Sept. 5, 1944. T. J. JUDGE 2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 1.

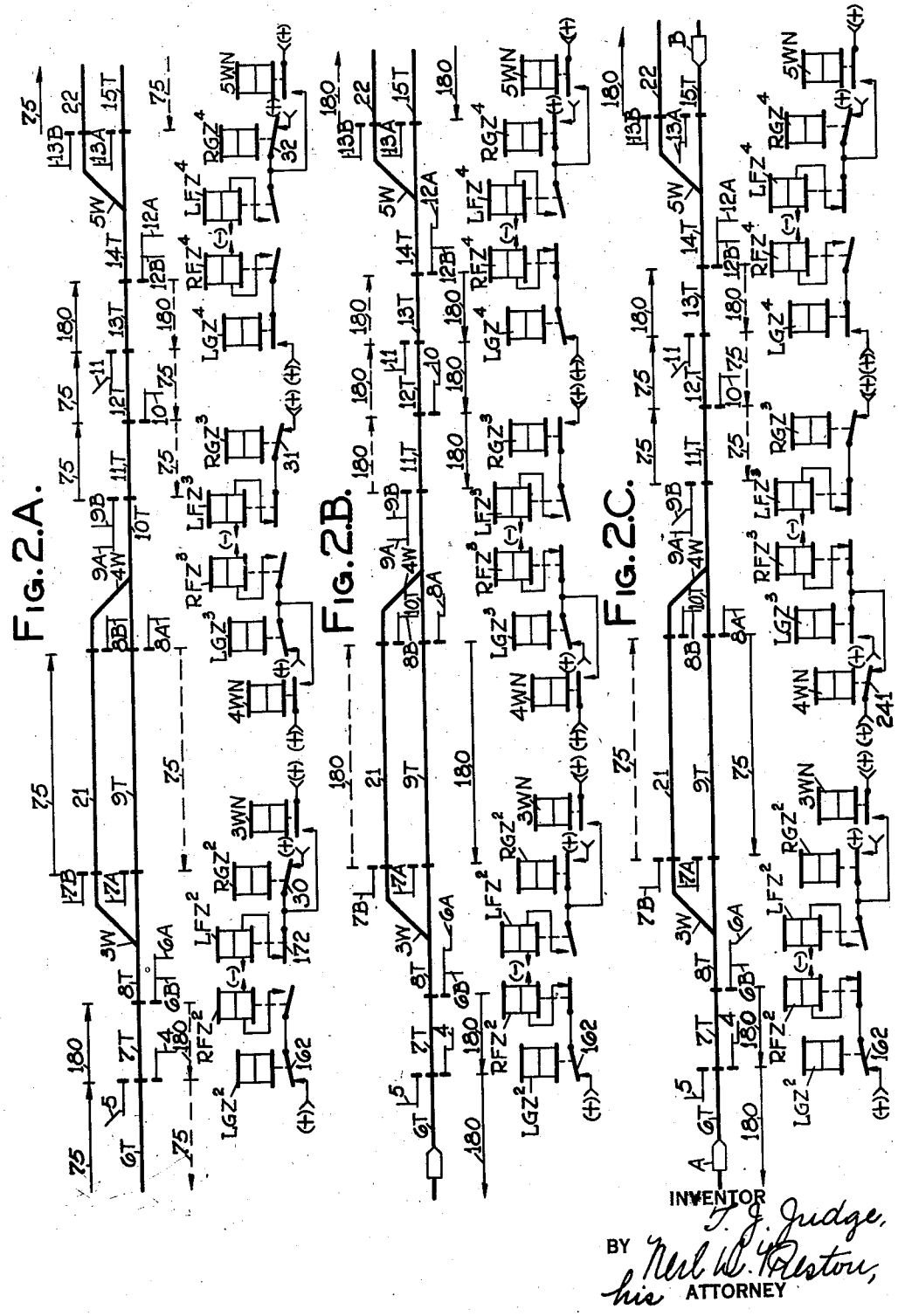
Impulse No.	1	2	3		4		5	6	
Field Station No. 2.	+	+	−	SW. 3W Normal / SW. 3W Reverse	+ / −	Sig. Right / Sig. Left / Sig. Stop	+ / − / −	− / + / −	Governs Switch and Signal Control Relays
	+	+	+		±		+	−	Traffic 2-6
	+	−	+		+		−	+	Traffic 9A-7A
Field Station No. 3.	+	−	+	SW. 4W Normal / SW. 4W Reverse	+ / −	Sig. Right / Sig. Left / Sig. Stop	+ / − / −	− / + / −	Governs Switch and Signal Control Relays
	+	+	−		+		+	−	Traffic 6A-8A
	+	−	−		±		−	+	Traffic 13-9
Field Station No. 4.	+	−	−	SW. 5W Normal / SW. 5W Reverse	+ / −	Sig. Right / Sig. Left / Sig. Stop	+ / − / −	− / + / −	Governs Switch and Signal Control Relays
	+	−	+		±		+	−	Traffic 8-12
	−	+	+		+		−	+	Traffic left-13

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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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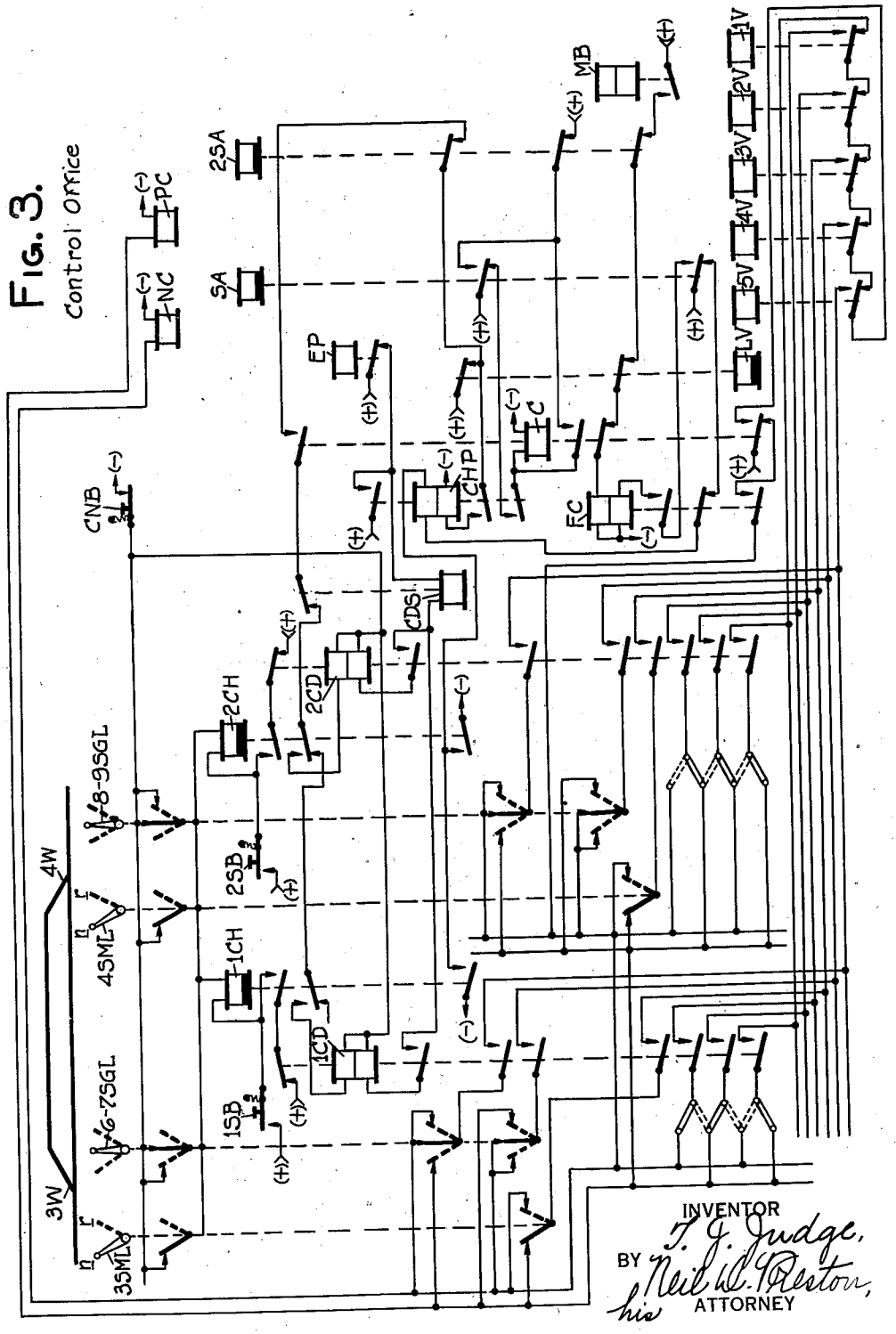


FIG. 3.

