing of signal 11A. Such relay is held up by a stick circuit whenever the signal is clear, whenever that track section 8—11T is occupied by a train, or whenever the OS track section 10—11T is occupied by a train.

More specifically, the picking up of the station relay C—ST during the reception of an indication cycle transmitted from field station C after the establishment of the route as has been described from signal 11A to signal 9A, provides for the picking up of the block indication relay 11—8LBK. During that cycle of operation the relay 11—8LBK is energized by an obvious circuit including front contact 290 of relay C—ST connected to the indication channel wire 273. In accordance with the picking up of that relay, the relay 11LFS is picked up by the energization of a circuit extending from (+), including contact 121 of signal control lever 10—11SIG in its left-hand position, contact 122 of the switch control lever 4SW in its normal position, back contact 123 of relay 8RFS, front contact 291 of relay 11—8LBK, and winding of relay 11LFS, to (—).

Upon the reception of an indication that the

signal 11A has been cleared, the relay 10—11GK (see Fig. 2D) is picked up during the indication cycle in accordance with its connection to the channel wire 271 through front contact 292 of relay C—ST, and the picking up of such relay establishes the stick circuit for relay 11LFS (see Fig. 2B) extending from (+), including back contact 293 of relay 8RFS, front contact 294 of relay 11LFS, back contact 295 of relay 4WK, front contact 296 of relay 10—11GK, and winding of relay 11LFS, to (—). The inclusion of back contact 295 of the switch indication relay 4WK in this circuit provides that the stick circuit is established over the track switch 4W in its normal position. In other words, if the signal 11B is cleared for the passage of a train into the passing siding, the relay 10—11GK is picked up, but the operation of the track switch to its reverse position is indicated by the picking up of the relay 4WK which is ecective to open the stick circuit just described for the relay 11LFS at back contact 295.

The relay 11LFS is held up whenever the OS track section 10—11T is occupied by a train by the indication relay 10—11TK which is picked up in accordance with such track occupancy upon the energization of the channel wire 272 with the front contact 297 of relay C—ST closed. The picking up of relay 10—11TK establishes a stick circuit for the relay 11LFS extending from (+), including back contact 293 of relay 8RFS, front contact 294 of relay 11LFS, front contact 298 of relay 10—11TK, and winding of relay 11LFS, to (—).

When a train occupies the track section 8—11T, an indication is transmitted to the control office to energize the relay 11—8LBK with a polarity to cause it to be dropped away, and the dropping away of such relay establishes a stick circuit for the relay 11LFS extending from (+), including back contact 293 of relay 8RFS, front contact 294 of relay 11LFS, back contact 291 of relay 11—8LBK, and winding of relay 11LFS, to (—).

To illustrate specifically how the interlock is effective as provided by the relays LFS and RFS, it will be assumed that the relay 2RFS (see Fig. 2A) is picked up as has been described for the establishment of a route for eastbound traffic in the block between field stations A and B, and it will also be assumed that the relay 11LFS (see Fig. 2B) is picked up as has been described in accordance with the establishment of a route signal 11A to signal 9A. Under such conditions, it will be assumed that an operator inadvertently attempts to extend the route for the westbound train by establishing a route from signal 9A to signal 3. To do this he operates the switch lever 3SW (see Fig. 2A) to its normal position and positions the signal control lever 8—9SIG to the left. The depression of the start button for field station B provides for the picking up of the relay B—CH by the closure of contact 96, and the control cycle is thus initiated for the transmission of the controls thus selected.

The switch control selected is transmitted as an (LS) character by the energization of a circuit for the relay LS (see Fig. 2C) extending from the channel wire 49, including front contact 98 of relay B—LC, contact 99 of switch control lever 3SW in its normal position, and winding of relay LS, to (—).

The code character transmitted following the character used for controlling the track switch should necessarily be an (SL) character for rendering the code transmitter inactive at the right-hand end of the block between the field stations

A and B (see Fig. 6) but, because of the relay 2RFS being picked up at this time for the route established for eastbound traffic, this particular character of the code is selected as an (LS) character to provide for the transmission of a control code corresponding to the route which has been previously established, rather than corresponding to the route which has been subsequently designated for establishment. The energization of the relay LS under such conditions is provided by a circuit extending from the channel wire 50 including front contact 79 of relay B—LC, back contact 80 of relay 9LFS, front contact 81 of relay 2RFS, and winding of relay LS, to (—). It will be noted that if the route prior established had been for a westbound train in the block between the passing sidings A and B to provide for the picking up of the relay 9LFS, such character would be an (SL) character because of the closure of a circuit under such conditions extending from the channel wire 50, including front contact 79 of relay B—LC, front contact 80 of relay 9LFS, back contact 100 of relay 2WLS, and winding of relay (SL), to (—).

To consider the next character of the control cycle which would be used for conditioning the track circuit code transmitter for the track section at the right of field station B, such character is transmitted as an (LS) character in accordance with the energization of a circuit closed from the channel wire 51, including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 8RFS, front contact 86 of relay 11LFS, wire 101, and winding of relay LS, to (—). It will be noted that this character is in accordance with the direction of traffic which is assumed to be established in the track section 8—11T; but if the direction had been previously established for an eastbound train, and the relay 8RFS picked up in accordance with such route, the relay SL would be picked up for that character of the code rather than the relay LS by the energization of a circuit extending from the channel wire 51, including front contact 83 of relay B—LC, wire 84, front contact 95 of relay 8RFS, wire 99, and winding of relay SL, to (—).

The code characters transmitted for the remainder of the control cycle under the above assumed conditions merely provide for the control of the signals in accordance with the controls designated by the signal control lever 8—9SIG in its left-hand position in accordance with the usual practice for the communication of these signal controls. Inasmuch as these signal controls are contrary to the conditions previously established at field station B, they are ineffective when they are received, as is the control for the operation of track switch 3W to its normal position, because of the switch and signal control relays 3WR and B—RGZ respectively having been previously energized in accordance with the establishment of other routes as has been described. The interlock in the field in the control of these application relays provides that the reception of the controls just described is ineffective to change the condition of the track switch and signals.

Inasmuch as the positioning of the traffic direction relays 2RFS and 9LFS for the stretch of track between the field stations A and B is in correspondence with the route established for an eastbound train, the circuit is open by which the relay A—ACH would be normally picked up for the automatic start of a control cycle to the field station A. That is, the designation of a

signal control for a direction of traffic contrary to that which has been established does not cause an automatic start at the next field station in advance of the field station for which such control has been designated. Thus, under the assumed conditions where an operator attempts to transmit a control for the clearing of signal 9A when a route is established for eastbound traffic in the block between the passing sidings A and B, the circuit for the automatic start relay A—ACH is open at back contact 299 of relay 2RFS. If the relay A—ACH cannot be picked up under such conditions, there is no control cycle of operation transmitted to the field station A.

Having thus described various specific conditions of the manner in which the interlock is provided at the control office, it is to be understood that such conditions are typical of the mode of operation provided at other field stations and under various modified conditions of traffic. It is therefore believed to be readily apparent to those skilled in the art how these principles are applied under traffic conditions not specifically described and at various field stations other than those specifically considered with respect to conditions involving the interlock for traffic direction control.

Passage of trains.—It will be assumed that the routes are established as has been specifically described, one route being for the passage of an eastbound train from signal 2A through the track switch 3W and into the passing siding at field station B, and the other route being for passage of a westbound train to enter the siding section 8—11T associated with the passing extending between field stations B and C.