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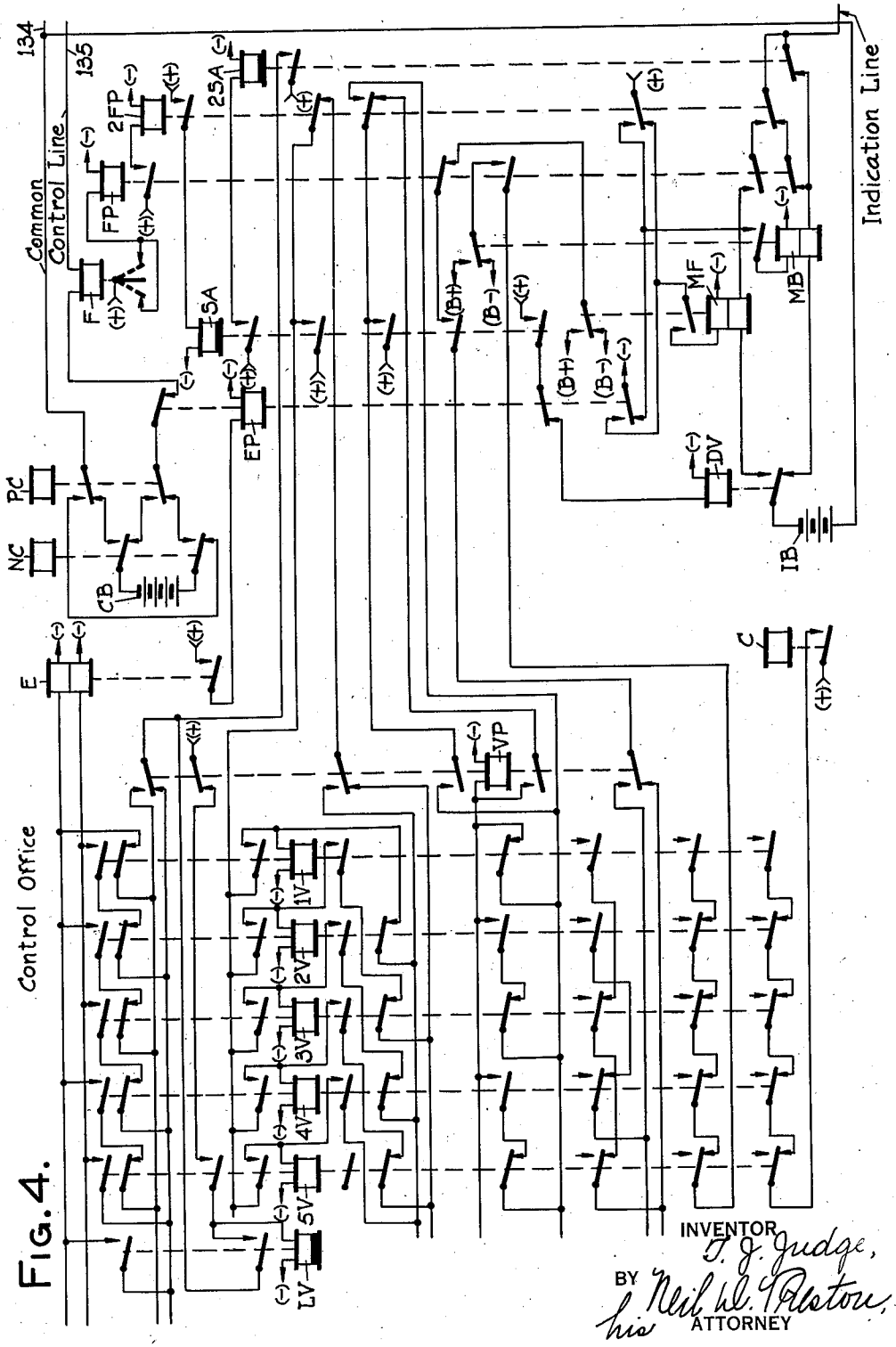


FIG. 4.

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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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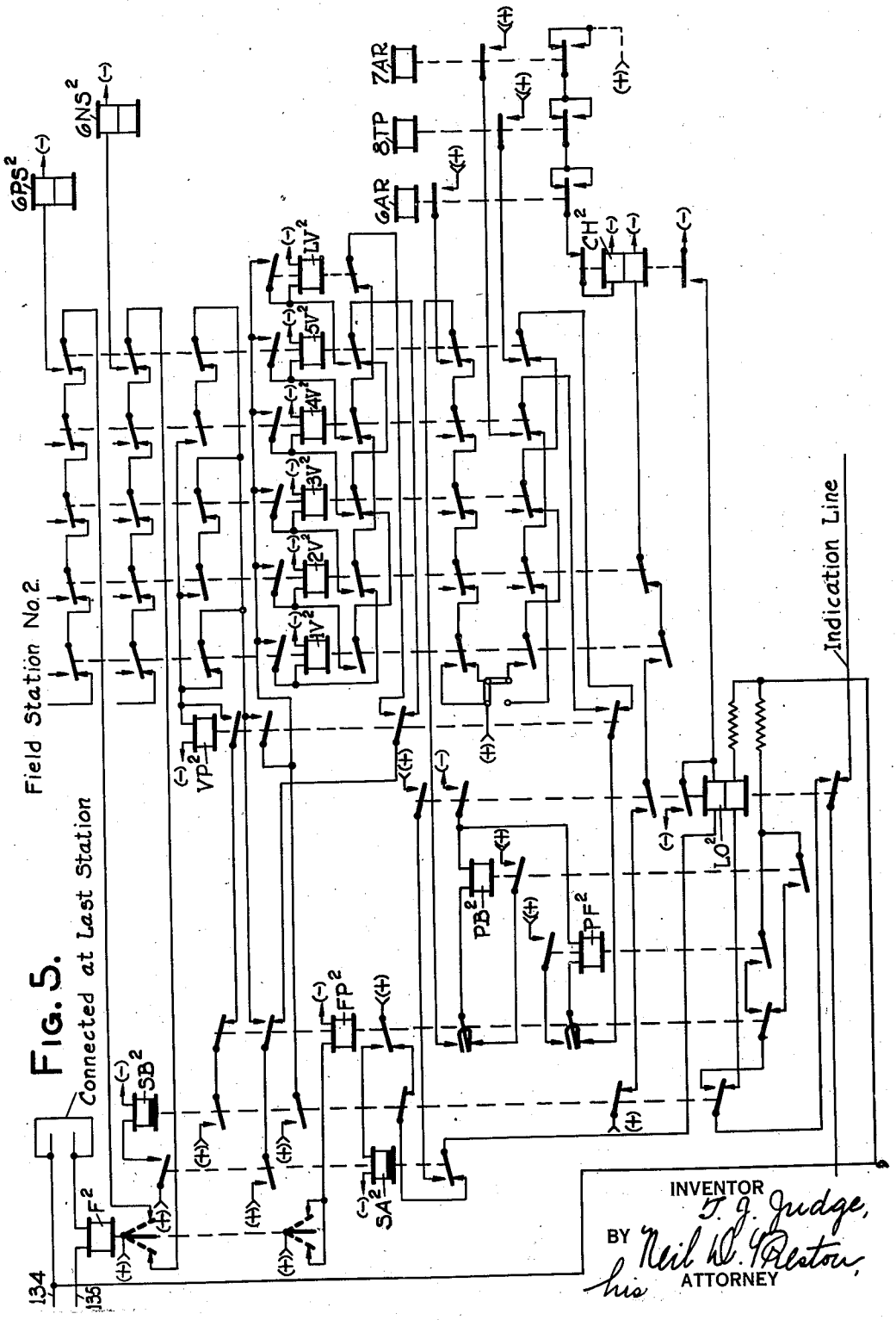


FIG. 5.