When the eastbound train accepts the signal 2A and enters the track section 2—3T, the dropping away of the track relay 2—3TR (see Fig. 5), prior to the dropping away of its repeater relay 2—3TP, opens the stick circuit for the signal control relay A—RGZ at front contact 300 and back contact 301 of relays 2—3TR and 2—3TP respectively, to provide for restoration of the signal 2A to stop. Such restoration is provided by the shifting of contacts 223 and 224 of relay A—RGZ in an obvious manner (see Fig. 3A).

When the eastbound train enters the track section 2—5T, the shunting of the track relay 2TR causes the dropping away of the relay 2FP, and the dropping away of that relay, together with the dropping away of the relay 2—3DX, provides for the transmission of an indication to the control office that the block has become occupied. The manner in which the reception of this indication at the control office is effective to provide a stick circuit to maintain the traffic direction relay 2RFS (see Fig. 2A) picked up has been described when considering specifically the traffic direction interlock at the control office. The manner in which the transmission of this indication to the control office is used to energize a block indicator lamp will be hereinafter considered when considering the indication means more specifically.

The series relay 5AR is picked up when the train occupies the track section 2—5T because the relay 5CP is active at that time for the transmission of a code from right to left in such track section. Thus, in accordance with the closure of front contact 302 of relay 5AR, the directional stick relay 4S is picked up when the train occupies the track section 2—5T by the energization of a circuit extending from (+), including contact 303 or contact 304 of signal 4, dependent upon whether the signal is at clear or caution, front contact 302 of the approach relay 5AR, and winding of relay 4S, to (—). Relay 4S is sufficiently slow acting to be maintained steadily picked up by the pulsing of contact 302 of the series relay 5AR. The presence of the eastbound train in the track section 4—7T, after the train accepts signal 4, establishes a stick circuit at back contact 305 of the relay 4—5H to maintain the stick relay 4S picked up as long as either the track section 4—7T, or the track section 7—4T, is occupied by the train.

In accordance with the dropping away of the relay 4—5H as caused by the shunting of the track section 4—7T, the signal 4 is deenergized and a circuit is closed by which the relay 5CP becomes active for the transmission of a 75 code. Such circuit extends from (+), including normally closed contacts 198 and 199 of signal 5, contact 306 of oscillator 75CT, front contact 307 of relay 4S, back contact 203 of relay 4—5H, back contact 204 of relay 4—5H, back contact 206 of relay 5S, back contact 207 of relay 5FP, and winding of relay 5CP, to (—).

The relay 5CP is active for the transmission of a 75 code as described above until the relay 4—5H is picked up by the 75 code transmitted through the track sections 4—7T and 7—4T when such track sections become unoccupied in the rear of the train. When the relay 4—5H is picked up under such conditions, the relay 5CP becomes active for the transmission of a 120 code by the energization of a circuit extending from (+), including normally closed contacts 198 and 199 of signal 5, contact 308 of oscillator 120CT, back contact 201 of relay 4—5D, front contact 202 of relay 4FP, front contact 203 of relay 4—5H, front contact 204 of relay 4—5H, back contact 205 of relay 5FP, back contact 206 of relay 5S, back contact 207 of relay 5FP, and winding of relay 5CP, to (—).

At the left-hand end of the track section 2—5T, the reception of the 75 code causes the picking up of the relays 2FP and 2H but not the relays 2—3D and 2—3DX. It is therefore provided that the signal 2A or the signal 2B can be operated to its caution indicating position under such conditions if the dispatcher causes the transmission of a control cycle of operation of the communication system for the clearing of either of such signals.

The reception of the 120 code, as the eastbound train progresses through the block, is effective to cause the picking up of the relay 2—3D because of its connection through its tuned circuit 120DU across the windings of the decoding transformer. In accordance with the picking up of the relay 2—3D, the shifting of contacts 217 and 218 provides a means by which the signal 2A or the signal 2B can be energized with a polarity to allow the clearing of such signal, if a control is communicated for the clearing of that signal from the control office.

At the signal 6, the stick relay 6S is picked up when the train approaches that signal by the closure of front contact 309 of the approach relay 7AR, and that stick relay is maintained steadily energized after the eastbound train has entered the track section 6—9T by the closure of back contact 310 of the relay 6—7H when such relay is dropped away because of the failure of the track relay 6TR to remain active. The dropping away of the relay 6—7H also opens the circuit for signal 6 to cause that signal to be restored to danger, and the opening of front contact 156 of the relay 6FP is effective to further open the circuit for the signal 6 at front contact 156.

When the track section 7—4T has become unoccupied in the rear of the train, a 75 code is transmitted in such track section for the control of the signal 4 for a following train movement because of the relay 7CP being active by the energization of a circuit by each pulse of the oscillator 75CT. Such circuit extends from (+), including normally closed contacts 160 and 161 of signal 7, contact 311 of oscillator 75CT, front contact 312 of the stick relay 6S, back contact 164 of relay 6—7H, back contact 165 of relay 6—7H, back contact 167 of relay 7S, back contact 168 of relay 7FP, and winding of relay 7CP, to (—).

The reception at the left-hand end of the track section 4—7T of the 75 code provides for the picking up of the relay 4—5H, and the picking up of that relay opens the circuit for the stick relay 4S at back contact 305 to cause such relay to be dropped away. In accordance with the dropping away of relay 4S, the relay 5CP becomes active for the transmission of a 120 code from right to left in the track section 2—5T in a manner which has been described.

In accordance with the reception of the 75 code at the left-hand end of the track section 4—7T, the signal 4 is operated to its caution indicating position. The circuit by which the signal 4 is energized to such position extends from (+), including front contact 192 of relay 4—5H, back contact 193 of relay 5FP, front contact 194 of relay 4FP, back contact 196 of relay 4—5D, winding of signal 4, and back contact 195 of relay 4—5D, to (—). The contacts 195 and 196 of relay 4—5D select the polarity to cause the signal 4 to be operated to its caution indicating position. It will be noted, however, that the lamp of signal 4 is not energized under these conditions unless a train is in approach of that signal to provide for the picking up of the stick relay 4S to close its front contact 313 to provide for the approach lighting of that signal.

Assuming further passage of the train, the acceptance of the signal 8B for the passage of the train into the passing siding (see Fig. 3E) provides for the restoration of that signal to stop in a manner comparable to that previously described with respect to the restoration of signal 2A to stop when the east-bound train was assumed to have accepted that signal.

The relay 9CP is active for the transmission of a 75 code from right to left in the track section 6—9T when the OS track section 8—9T becomes unoccupied in the rear of the train because the signal repeater relay 8YGP is dropped away by the restoration of signal 8B to stop. The relay 9CP is active under such conditions because of the energization of a circuit extending from (+), including back contact 139 of relay 9FP, contact 140 of oscillator 75CT, back contact 141 of relay 8YGP, front contact 142 of relay B—RFZ, front contact 143 of relay 8—9TR, front contact 144 of relay 9AS, and winding of relay 9CP, to (—).

The reception at the left-hand end of the track section 6—9T of the 75 code provides for the picking up of the relay 6—7H (see Fig. 3D), and the picking up of that relay provides for the dropping away of the stick relay 6S by opening its circuit at back contact 310. The dropping away of the relay 6S causes the code transmitter relay 7CP to be active for the transmission of a code at a 180 rate in the track section 7—4T. Relay 7CP is energized under such conditions by a circuit extending from (+), including normally closed contacts 160 and 161 of signal 7, contact 162 of oscillator 180CT, front contact 163 of relay 6FP, front contact 164 of relay 6—7H, front contact 165 of relay 6—7H, back contact 166 of relay 7FP, back contact 167 of relay 7S, back contact 168 of relay 7FP, and winding of relay 7CP, to (—).

The reception of the 180 code at the left-hand end of the track section 4—7T is effective to cause the picking up of the relay 4—5D (see Fig. 3B), and the picking up of that relay pole changes the circuit for the signal 4 at contacts 195 and 196 to cause that signal to be operated to a clear rather than a caution position. The picking up of the relay 4—5D is also effective to change the rate of code transmission in the track section 2—5T from a 120 to a 180 rate. The relay 5CP therefore becomes energized for each pulse of the 180 code in a manner heretofore described when considering the establishment of a route.

At the left-hand end of the track section 2—5T, the reception of the 180 code provides for the picking up of the relay 2—3DX (see Fig. 3A) which has its circuit tuned to the 180 rate. In accordance with the picking up of the relay 2—3DX, the relay 2—3D is maintained picked up by the closure of an obvious circuit for its winding by the front contacts 217 and 218 of relay 2—3DX. The relay 2—3DX picking up provides for the transmission of an indication to the control office that the block between the passing sidings A and B is now unoccupied as is illustrated in Fig. 1A. The shifting of contact 257 of relay 2—3DX is effective to start the transmission of an indication cycle from field station A to the control office because the back contact 259 of relay 2FP is open at that time. In accordance with the closure of front contacts 260 and 261 of relay 2—3DX and 2FP respectively, an indication is communicated during the indication cycle that the block is unoccupied, and such indication when received at the control office is effective to energize the block indicator relay 2—9RBK (see Fig. 2C) with a polarity to cause that relay to be picked up. The picking up of this relay causes the extinguishing of the block indicator lamp 2—9BE in a manner to be hereinafter considered, and provides for the transmission of a control cycle to field station B for shutting down the code transmitter at that field station in a manner to be hereinafter described.

To consider further the progress of trains through the routes which have been assumed to be established, it will be assumed that a westbound train accepts the signal 11A which is assumed to be cleared for a train movement into the section 8—11T. Such signal can only indicate caution because a 75 code is being transmitted in the track section 8—11T from left to right, and therefore the relay D associated with the control of signal 11A (not shown but corresponding to relay 2—3D of Fig. 3A) is dropped away.

The entrance of the westbound train into the OS track section 10—11T causes the restoration of the signal 11A to stop in the manner comparable to that which has been described for the restoration of the signal 2A to stop upon passage of a train past such signal.

The entrance of the train into the track section 8—11T causes the dropping away of the relay 11FP (see Fig. 1B) for the right-hand end of the track section, and the dropping away of that relay is effective to initiate a start for the communication of indications to the control office from field station C. Such start is initiated by the shifting of contact 263 of relay 11FP, and an indication is transmitted during that cycle of

operation in accordance with the opening of front contact 264 of relay 11FP to indicate occupancy of the track section 8—11T. Thus in accordance with the transmission of this indication, the block indicator relay 11—8LBK (see Fig. 2D) for the right-hand end of the track section 8—11T is dropped away, such relay having been previously picked up upon establishment of the route. The dropping away of this relay is effective in controlling the traffic direction relay 11LFS (see Fig. 2B) in a manner corresponding to that which has been described when considering specifically the interlock at the control office.

As the westbound train proceeds, so that the OS track section 10—11T becomes unoccupied in the rear of the train, the interlocking means at the control office for maintaining the direction established in the block at the right of field station C is released to allow the dispatcher to establish a route for passage of the eastbound train out of the passing siding.

The manner in which a reversal in the direction of code transmission in a block between passing sidings as would be required for the provision of non-stop meeting of trains will be hereinafter considered.

Shut-down of track circuit coding.—It has been described how an indication is communicated to the control office that the block between two passing sidings has become unoccupied in the rear of a train. Consideration will now be given to the manner in which this block indication is effective at the control office to cause the transmission of a control cycle of operation to the field to provide for the shutting down of the code transmitters for the respective track sections of that block.

Thus, with reference to Fig. 2C, the relay 2—9RBK is picked up in accordance with the closure of front contact 282 of relay A—ST during the reception of an indication cycle from field station A, and the picking up of that relay opens the stick circuit for the relay 2RFS (see Fig. 2A) at back contact 283. The picking up of the relay 2—9RBK is also effective to initiate the start of a control cycle for transmission to field station B by the closure of a circuit for the picking up of the relay B—ACH. Such circuit extends from (+), including contact 66 of signal control lever 2—3SIG in its normal position, back contact 314 of relay 2WLS, front contact 315 of relay 2—9RBK, back contact 316 of relay 2—3TK, back contact 317 of relay 2—3GK, front contact 318 of relay 2RFS, winding of relay B—ACH, and normally closed contact 39 of cancel button CAN, to (—). The relay B—ACH is maintained picked up by its stick circuit extending from (+), including back contact 75 of relay B—LC, front contact 76 of relay B—ACH, winding of relay B—ACH, and normally closed contact 39 of the cancel button CAN, to (—).

It will be noted that the pick-up circuit for the relay B—ACH under such conditions is only momentarily closed because the relay 2RFS has its stick circuit opened at back contact 283 of relay 2—9RBK at the same time that the circuit is closed at front contact 315 of relay 2—9RBK for the picking up of the relay B—ACH. The relay B—ACH is effective to start a control cycle in a manner corresponding to that which has been heretofore described specifically when considering the transmission of controls from the control office. The traffic direction code characters transmitted for control of track circuit coding are selected as (LS) and (SL) characters, dependent upon whether the respective track circuit code transmitters associated with field station B are to be initiated or rendered inactive.

The transmission of the control cycle provides for rendering the code transmitter inactive at the right-hand end of the block between the field stations A and B because an (SL) character is selected for the control of that code transmitter. Such (SL) character is selected because the traffic direction relays 2RFS and 9LFS are dropped away, and it is assumed that the signal control lever 2—3SIG has been restored to its normal center position by the dispatcher at the control office. Thus, with reference to Fig. 2C, the application of energy to the channel wire 50 for the code character following the character used for the control of the track switch, provides for the energization of the relay SL by a circuit extending from the channel wire 59 including front contact 79 of relay B—LC, back contact 80 of relay 9LFS, back contact 81 of relay 2RFS, back contact 82 of relay A—ACH, normally closed contact 63 of the signal control lever 2—3SIG, and winding of relay SL, to (—).

The next following code character in the control cycle, however, will not render the code transmitter inactive for the left-hand end of the track section 8—11T because an (LS) character is transmitted for the portion of the control associated with that code transmitter. This character is selected because the relay 11LFS is picked up at that time in accordance with a previously established route. With reference to Figs. 2C and 2D, the relay LS is picked up under such conditions when energy is applied to the channel wire 51 by a circuit extending from channel wire 51, including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 3RFS, front contact 86 of relay 11LFS, wire 101, and winding of relay LS, to (—).

In accordance with the transmission of a control cycle as has been described, the relay B—RFZ at field station B (corresponding to relay A—RFZ of Fig. 5) is energized during the execution period at the end of that control cycle with a polarity to shift the contacts of that relay to their dropped away positions. This is effected by the energization of a circuit for the lower winding of that relay in a manner corresponding to that which has been described when considering more specifically the reception of controls at the field stations.