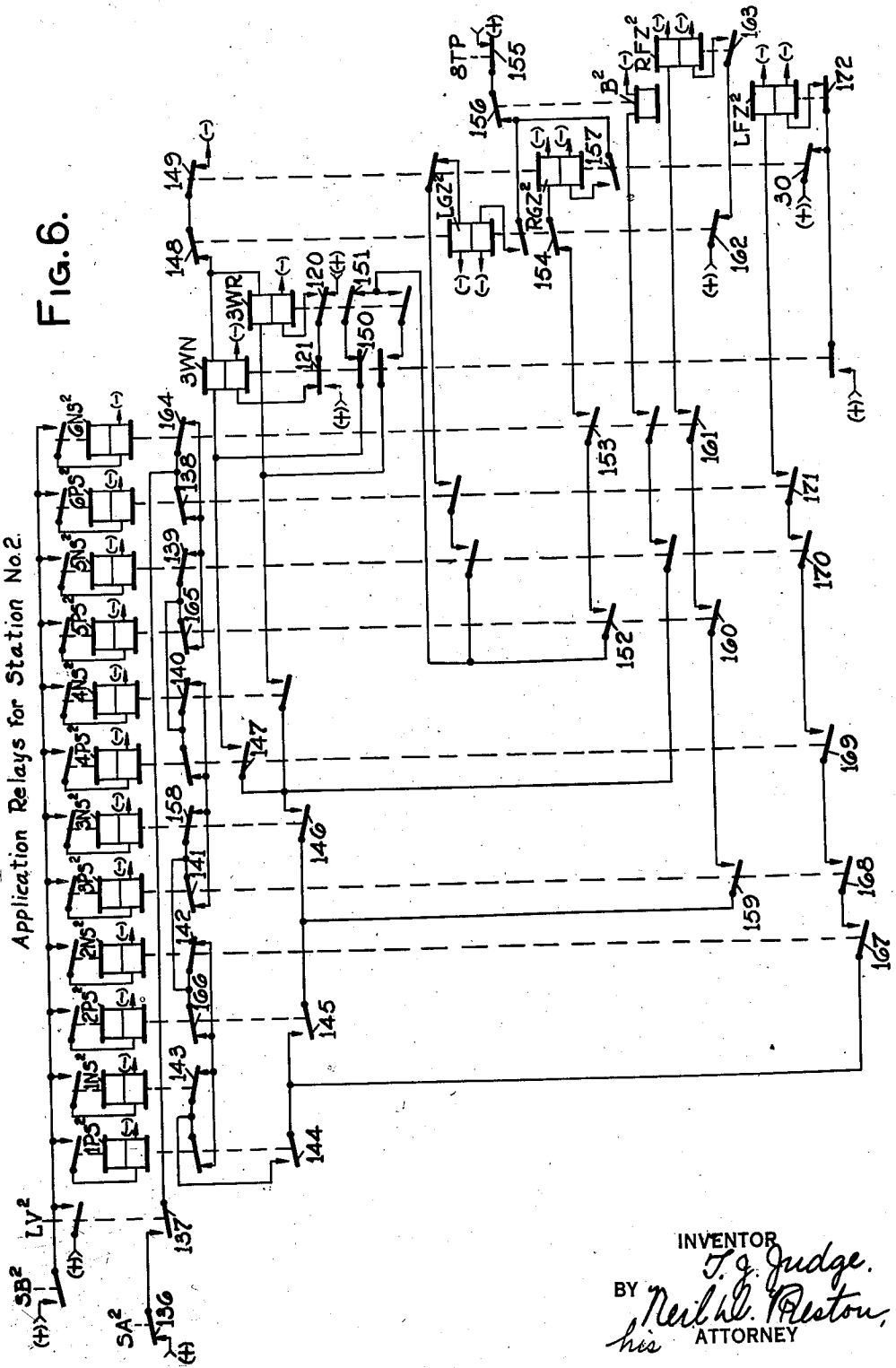
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Sept. 5, 1944. T. J. JUDGE 2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 6.



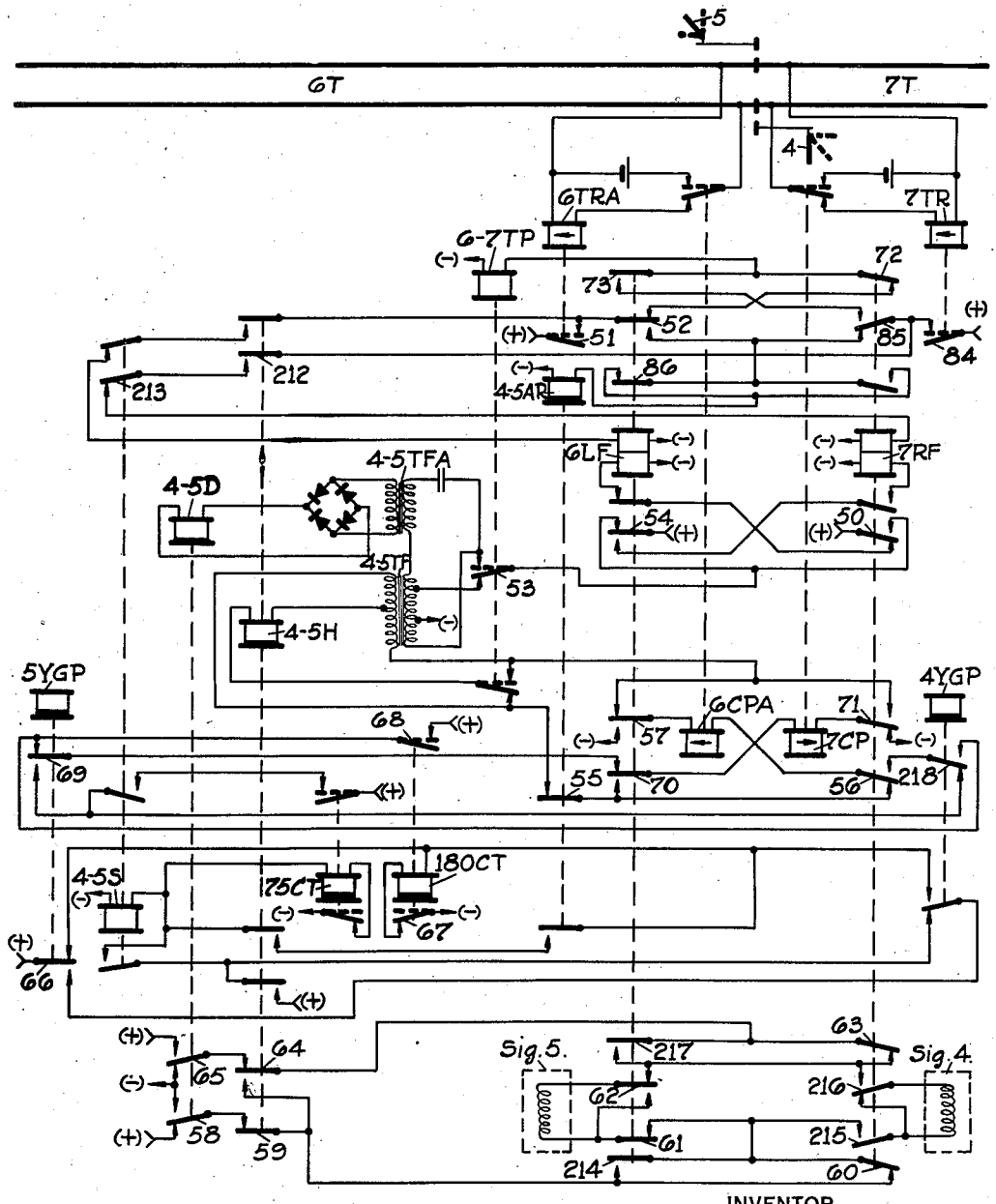
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7.A.



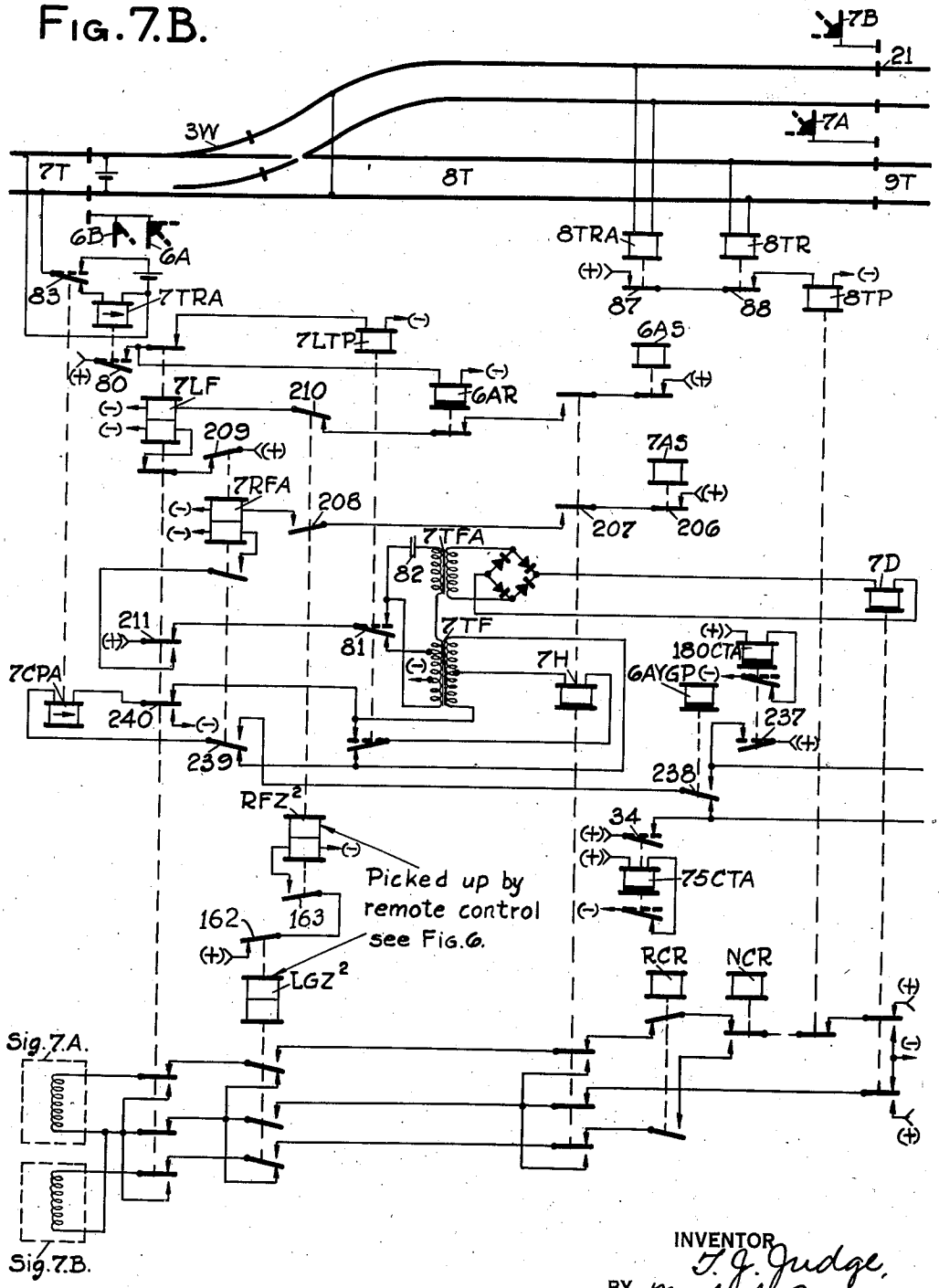
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7.B.



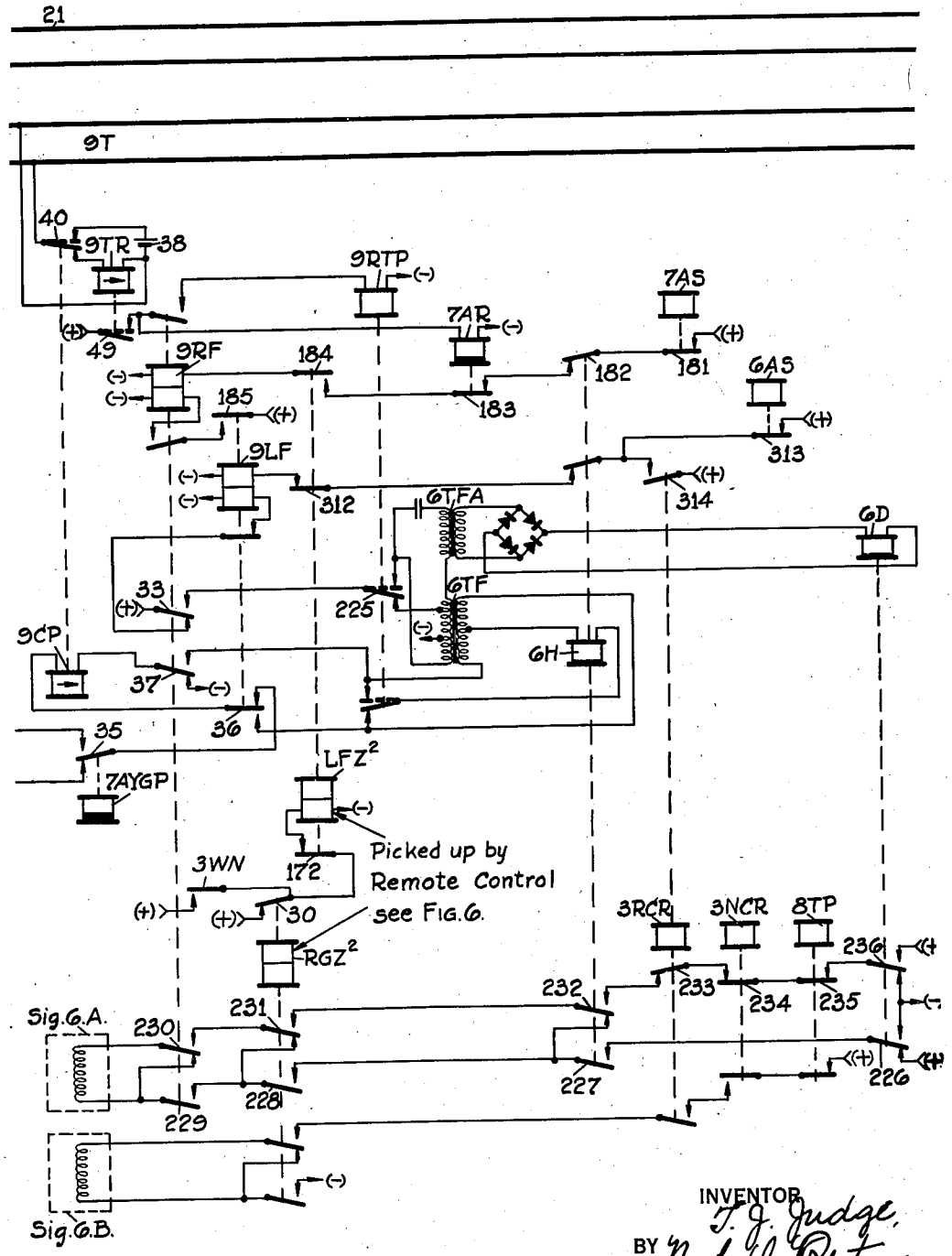
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7C.



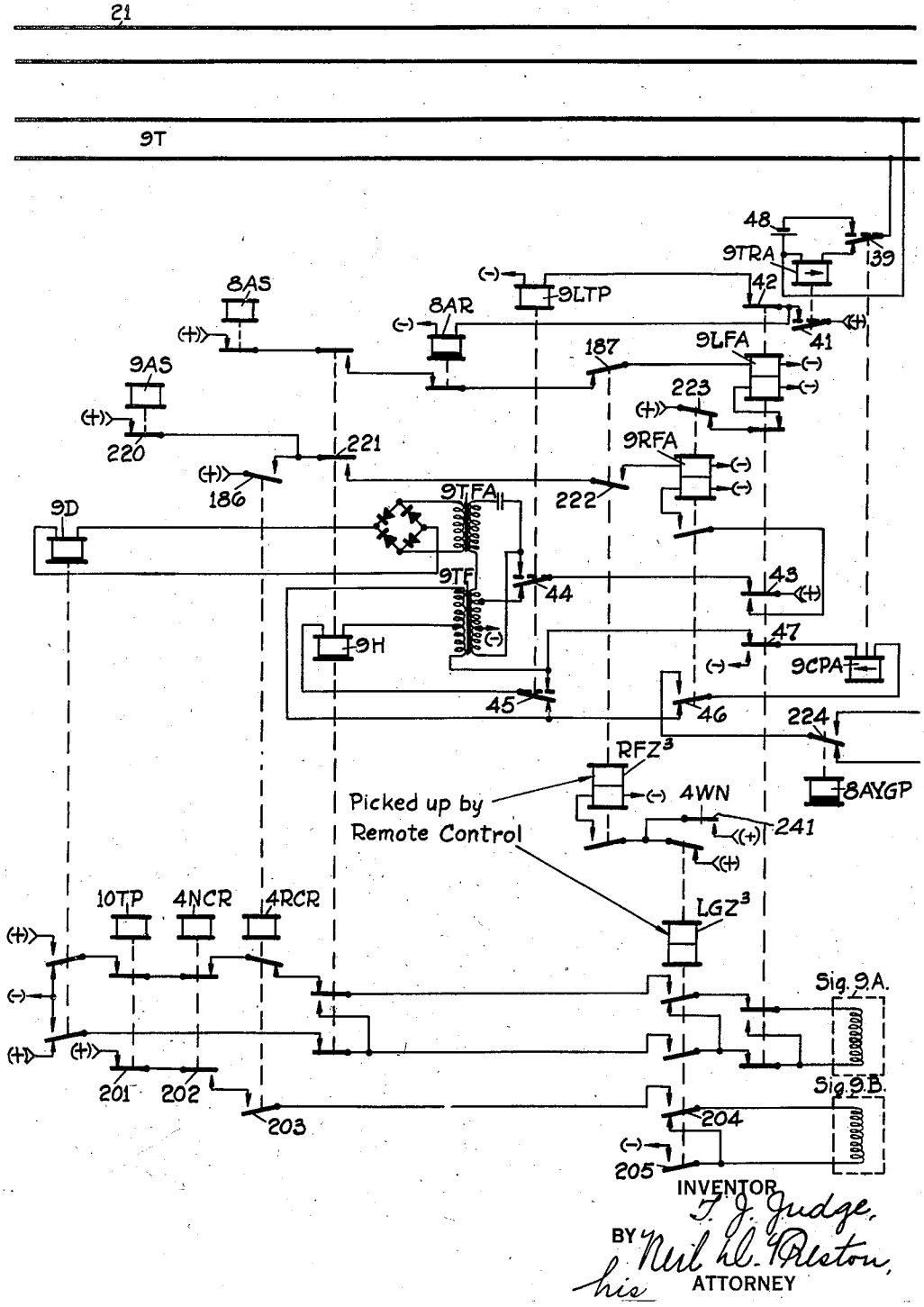
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Sept. 5, 1944. T. J. JUDGE 2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7.D.