The dropping away of the relay B—RFZ at field station B renders the code transmitter relay 9CP (see Fig. 3E) inactive because of the opening of its circuit at front contact 142.

The rendering inactive of the code transmitter relay 9CP causes the dropping away of the relay 6—7H (see Fig. 3D) at the left-hand end of the track section 6—9T, and the dropping away of that relay is effective to render the code transmitter relay 7CP inactive by the opening of its circuit at front contacts 164 and 165. The relay 7CP cannot then be effective to transmit a 75 code because the stick relay 6S is deenergized, and the circuit for the relay 7CP is thus opened at front contact 312 of that relay.

The failure to repeat a code through the track sections 7—4T and 4—7T provides that the relay 4—5H (see Fig. 3B) is dropped away at the left-hand end of the track section 4—7T, and the dropping away of that relay, with the stick relay 4S deenergized, renders the code transmitter relay 5CP inactive. The relay 4—5H opens the

circuit for relay 5CP at front contacts 203 and 204, and the circuit for relay 5CP is also opened at front contact 307 of the relay 4S. Thus, the rendering inactive of the relay 5CP completes the shutting down of the code transmitters for the block between the field stations A and B. It will be readily apparent that at each of the intermediate signal locations, the code oscillators are also rendered inactive in accordance with the dropping away of the relay H at that intermediate signal location, and the deenergized condition of the stick relay S at that intermediate signal location.

In accordance with the rendering inactive of the code transmitters for the respective track sections of the block, the relays 2—3DX and 2FP (see Fig. 3A) are dropped away, the relay 2—3DX being dropped away prior to the dropping away of the relay 2FP because of the relative drop-away timing of such relays. Thus, with reference to Fig. 1A, the shifting of contact 257 of relay 2—3DX prior to the closure of the back contact 259 of relay 2FP provides for the initiation of an indication cycle to be transmitted to the control office to provide an indication that the shut-down has become effective. Such indication is provided in accordance with the open contacts 259 and 261 of relays 2—3DX and 2FP respectively, and the reception of that indication at the control office is effective to energize the relay 2—9RBK (see Fig. 2C) with a polarity to cause the dropping away of that relay. The dropping away of the relay 2—9RBK completes the restoration to normal conditions of the apparatus associated with the establishment of routes through the block between the field stations A and B.

The shutting down of track circuit code transmission in a siding section, such as the track section 8—11T, is effected in a similar manner to the shutting down for a block between passing sidings as described above. To consider a specific example of the shutting down of a code transmitter for a siding section, it will be assumed that a route has been established for a westbound train through the track section 8—11T in a manner which has been described, and that the westbound train has passed through such route so as to leave the track section 8—11T unoccupied in the rear of the train.

When the track section 8—11T becomes unoccupied in the rear of the train, the relay 11FP (see Fig. 1B) is picked up at the right-hand end of that track section (corresponding to the relay 3FP of Fig. 3A) and the energization of such relay is effective to initiate the transmission of an indication cycle to the control office as illustrated in Fig. 1B. In this figure, the picking up of relay 11FP interrupts the stick circuit for the change relay at the field station C by the shifting of contact 263, and thus initiates the transmission of the indication cycle. During the transmission of that cycle, the closure of front contact 264 of relay 11FP provides that the indication relay 11—8LBK (see Fig. 2D) is picked up, and the picking up of that relay opens the stick circuit for the relay 11LFS (see Fig. 2B) at back contact 291 to cause that relay to be dropped away. It will be noted that the shifting of contact 291 of relay 11—8LBK does not close a pick-up circuit for the relay 11LFS because it is assumed that the signal control lever 10—11SIG has been restored to its center position by the dispatcher.

Because of the slow action of the relay 11LFS, a circuit is closed momentarily prior to the dropping away of that relay to pick up the automatic start relay B—ACH. Such circuit extends from (+), including contact 319 of signal lever 10—11SIG in its center position, front contact 320 of relay 11—8LBK, back contact 321 of relay 10—11TK, back contact 322 of relay 10—11GK, front contact 323 of relay 11LFS, wire 127, winding of relay B—ACH, and normally closed contact 39 of the cancel button CAN, to (—).

The picking up of the relay B—ACH under the above described conditions provides for the picking up of the relay B—LC and other relays involved in the transmission of a control cycle in a manner corresponding to that which has been heretofore described when considering in detail the manner of transmission of a control cycle to field station B. The code characters selected for transmission during such cycle of operation for controlling the track circuit code transmitters in the field are both (SL) characters for shutting down such code transmitters if the normal positions of the signal control levers associated with the respective field stations A and C are assumed. The third control character for the control cycle is an (SL) character because of the closure of a circuit extending from the channel wire 51 (see Fig. 2C), including front contact 83 of relay B—LC, wire 84, back contact 85 of relay 8RFS, back contact 86 of relay 11LFS, back contact 87 of relay C—ACH, contact 88 of switch control lever 4SW in its normal position, contact 89 of signal control lever 10—11SIG in its normal position, wire 90, and winding of relay SL, to (—).

In accordance with the reception of this code character at the field station B, the magnetic stick relay B—LFZ (see Fig. 3E) is energized with a polarity to open the front contact 236 which is included in the circuit for the code transmitter relay 8CP. Rendering the code transmitter relay 8CP inactive in this manner provides that the code receiving apparatus at the right-hand end of the track section 8—11T also becomes inactive and is therefore restored to its normally inactive condition.

When the relay 11FP (see Fig. 1B) is dropped away as a result of the removal of the code from the track section 8—11T, the shifting of contact 263 is effective to initiate the transmission of an indication cycle to the control office to provide for the restoration of the block indicator relay 11—8LBK (see Fig. 2D). The dropping away of the relay 11—8LBK completes the restoration to normal conditions of the apparatus associated with the siding section between the field stations B and C.

It will be noted with reference to Fig. 3E, that the shutting down of the code transmitters at field station B for the track section 6—9T and 8—11T respectively renders the code oscillators 180CT and 75CT at that field station inactive because of the opening of the circuits for such relays at front contact 232 of the relay B—LFZ.

Non-stop meeting of trains.—It has been pointed out how routes can be established for respective eastbound and westbound trains through the stretch of track used in this embodiment of the present invention, it having been described how the eastbound train can proceed from signal 2 into the passing siding at field station B over the track switch 3W in its reverse position. It has also been described how a route can be established for a westbound train for passage of such train from signal 11A to the signal

9A. Assuming these conditions to exist for a meeting of trains, the locking is maintained effective at the control office for the traffic direction established in the block between the field stations A and B as long as such block is occupied by the eastbound train, however, when such block becomes unoccupied in the rear of a train, the transmission of an indication that the block is clear to the control office provides for the shutting down of the code transmitters in the respective track sections of the block in a manner which has been described when considering specifically the mode of operation of the system in rendering the code transmitters inactive after passage of a train. The extinguishing of the block indicator lamp 2—9BE (controlled in a manner to be hereinafter described) brings to the dispatcher's attention that the block has become unoccupied in the rear of a train, and that the traffic direction locking has been released by the dropping away of the relay 2RFS. It is thus provided that the dispatcher can then proceed to designate the route desired for the westbound train by operating the switch control lever 3SW back to its normal position and the signal control lever 8—9SIG to its left-hand position. The depression of the start button to close contact 96 for the picking up of the relay B—CH initiates the transmission of the controls thus designated, and the initiation of such control cycle is effective to cause an automatic start for transmission of a control cycle to field station A, by the picking up of the relay A—ACH, all in a manner comparable to the manner of control which has been specifically described when considering the mode of operation of the system for the establishment of the route for an eastbound train governed by the signal 2A. The reception at the field stations A and B of these respective control cycles provides for the transmission of track circuit codes and the conditioning of application relays to provide for the operation of the track switch 3W to its normal position and the clearing of signal 9A for the passage of the westbound train, the actual operation of the track switch 3W and the clearing of the signal 9A of course being delayed by the electric locking at field station B until the OS track section 8—9T becomes unoccupied by the eastbound train moving into the passing siding.

Outlying switch.—In the use of an outlying hand-throw switch between two field stations, it may be required that the switch be provided with an electric lock of a type generally employed for such purposes such, for example, as the electric lock shown in the patent to J. E. Stephenson, No. 1,710,668, dated April 23, 1929. Such an arrangement is illustrated in Fig. 3C in which the outlying track switch 2W is provided with an electric lock and with a short release track section RT for releasing the lock when the train desires to enter such outlying track switch.

To consider the manner in which the passage of a train can release the electric lock for entering the outlying track switch from the main track, it will be assumed that an eastbound train occupies the track section 4—7T, and desires to enter the outlying track switch.

The entrance of the train into the release track section RT, by causing the release of the track relay RTR, closes a circuit to condition the winding L of the electric lock mechanism for energization upon closure of the door contact 324 when the door of the electric lock mechanism is opened. Thus the opening of the door of the electric lock mechanism provides for the energization of the winding L of the electric lock by a circuit extending from (+), including door contact 324, back contact 325 of relay RTR, and winding L, to (—). The energization of the winding L, under such conditions, releases the locking member 326 from the locking cam 327, and therefore allows the withdrawal of the locking bar 328 from its engagement with the lock rod 329 to allow the hand operation of the track switch 2W to its reverse position. The closure of the door of the electric lock mechanism after the track switch has been operated to its reverse position opens the contact 324 in the circuit for the winding L of the electric lock mechanism to provide that the restoration of the track switch 2W to its normal position after passage of the train is effective to provide for the restoration of the electric lock to its normal locking position.

For considering the mode of operation of the system upon movement of a train out of an outlying track switch to the main track, it will be assumed that the normal conditions of the system exist as they have been described, and that a trainman communicates with the dispatcher from the location of the outlying switch to ask for permission to operate the track switch 2W to its reverse position and proceed in the direction of the passing siding at field station B after entering the block between the field stations A and B.

When the dispatcher is agreeable to this train movement, he instructs the trainman that he may open the door of the electric lock mechanism, and the opening of such door provides for the dropping away of the relay LP (see Fig. 3C) by opening the circuit for such relay at the normally closed door contact 330. The dropping away of relay LP opens the circuit at front contact 177 for the code repeater relays 4CPR[1] and 7CPR[1] so as to isolate the stretches of track adjacent to the short release track section RT and thereby prevent the code from the track section 4—7T from repeating into the track section 7—4T or vice versa.

In accordance with the desired direction of train movement after the train enters the main track from the outlying track switch, the dispatcher actuates the switch lock lever SWLL (see Fig. 2A) to its right-hand position and depresses the start button associated with the switch lock lever SWLL to close contact 331. The depression of that button provides for the picking up of the relay 2WL by the energization of a circuit extending from (+), including contact 331 of the start button in its depressed position, back contact 332 of relay 9—9GK, back contact 333 of relay 2—3GK, and winding of relay 2WL, to (—). It will be noted that this arrangement checks that the signals at field stations A and B are both at stop before the designated controls for the energization of the electric lock for the track switch 2W can be transmitted.

The picking up of relay 2WL, with the lever SWLL in its right-hand position, closes a circuit for the energization of the relay 2WLS extending from (+), including contact 334 of lever SWLL in its right-hand position, front contact 335 of relay 2WL, and winding of relay 2WLS, to (—). The picking up of relay 2WLS closes a stick circuit at front contact 336 to shunt front contact 335 of relay 2WL out of the pick-up circuit just described. Thus, the relay 2WL is dropped away when the start button is restored, but the relay 2WLS remains picked up. The closure of back

contact 337 of relay 2WL provides stick circuit energy for the relay 2WLS to maintain that relay picked up until such time as the dispatcher again actuates the start button associated with the lever SWLL to again cause the picking up of relay 2WL. Relay 2WLS is maintained picked up under such conditions by a stick circuit extending from (+), including back contact 337 of relay 2WL, front contact 336 of relay 2WLS, and winding of relay 2WLS, to (—).

The picking up of the relay 2WL causes the picking up of the automatic start relays A—ACH for field station A and B—ACH for field station B, thus initiating the transmission of a control cycle of operation to each of those field stations. The relay A—ACH is picked up under such conditions by the energization of a circuit extending from (+), including front contact 338 of relay 2WL, winding of relay A—ACH and normally closed contact 39 of cancel button CAN, to (—). The relay B—ACH is picked up under such conditions by the energization of a circuit extending from (+), including front contact 339 of relay 2WL, winding of relay B—ACH, and normally closed contact 39 of cancel button CAN, to (—).

In accordance with the direction of traffic designated by the dispatcher upon the operation of the lever SWLL to its right-hand position, the relay 2RFS is picked up to provide locking for that direction of traffic by the energization of a circuit extending from (+), including front contact 340 of relay 2WLS, contact 341 of lever SWLL in its right-hand position, front contact 342 of relay B—ACH, back contact 343 of relay 9LFS, and winding of relay 2RFS, to (—). The relay 2RFS is maintained picked up by a stick circuit, dependent upon the front contact 284 of the relay 2WLS. Such stick circuit extends from (+), including back contact 286 of relay 9LFS, front contact 287 of relay 2RFS, front contact 284 of relay 2WLS, and winding of relay 2RFS, to (—).

The selection of code characters for transmission to the respective field stations A and B is provided in a manner similar to that which has been heretofore described for the communication of controls to those field stations, the code characters provided for the initiation of the track circuit code transmitter at the right-hand end of the block between those two field stations being provided in a manner comparable to that which has been heretofore described under similar conditions as selected by the energization of the relay 2RFS. The actual code character used for starting the code transmitter at the right-hand end of the block is an (LS) character because of the closure of a circuit during that cycle extending from the channel wire 50 including front contact 79 of the relay B—LC, back contact 80 of relay 9LFS, front contact 81 of relay 2RFS, and winding of relay LS, to (—).

The transmission of the control cycle to the field station A is effective to start the code transmitter at the left-hand end of the block between the two field stations because of the energization of the relay LS during the control cycle by a circuit extending from the channel wire 51 including front contact 57 of relay A—LC, front contact 58 of relay 2RFS, front contact 100 of relay 2WLS, and winding of relay LS, to (—).

In accordance with the starting of the transmission of track circuit codes at both ends of the block, codes are received from both directions at the location of the outlying track switch, thus providing for the energization of the relays 4FP[1], 4BP[1], 7FP[1] and 7BP[1] (see Fig. 3C). The relays 4FP[1] and 4BP[1] are picked up because of the pulsing of contact 343 of the relay 4TR[1] at the right-hand end of the track section 4—7T, and similarly the relays 7FP[1] and 7BP[1] are picked up in accordance with the pulsing of contact 344 of relay 7TR[1] at the left-hand end of the track section 7—4T. Thus, with the door of the electric lock mechanism open, a circuit is closed for the energization of the winding L of the electric lock extending from (+), including electric lock door contact 324, front contact 345 of relay 4BP[1], front contact 346 of relay 7BP[1], and winding L of the electric lock mechanism, to (—). In accordance with the energization of this circuit, the locking member 326 of the electric lock mechanism is operated to a position to release the locking cam 327 and allow the release of the lock rod 329 by the locking bar 328 to allow the trainman to operate the track switch 2W to its reverse position. The train occupying the track switch connected to the main track by the outlying track switch 2W can now move into the main track, and the track switch 2W can be restored to its normal position to allow for the passage of the train in the assumed direction toward the field station B.