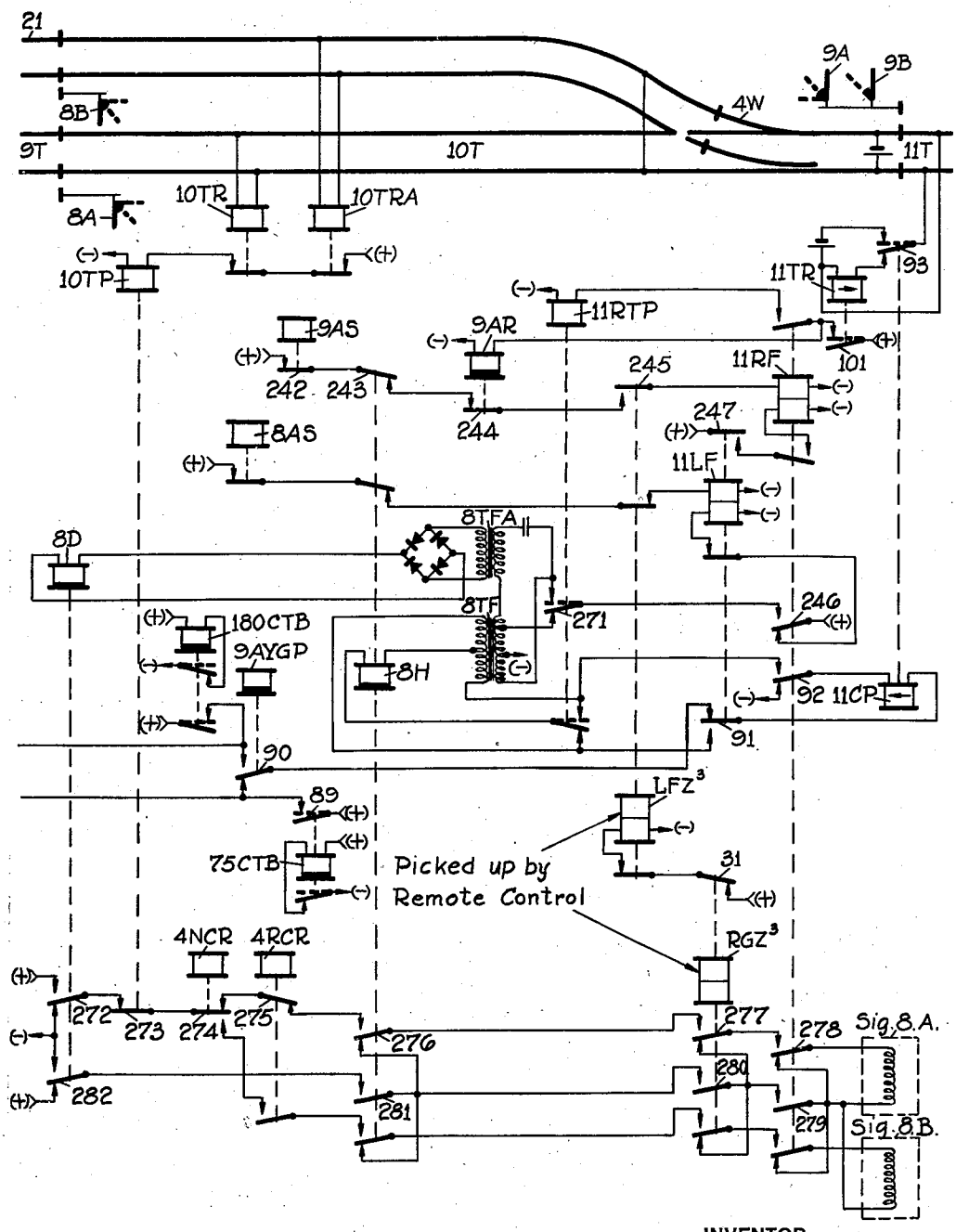
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Sept. 5, 1944. T. J. JUDGE 2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7.E.



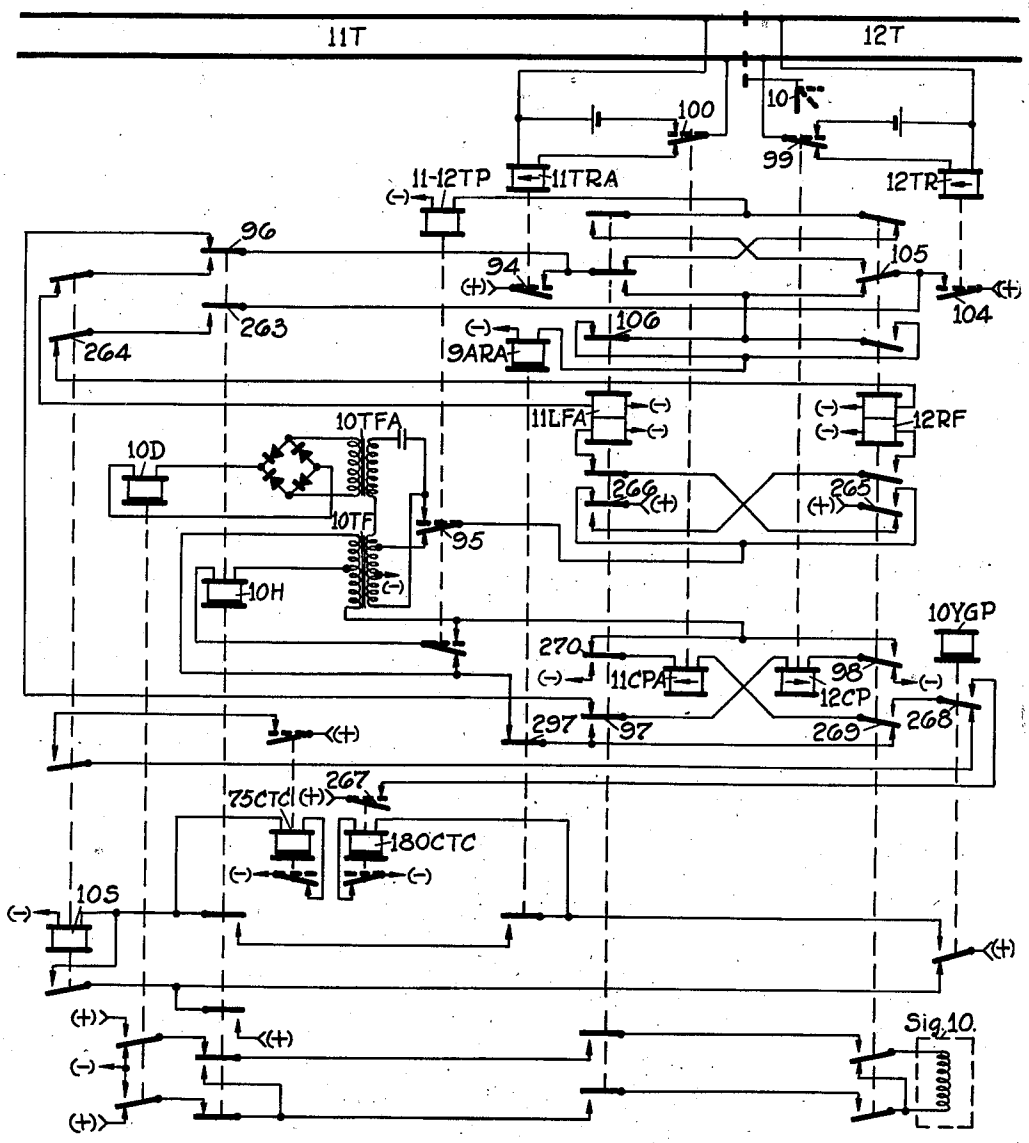
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7. F.



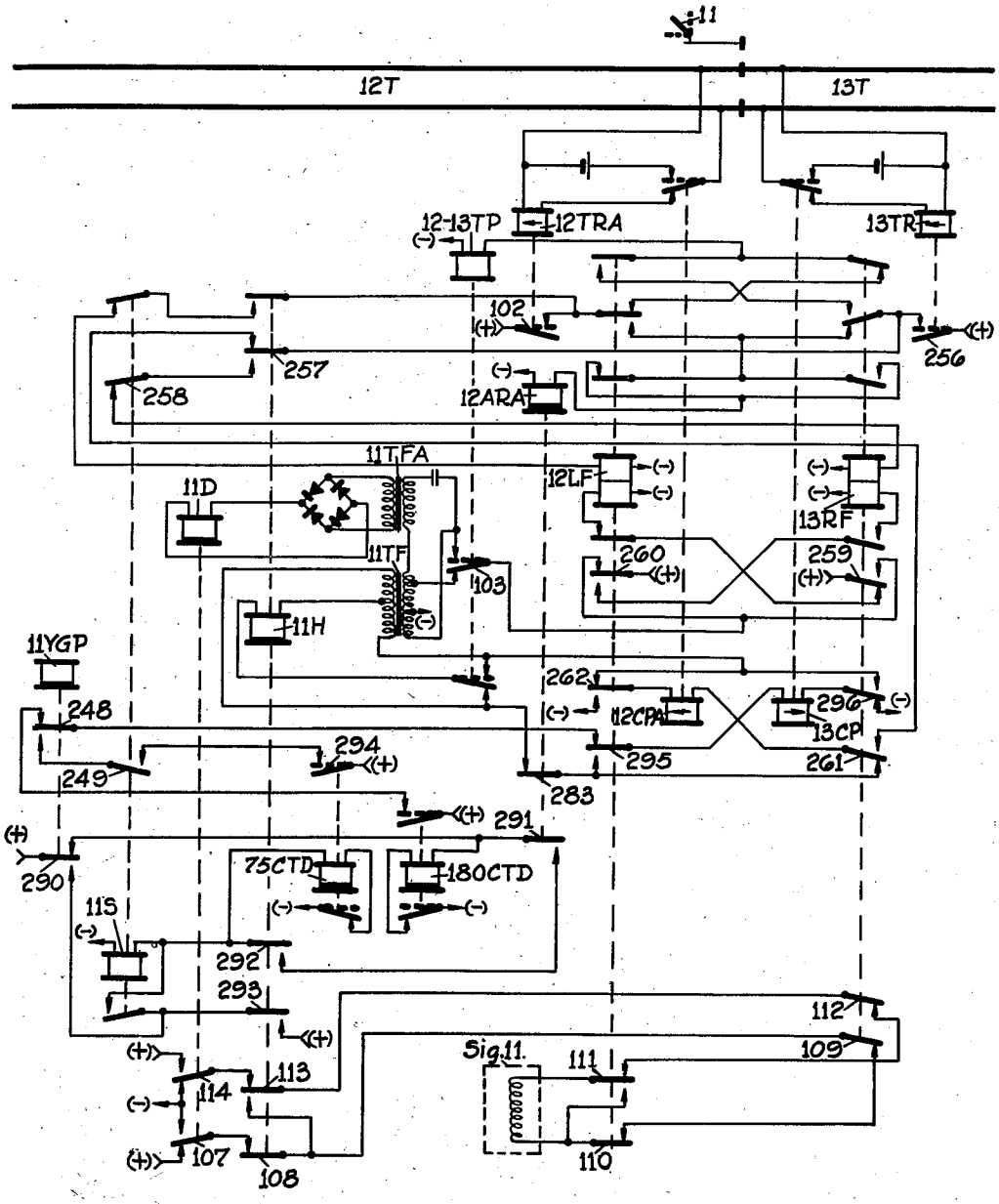
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7.G.



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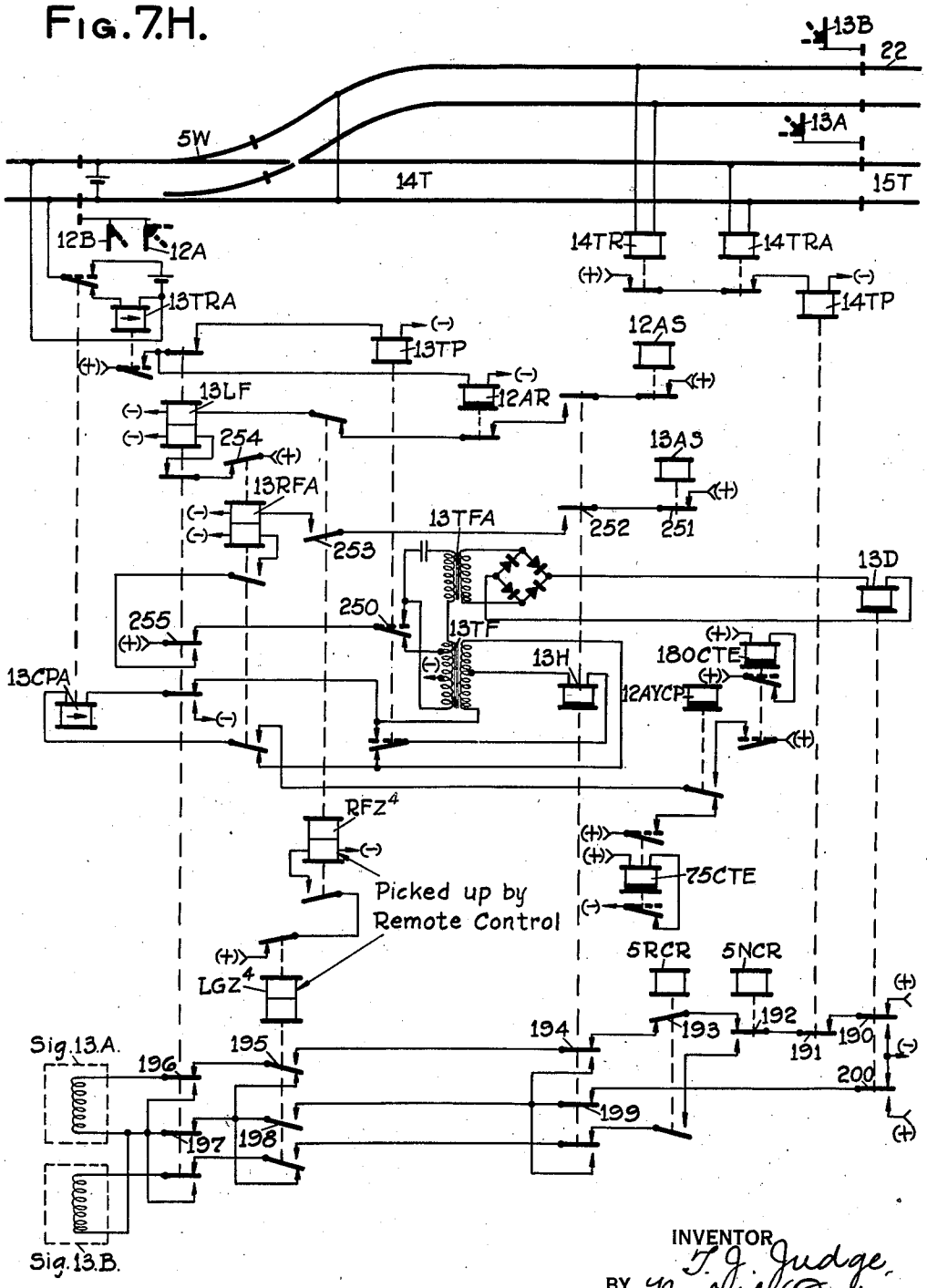
BY his Neil H. Reston, ATTORNEY

Sept. 5, 1944. T. J. JUDGE 2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 7H.