Assuming that the signal 8 at field station B is at stop, a 75 code is transmitted through the track section 6—9T for operating the mechanism of signal 6 to its caution indicating position, and thus the eastbound train can proceed under automatic signal indications to the field station B. The dispatcher can, of course, provide for the clearing of signal 8 for governing further passage of the eastbound train in accordance with the mode of operation for the establishment of routes which has been heretofore described.

With reference to Fig. 3C, the closure of the door to the electric lock mechanism and the restoration of the track switch 2W to its normal position provides for the energization of the relay LP by a circuit extending from (+), including door contact 330, back contact 347 of the electric lock operating mechanism, contact 348 of the switch circuit controller for the track switch 2W closed in its normal position, and winding of relay LP, to (—). The picking up of that relay, by the closure of front contact 177 conditions the relays 4CPR[1] and 7CPR[1] so that either of such relays can become effective to repeat track circuit code pulses around the release track section RT whenever the single direction is established for code transmission through the block corresponding to the direction for which such relay is provided. In other words, as long as the code transmitters are active at both ends of the block so as to cause the relays 4FP[1] and 7FP[1] both to be picked up, neither of the relays 4CPR[1] or 7CPR[1] can be active because the circuit for relay 4CPR[1] is held open at back contact 182 of relay 4FP[1], and similarly the circuit for relay 7CPR[1] is held open at back contact 349 of relay 7FP[1].

Upon considering the conditions as they have been assumed to have been established for the passage of the train out of the outlying track switch, it will be apparent that the maintaining of the relay 2WLS (see Fig. 2A) energized is effective to select control codes for transmission to field stations A and B for controlling the track circuit code transmitters at the respective ends of the block in a manner to maintain these code transmitters both active, irrespective of the designation of routes for establishment by the dispatcher calling for track circuit code transmission conditions to the contrary. This is true in connection with field station A because the code character (LS) is selected for transmission for

the control of the relay A—RFZ at field station A, irrespective of the controls designated for transmission to the field station A, so long as the relays 2RFS and 2WLS are maintained picked up as heretofore described in connection with the control of the switch lock for the outlying track switch 2W. The circuit by which the relay LS is energized under such conditions extends from the channel wire 51 including front contact 57 of relay A—LC, front contact 58 of relay 2RFS, front contact 100 of relay 2WLS, and winding of relay LS, to (—).

In a similar manner, the relay LS is picked up for the character in any control cycle transmitted to field station B for the control of the relay B—LFZ. The relay LS is energized under such conditions by a circuit extending from the channel wire 50 including front contact 79 of relay B—LC, back contact 80 of relay 9LFS, front contact 81 of relay 2RFS, and winding of relay LS, to (—). It will be noted upon consideration of the circuit just described that such (LS) character is selected particularly in accordance with the closure of front contact 81 of relay 2RFS without the inclusion of a contact of the relay 2WLS in its circuit. By this arrangement it is therefore provided that the code transmitter at the right-hand end of the block is maintained active for providing track circuit codes for east-bound trains as long as the relay 2RFS is maintained picked up, irrespective of the restoration of the relay 2WLS.

It will now be assumed that a trainman at the outlying switch communicates with the dispatcher at the control office to inform him that the train has moved into the main track, and that the release of the electric lock is no longer required. In accordance with the reception of such information by the dispatcher, the dispatcher can proceed to restore the switch lock lever SWLL to its center position and depress the start button associated with that lever to close the contact 331 and provide for the momentary energization of the start relay 2WL. The picking up of the start relay 2WL under such conditions opens the stick circuit for the relay 2WLS at back contact 337, to provide for the dropping away of that relay.

The picking up of the relay 2WL as described above is effective to initiate the transmission of a control cycle to field station A and also to field station B in accordance with the closure of front contacts 338 and 339 for the energization of the circuits of the relays A—ACH and B—ACH respectively. It will be readily apparent that if the dispatcher desires to change the condition of the switches and signals at these field stations he can select these conditions by the positioning of the switch and signal control levers associated with the field stations A and B prior to the actuation of the start button associated with lever SWLL.

During the transmission of the control cycle to field station A, a control is transmitted for rendering inactive the track circuit code transmitter at the left-hand end of the block because of the selection of an (SL) character for communication of such control in accordance with the dropping away of the relay 2WLS. Thus, the relay SL is picked up under such conditions upon the closure of a circuit during the control cycle extending from the channel wire 51 including front contact 57 of relay A—LC, front contact 58 of relay 2RFS, back contact 100 of relay 2WLS, and winding of relay SL, to (—). It will be noted, however, as has been described above, that the code transmitter at the right-hand end of the block between the field stations A and B is maintained active because of the code character for its control being selected as an (LS) character on account of the relay 2RFS being maintained picked up as long as the block is occupied by the east-bound train. The relay 2RFS is maintained picked up after the relay 2WLS has been dropped away by its stick circuit which is dependent upon the back contact 283 of the block relay 2—9RBK in a manner which has been specifically described when considering the mode of operation of the relays 2RFS and 9LFS for providing an interlock at the control office to maintain track circuit code transmitters active as required for established and occupied routes.

It has been described with reference to Fig. 3C that the rendering inactive of the code transmitter at either end of the block renders effective the repeating of the code for the direction of traffic established around the released track section RT. This is accomplished by the dropping away of the relays 4FP[1] and 4BP[1] when they fail to receive track circuit code so as to close the circuit for the code transmitter relay 4CPR[1] at back contacts 182 and 181 respectively so that the track circuit code received at the left-hand end of the track section 1—4T can be repeated into the right-hand end of the track section 4—7T. The repeating of the code around the release track section RT restores the operating conditions of the system to the conditions that would be effective upon passage of an east-bound train without any particular reference to an outlying track switch. It will therefore be provided that the shutting down of the track circuit code transmitters will be effective in a manner which has been described when the east-bound train has left the block, and it will be readily apparent that routes can be set up for following trains as required after the restoration to normal of the parts of the system associated with the release of the switch lock for the outlying track switch 2W.

From the typical operating condition which has been specifically described with reference to passage of a train out of the outlying track switch 2W it has therefore been described how the switch 2W can be unlocked only by permission from the dispatcher, only if the block is unoccupied, and only if the signals governing entrance to that block are at stop. Once a train has entered the block, it is assured that the transmission of codes for the control of signals required for governing passage of that train cannot be inadvertently interrupted if the dispatcher designates a route over that corresponding stretch of track for the opposite direction of traffic. It is provided, however, that the direction of track circuit code transmission in the portion of the block which is contrary in direction of transmission to the direction of movement of the train can be changed with the block occupied by the train which is assumed to have moved off of the outlying track switch, if it is desirable to establish a route for a following train, even though the first train is still occupying the block.