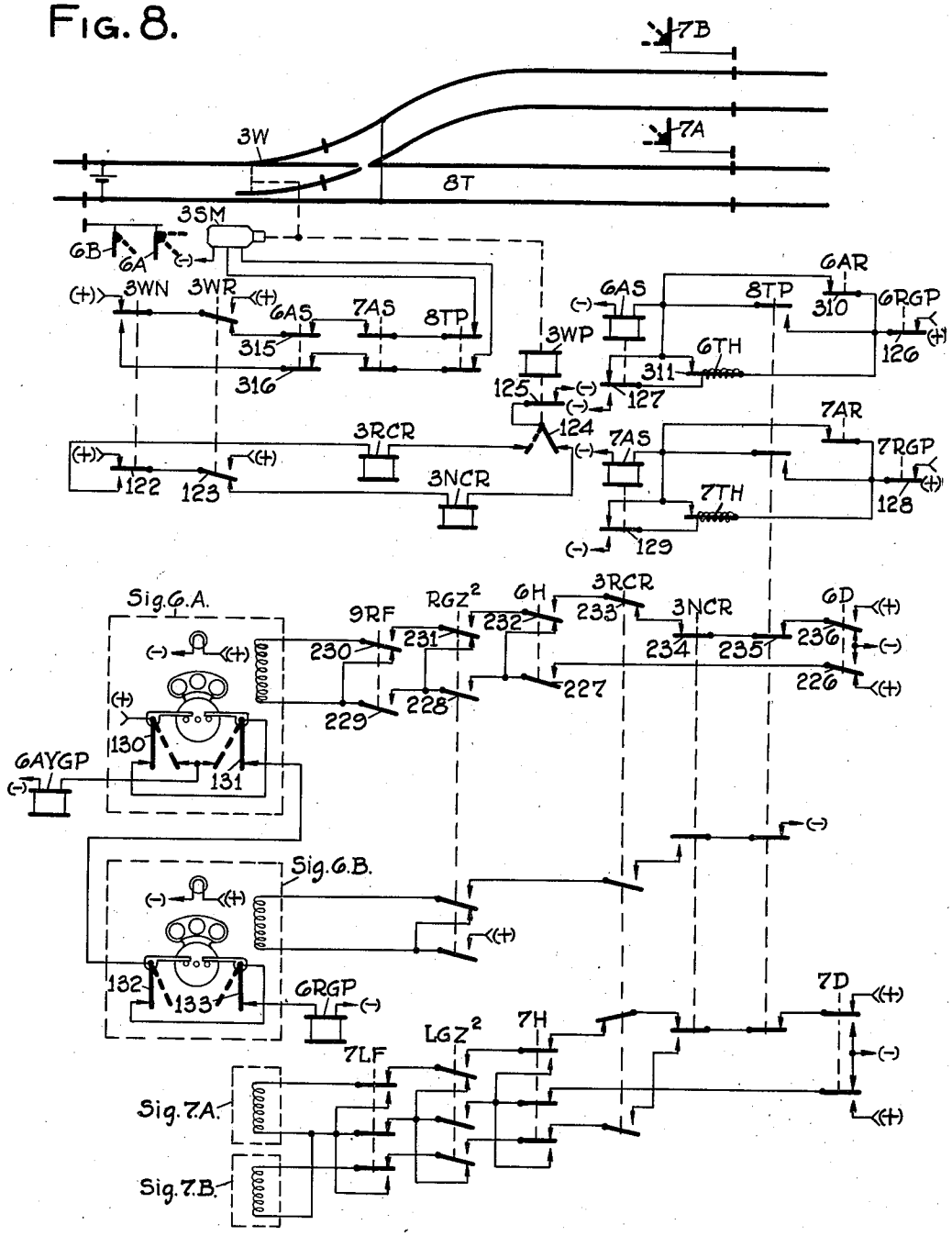
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SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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FIG. 8.



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Patented Sept. 5, 1944 2,357,518

UNITED STATES PATENT OFFICE

2,357,518

SWITCH AND SIGNAL CONTROL SYSTEM FOR RAILROADS

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

Application November 14, 1940, Serial No. 365,669

53 Claims. (Cl. 246—3)

This invention relates to switch and signal control systems for railroads, and it more particularly pertains to the remote control of switches and signals when the automatic control of the signals in the field is dependent upon coded track circuits.

This invention contemplaes the remote control from a control office of switches and signals at the ends of passing sidings on a single track railroad signalled for traffic in both directions, the power operation of the track switches being of course dependent upon safety circuits in the field; and likewise, the clearing and restoration of signals is dependent upon traffic conditions in the field. The automatic control of the signals in the field, the signals between sidings being entirely automatic, is dependent upon coded track circuits, there being no line wires connecting signal locations except such wires as are used for communicating switch and signal controls from the control office to the various field stations at the ends of the sidings. The control apparatus grouped at each end of each siding constitutes a field station, and each field station is connected by the communication system to the control office.

Although communication can be maintained by direct wire control between the control office and each of the field stations, it is preferable from the standpoint of saving line wires that the communication system be of the coded type such as that disclosed, for example, in the patent to Judge et al., Patent No. 2,082,544, dated June 1, 1937. Such a system is normally at rest and is initiated into a cycle of operation when controls are to be transmitted. A cycle of operation for the transmission of controls comprises a series of selected impulses characteristic of a particular station and certain switch and signal controls for that station.

The automatic control of signals by coded track circuits provides signal indications comparable to the signal indications provided upon passage of a train in the well-known absolute-permissive-block signalling system. Each block extending between adjacent signal locations has a coded track circuit in the system provided by the present invention except the short detector track sections for the power track switches, which have track circuits of the steadily energized type. Each of the coded track circuits has at each end apparatus effective to transmit and to receive codes through the rails of that block. In other words, there is a code transmitter and a code receiver at each end of each of the coded track circuits. A transmitter is said to transmit a "driven" code when the impulses forming the code are applied or repeated from a power driven impulse coder, the length of each impulse and the number of impulses per minute being predetermined by the characteristics of the impulse coder. The transmitter is said to transmit an "inverse" code when the impulses of the code it transmits are synchronized to fit into the deenergized or "off" periods of a driven code transmitted from the opposite end of that track circuit. In accordance with the present invention it is provided that the clearing of a signal is dependent upon a driven code transmitted from the opposite end of the block indicative of traffic conditions in advance of that signal. The inverse code is used for indicating purposes and for approach control.

An object of the present invention is to provide traffic direction storage means for each signal location whereby the direction of traffic last established is maintained for the transmission of driven codes through the track circuits until a change in direction is called for. Thus, for example, if traffic direction has last been established for west bound traffic (to the left) at the signal location at each end of a block, a driven code is transmitted in the track circuit from the left end of that block to the west bound signal governing entrance thereto.

Another object of the present invention is to provide that the direction storage means for the signal locations at each of the field stations can be governed from the control office. It is further provided that a change in such direction storage means at a field station effects a similar change of the direction storage means provided for each of the automatic signal locations if the direction and the signal controls designated for that field station are such as to require the clearing of such automatic signals. More specifically, for example, if a signal is to be cleared for governing traffic from a passing siding into a stretch of single track against the direction of traffic maintained by the traffic direction storage means for the signal locations involved, the reception of a control transmitted from the control office for clearing the signal governing entrance into such stretch of track reverses the traffic direction storage means at that signal location, and thereby stops the transmission of code east (to the right) of that signal location to cause the tumble-down of signal clearing control apparatus for each signal location between that field station and the next field station in the direc-

tion to be established. Upon reception of a control transmitted from the control office at such next field station for the reversal of direction, the traffic direction storage means at that field station is correspondingly conditioned as soon as the tumble-down has become complete between the two field stations involved.

Another object of the present invention is to cause the transmission of a signal control code from the control office to affect not only the signal for which it is intended and the traffic direction at that location, but also to cause corresponding direction to be established by the direction storage means at that next field station in advance of that signal.

Another object of the present invention is to cause the signal clearing code transmitted from the control office during a control signal to a given field station to also be received at the next field station in advance of that signal, and to be effective at that advance field station to cause correspondingly the establishment of the direction storage means.

Another object of the present invention is to delay a change in the direction of the coding in the track circuits in accordance with approach or time locking under operating conditions in which such type of locking are generally involved.