Indications.—In addition to the usual approach, OS, and block indications which are generally required in such a system, provision is made to provide indications at the control office of land slides, washed out bridges, and the like, at any time that such conditions may occur, irrespective of whether the track circuit coding

is active or not. These conditions are indicated at the nearest field stations because of steady energization of the track rails for the portions of the block between the land slide detectors and the nearest field stations, and in accordance with this steady energization, an indication is communicated to the control office by the code communication system of this condition, and a visual indication is provided on the control panel of the control machine.

With reference to Fig. 2C, the approach indicator lamps 3AE and 8AE are provided for indicating approach of a train to the signals 3 and 8 respectively, and the block indicator lamp 2—9BE is provided for indicating occupancy of the block between the field stations A and B.

These indicator lamps also serve as slide indicator lamps used in combinations to locate the nearest end of the block with which the slide or other dangerous obstruction has become effective. More specifically, the flashing of the lamps is an indication of a land slide or other dangerous obstruction, and the location of such condition with respect to the nearest end of the block is provided by flashing the approach indicator lamp for that nearest end in combination with the block indicator lamp. Such arrangement of indications is effective to immediately call the dispatcher's attention to the indication, and he can readily identify, from the distinctive indication thus provided, the point at which the dangerous condition is located.

To consider specifically the manner in the field in which a land slide is detected, with reference to Fig. 3B, it will be assumed that a land slide has become effective to open the contact 350 by the use of a slide fence or other detecting means. The opening of this contact causes the dropping away of the relay 4SD in an obvious manner, and the dropping away of that relay opens the track circuit connections around the insulated rail joints 185 and 186 at front contact 351. The closure of back contact 351 of relay 4SD closes a circuit by which the track rails at the left of the insulated joints 185 and 186 are steadily energized by the track battery 352. This track battery is connected across the track rails at the left of the insulated joints through the back contact 351 of relay 4SD and the adjustable track resistance 353 in an obvious manner. The steady energization of the track rails of track section 4—7T at the left of the insulated joints 185 and 186 under such conditions provides for the steady energization of the track relay 4TR with a polarity corresponding to that by which such relay would be energized by the track circuit code, and thus provides that the relay 4TR is maintained steadily picked up under such conditions, irrespective of whether the track circuit code transmitters are active or inactive at the time that the slide detector relay 4SD is dropped away.

The steady energization of the relay 4TR causes the relay 5CP to be steadily energized to provide for the steady energization of the track section 2—5T. The relay 5CP is maintained steadily energized under such conditions by a circuit extending from (+), including normally closed contacts 198 and 199 of signal 5, front contact 354 of relay 4FP, back contact 307 of relay 4S, back contact 203 of relay 4—5H, back contact 204 of relay 4—5H, back contact 206 of relay 5S, back contact 207 of relay 5FP, and winding of relay 5CP, to (—).

At the left-hand end of the track section 2—5T, the relay 2H is deenergized because of the steady energization of the relay 2TP, and thus opens the circuit for the normally energized relay 2SD at front contact 355. The circuit is also open at back contact 20 of relay 2FP, and therefore the relay 2SD is dropped away, and the dropping away of that relay is effective to initiate an indication cycle at field station A by the shifting of contact 356 of relay 2SD (see Fig. 1A) in the stick circuit for the change relay at that field station. The transmission of that indication cycle with the indication circuit closed at back contact 278 provides that the relay A—SDK at the control office (see Fig. 2C) is picked up. In accordance with the picking up of the relay A—SDK, the lamp 3AE is energized intermittently upon the closure of front contact 357, and also the block indicator lamp 2—9BE is energized intermittently in accordance with the closure of its circuit at front contact 358 of relay A—SDK. The circuit by which the indicator lamp 2—9BE is energized under such conditions extends from (FL+), including front contact 358 of relay A—SDK, back contact 359 of relay B—SDK, and lamp 2—9BE, to (—).

It will be noted from the circuit just described that in case the slide detectors should both be actuated at the same time for the block between the field stations A and B, all three lamps will be intermittently energized, the energization of the lamp 8AE for the right-hand end of the block being effective in a manner similar to the manner which has been described in which the intermittent energization of the lamp 3AE is effective in accordance with the operation of the slide detector associated with that end of the block. It will be noted that the block indicator lamp 2—9BE is energized with flashing energy in response to the picking up of either or both of the relays A—SDK or B—SDK to close front contact 358 of relay A—SDK or front contact 359 of relay B—SDK.

The steady energization of the approach indicator lamps is provided in accordance with the energization of approach relays ARS at the respective ends of the block. With reference to Fig. 3A, for example, the relay 2ARS is sufficiently slow acting so that it will be maintained steadily picked up in the pulsing of the contact 360 of the series approach relay 2AR which is connected in series with the track battery 361 at the left-hand end of the track section 2—5T. It is therefore provided by this arrangement that the approach relay 2ARS is picked up by the presence of a westbound train in the track section 2—5T because at that time the code transmitter relay 2CP is active for the transmission of track circuit code in the track section 2—5T from left to right.

When considering passage of an eastbound train through the track section 2—5T, however, the relay 2CP is inactive because the track circuit code is being transmitted from the right-hand end of that track section and therefore other means is provided for energizing the approach relay 2ARS. The relay 2S is instrumental in energizing the relay 2ARS under such conditions, and such relay is picked up when the eastbound train occupies the OS track section 2—3T by the energization of a circuit extending from (+), including front contact 362 of relay 2H, back contact 363 of relay 2—3TR, and winding of relay 2S, to (—). When the eastbound train enters the track section 2—5T, the shunting of that track section causes the dropping away of the relay 2H, and the dropping away of that relay is effective under such conditions to cause the picking up of the approach control relay 2ARS.

Relay 2ARS is picked up under such conditions by the energization of a circuit extending from (+), including back contact 362 of relay 2H, front contact 364 of relay 2S, and winding of relay 2ARS, to (—). Upon the picking up of relay 2ARS a stick circuit is closed for the relay 2S. Such circuit extends from (+), including front contact 365 of relay 2S, front contact 366 of relay 2ARS, and winding of relay 2S, to (—).

By the above described circuit arrangement it is provided that the approach relay 2ARS is maintained picked up whenever an eastbound train occupies the track section 2—5T, and it is dropped away along with the relay 2S when the track section 2—5T becomes unoccupied in the rear of the train so as to permit the picking up of the relay 2H. The picking up of relay 2H under those conditions opens the stick circuit for the relay 2ARS at back contact 362, and the dropping away of relay 2ARS opens the stick circuit for the relay 2S at front contact 366 to cause that relay to be dropped away. The pick-up circuits for both the relays 2ARS and 2S are open at that time in accordance with the energization of the OS track relay 2—3TR.

With reference to Fig. 1A, the shifting of contact 367 of relay 2ARS is effective to initiate an indication cycle, and during that cycle the closure of front contact 277 of that relay is effective during the cycle to provide for the picking up at the control office of the approach indication relay 3AK. The picking up of that relay closes a circuit at front contact 368 including back contact 357 of relay A—SDK to provide for the steady energization of the approach indicator lamp 3AE. It will be readily apparent that the lamp 3AE remains energized until the relay 3ARS in the field is dropped away to provide for the transmission of an indication cycle during which the magnetic stick relay 3AK is energized with a polarity to cause that relay to be dropped away. Having thus described specifically the mode of operation in the control of the approach indicator lamp 3AE, it is believed readily apparent that a similar mode of operation is provided in the control of the indicator lamp 8AE associated with the right-hand end of the block.

Upon considering the circuit provided for the control of the block indicator lamp 2—9BE it will be apparent that such lamp is normally dark because of its circuit being open at front contacts 369 and 370 of relays 2RFS and 9LFS which are normally dropped away. It has been pointed out that in the establishment of a route, the rendering active of the code transmitters for the respective track sections of the block is effective to initiate the transmission of an indication to the control office that the block is unoccupied, and the reception of such indication is provided by the picking up of the block indication relay 2—9RBK (assuming eastbound traffic to be established as has been heretofore described). It has been described that the picking up of this relay is effective to cause the picking up of the relay 2RFS, but the picking up of relay 2RFS cannot cause the illumination of the block indicator lamp under such conditions by the closure of front contact 369, because the opening of back contact 371 of the relay 2—9RBK in the circuit for the block indicator lamp 2—9BE prevents the energization of that lamp. It is therefore provided that the block indicator lamp remains dark until a train has entered the block to cause the transmission of an indication to the control office that the block is occupied to provide for the dropping away of the relay 2—9RBK. The dropping away of this relay when a train enters the block provides for the steady energization of the block indicator lamp by a circuit extending from (+), including front contact 369 of relay 2RFS, back contact 370 of relay 9LFS, back contact 372 of relay 9—2LBK, back contact 371 of relay 2—9RBK, back contact 358 of relay A—SDK, back contact 359 of relay B—SDK, and lamp 2—9BE, to (—). It has been described that the relay 2—9RBK remains dropped away as long as the block is occupied by a train, because such relay can be picked up only upon the reception of a block clear indication at the left-hand end of that block. Thus, the relay 2—9BE is maintained steadily energized as long as the block is occupied, and after the block becomes unoccupied, the picking up of relay 2—9RBK causes the extinguishing of the lamp by the opening of black contact 371, and the dropping away of the relay 2RFS in response to the picking up of relay 2—9RBK is effective to further open the circuit 2—9BE at front contact 369, thus providing that the lamp will remain dark after the relay 2—9RBK is again dropped away due to the shutting down of the track circuit code transmitters through the block. Having thus described specifically the conditions effective upon the passage of an eastbound train for controlling the block indicator lamp 2—9BE, it is believed to be readily apparent to those skilled in the art that a similar mode of operation is effective for controlling the block indicator lamp in accordance with the passage of a westbound train, the relays involved in the control of the lamp for a westbound train being the relays 9—2LBK and 9LFS.

Having thus described a centralized traffic controlling system employing coded track circuits for a particular stretch of track 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 the invention may assume, and it is to be further understood that various adaptations, alterations and modifications may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What I claim is:

1. In a code track circuit signalling system for a stretch of single track, said stretch having normally deenergized coded track circuits, normally inactive track circuit code transmitters connected to the track rails at both ends of the stretch, track obstruction detecting means at an intermediate point in said stretch of track having distinctive normal and operated positions, means responsive to the operation of said track obstruction means to said operated position for applying steady energization to the track rails and preventing the application of coded energy, means at one end of said stretch distinctively responsive to the steady energization of the track rails as compared to the coded energization thereof for communicating a distinctive indication to a remote control office for providing a distinctive indication to a dispatcher of a dangerous condition, and signals governing entrance to the respective ends of said stretch cleared only in response to coded energy transmitted through the track rails in advance thereof.

2. In a centralized traffic controlling system of the character described for a stretch of track

having head-block signals at the respective ends of the stretch capable of being cleared only by coded energy feeding through normally deenergized coded track circuits comprising normally inactive track circuit code transmitters connected to the track rails in advance thereof, a normally energized detector relay at one end of said stretch, track obstruction detecting means at an intermediate point in said stretch of track having distinctive normal and operated positions, means for rendering at least one of said code transmitters inactive and steadily energizing the track rails of said stretch in response to the operation of said track obstruction detecting means to said operating position, means at one end of said stretch distinctively responsive to said steady energization of the track rails as compared to the energization of the track rails by coded energy and effective when responsive to deenergize said normally energized detector relay, and means responsive to the deenergization of said detector relay for communicating a distinctive indication to the control office.

3. In a centralized traffic controlling system for a stretch of track having normally deenergized coded track circuits, normally inactive track circuit code transmitters connected to the track rails at the respective ends of the stretch for the transmission of track circuit codes through the track rails for the control of head-block signals at the opposite ends of said stretch, track obstruction detecting means at an intermediate point in said stretch of track having distinctive normal and operated positions, means responsive to the operation of said track obstruction detecting means to said operated position for streadily energizing the track rails and rendering one of said code transmitters effective between the location of such obstruction and the nearest end of said stretch, such steady energization being isolated from the remainder of said stretch, and means at said one end of said stretch distinctively responsive to the steady energization of the track rails at that end as compared to coded energization for communicating a distinctive indication to a remote control office.

4. In a coded track circuit signalling system for a stretch of track having normally deenergized track circuits with normally inactive code transmitters for controlling the signals, track obstruction detecting means at a plurality of intermediate points in said stretch of track each of such means having normal and operated positions, means responsive to the operation of said track obstruction detecting means to said operated position for applying steady energization to only that portion of the track rails of said stretch extending between the location of that track obstruction detecting means and the nearest end of said stretch, and means at each end of said stretch distinctively responsive to the steady energization of the track rails at that end as compared to coded energization for communicating a distinctive indication to a remote control office, whereby a plurality of track obstructions along a stretch of track can be distinctively indicated at the control office as to the particular end of said stretch of track with which such obstructions are more closely associated without the use of line wires within said stretch.

5. In a centralized traffic controlling system for a stretch of single track in which approach indications are communicated for respective portions of the trackway by a coded line circuit from the respective ends of the stretch to a remote control office, track obstruction detecting means located at an intermediate point in said stretch and effective in response to the occurrence of a track obstruction to communicate an indication through the track rails to one end of the stretch and from there to the control office distinctive as to the particular end of said stretch that is nearest to said obstruction, approach track occupancy indicator lamps at the control office for the respective ends of said stretch of track, means at the control office for steadily energizing said track occupancy indicator lamps associated with track sections at the respective ends of said stretch in response to approach indications communicated from such ends when such track sections are occupied by a train, and means responsive to said track obstruction detecting means for distinctively energizing the track rails of said stretch and through the coded line circuit to the control office from one end of the stretch to cause the flashing of the track occupancy indicator lamp for the end of said stretch nearest such obstruction detecting means irrespective of the condition of occupancy of the track section at that end.

6. In a centralized traffic controlling system for a stretch of track constituting a block having head-block signals at its end in which respective block occupancy and approach occupancy indications are communicated by the respective ends of code track circuits to the stretch and from there by line circuit to a remote control office, a block indicator lamp at the control office for indicating track occupancy of said block, approach indicating lamps at the control office for indicating occupancy of the respective track sections at the ends of the stretch, means for steadily energizing said block indicator lamp in accordance with the occupancy of said block by a train, means for steadily energizing each of said approach indicator lamps in accordance with the occupancy of that track section by a train, track obstruction detecting means located at a plurality of intermediate points in said stretch, each of such means having normal and operated positions, means responsive to the operation of said track obstruction detecting means to said operated position for applying a distinctive condition of energization to only the portion of the track rails of said stretch extending between the location of that obstruction detecting means and the nearest end of said stretch, means for flashing said block indicator lamp at the control office in response to said distinctive energization of the track rails at either end of said stretch, and means for flashing said approach indicator lamps only in response to said distinctive energization of the track rails at the ends of the stretch with which such lamps are respectively associated.

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