Another object of the present invention is to so organize the system that an attempt by an operator inadvertently to reverse the traffic direction establishing means for a stretch of track occupied by a train is ineffective to stop the transmission of track circuit codes essential to the clearing of signals governing passage of the train to the next field station. More specifically, for example, the entrance of a train into a stretch of single track between sidings insures that a change in the direction storage means cannot be effected at the next field station in advance of the train so as to cause the tumble-down of the automatic signals governing passage of that train to the next field station in advance, irrespective of the number of automatic signals involved.

Another object of the present invention is to employ the control codes transmitted from the control office for the power operation of the track switches to determine whether or not traffic direction is to be established at the next field station in advance. That is, for example, when a control cycle is transmitted for clearing a signal governing entrance of a train into a siding, the track switch at that end of the siding is called for to be operated to a reverse position, and such being the case it is not necessary to condition the traffic storage means at the next field station in advance. However, if the train instead of entering the siding is to proceed on the main track, the calling for the track switch to be operated to a normal position provides that the traffic direction storage means for the next field station in advance is properly conditioned to provide track circuit code for clearing the signal governing train movement over that track switch in its normal position. Such mode of operation is desirable, for example, where non-stop meets of trains are involved.

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 corresponding reference characters are used to designate corresponding parts throughout the various figures, in which like letter reference characters are used to designate parts having similar features and functions, such parts being generally made distinctive by reason of preceding numerals or by exponents indicative of the particular locations or functions with which such devices are associated, and in which—

Fig. 1 shows diagrammatically the general organization of one embodiment of the present invention together with a code chart showing the codes assigned to the control from the control office of various functions at the various field stations;

Figs. 2A, 2B and 2C show diagrammatically in a simplified manner the effect of a change in direction of traffic and certain traffic conditions upon the system provided for this embodiment of the present invention;

Fig. 3 shows the circuits for the selection of control codes for transmission from the control office to the field stations;

Fig. 4 illustrates the control office stepper and various control apparatus and circuits associated with the transmission of control codes to the field and the reception of indications transmitted from the field;

Fig. 5 illustrates in detail the stepper and code receiving apparatus and circuits at a particular field station as typical of apparatus provided at each of the other field stations in this embodiment of the present invention.

Fig. 6 illustrates as typical for all field stations the decoding means employed in connection with the reception of codes by the stepper shown in Fig. 5 for a particular field station, and the manner of execution for the energization of application relays more directly employed in the control of switches and signals and traffic direction at that field station;

Figs. 7A, 7B, 7C, 7D, 7E, 7F, 7G and 7H, when placed side by side illustrate in detail the coded track circuit control of the signals for this embodiment of the present invention; and

Fig. 8 shows certain switch and signal control circuits for one end of a passing siding as typical of the circuits associated with each end of each of the passing sidings in this embodiment of the present invention.

Various parts and circuits constituting this embodiment of the present invention have been shown diagrammatically for the purpose of simplifying the illustration and facilitating in the explanation thereof, rather than for the purpose of showing the specific construction and arrangement of parts that would be employed in practice. The various relays and their contacts are therefore illustrated in a conventional manner and symbols are used to indicate connections to the terminals of batteries or other sources of electric current instead of showing all of the wiring connections to the terminals. Some relays for convenience have been shown in more than one figure, and such relays can readily be identified as being the same by the use of similar reference characters, some relay contacts being shown in the conventional written-circuit manner and identified as of a particular relay by the relay reference character above each of 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. If alternating current is to be used the symbols (+) and (—) are to be considered as instantaneous relative polarities.

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 character by use of the letter reference characters without exponents or preceding numerals. It is to be understood that such a reference applies to any parts designated in the drawings by reference characters that are similar except for numerals associated therewith.

Track layout.—With reference to Fig. 1, the track layout of this embodiment of the present invention is illustrated as comprising a stretch of single track having passing sidings 20, 21 and 22, only the right end and left end of sidings 20 and 22 respectively being shown.

Each end of each siding has a power operated switch, a detector track section, and signals for governing traffic in both directions. For example, at the left end of siding 21 the track switch 3W is power operated by a switch machine (see Fig. 8), such as the switch machine disclosed in the patent to W. K. Howe, Patent No. 1,466,903, dated September 4, 1923, and the detector track section is of the well-known steadily energized type with track battery fed in both directions over the track switch 3W. Signal 6A (see Fig. 1) is provided for governing east bound traffic (to the right) over track switch 3W in a normal position, and signal 6B is provided for governing east bound traffic over track switch 3W in its reverse position. Signals 7A and 7B govern west bound traffic (to the left) over track switch 3W, signal 7A governing traffic over track switch 3W in a normal position, and signal 7B governing traffic over track switch 3W in its reverse position.

Between sidings 20 and 21 is a double automatic signal location having signals 4 and 5, signal 4 being provided for governing east bound traffic and signal 5 being provided for governing west bound traffic. Between sidings 21 and 22 are automatic staggered signals 10 and 11, signal 10 being provided for governing east bound traffic and signal 11 being provided for governing west bound traffic.

The signals illustrated are of the search light type, such, for example, as the search light signal disclosed in the patent to O. S. Field, Patent No. 1,835,150, dated December 8, 1931. Each of the signals when deenergized provides a red indication for danger or stop, when energized with one polarity provides a yellow indication for caution, and when energized with the opposite polarity provides a green indication for clear. Although search light signals are shown in this embodiment of the present invention it is believed to be readily apparent to those skilled in the art how other types of signals such as color-light signals having individual color lamp units, positioned light signals, and semaphore signals can be employed.

For convenience in illustrating the indications displayed by the various searchlight signals, signal symbols are used having red, yellow, and green indications illustrated by lines comparable to the position of the arm of a semaphore signal. Each symbol having an arc (see signal 6A, Fig. 7B) is a semi-automatic stick signal.

The locked position of each of the track switches in correspondence with the locked condition of the power switch machine associated therewith is repeated by a polar neutral relay WP in the usual manner. Such relay is energized with one polarity when the switch points and switch machine are locked in a normal position, and with the opposite polarity when such switch points and switch machine are locked in a reverse position. When the switch machine and/or switch points become unlocked from either of such conditions, the relay WP is dropped away.

The trackway is divided into track sections by insulated joints in the usual manner, there being one track circuit for each block extending between signals. Of the track circuits provided for this embodiment of the present invention, the circuits for the track sections 5T, 8T, 10T and 14T are fed with steady energy, and the circuits for the track sections 4T, 6T, 7T, 9T, 11T, 12T, 13T and 15T are at times fed with coded energy. Each end of each of the blocks which is fed with coded energy has a track battery, a track relay TR or TRA, and the track circuit is impulsed when code is being transmitted from that end of the block by an impulse relay CP or CPA.

It is believed that it will be readily apparent as the description progresses how the system can be applied to practically any track layout of the character of the track layout chosen for this embodiment, each signal location being considered as a typical unit which can be used in various combinations with other units. For example, the stretch of track between sidings 21 and 22 could also include a double intermediate signal location having signals such as signals 4 and 5 if the length and condition of such stretch of track requires such an allocation of the signals.

Communication system devices.—For the purpose of simplifying the disclosure of the present invention, reference characters have been used for communication devices similar to reference characters for similar devices shown and described in detail in the above mentioned patent to Judge et al., Patent No. 2,082,544, in order that reference can be made to such patent for a more detailed description of the apparatus and mode of operation of the communication system.

The control office communication apparatus comprises change relays CH (see Fig. 3) used in initiating the system into operation responsive to the manual designation of controls to be transmitted by the actuation of switch and signal control levers SML and SGL respectively and start buttons SB. The relays CD, CDS, CHP and C are provided to maintain a proper order in the transmission of controls when controls for more than one field station are designated to be transmitted while the system is in operation. The selective energization of the relays NC and PC applies the codes of selected polarities to the line circuit for transmission to the field stations. The relays SA and 2SA (see Fig. 4) are used as cycle marking relays and the relays MF, MB, DV, and FC (see Fig. 3) are used in connection with the reception of indications. The relays E and EP (see Fig. 4) are associated with the impulsing of the line circuit, the line relay F follows the impulsing, and its repeater relays FP and 2FP operate the control office stepper consisting of stepping relays 1V, 2V, 3V, 4V, 5V, LV and the half-step relay VP.

The communication apparatus for each of the field stations (see Fig. 5) comprises a line relay F, a line repeater relay FP, cycle marking relays SA and SB, relays PF, PB, LO and CH associated

with the transmission of indications, decoding relays PS and NS for each impulse included in a control cycle of operation, and a field station stepper consisting of stepping relays 1V, 2V, 3V, 4V, 5V and LV together with a half-step relay VP. Relays WN and WR (see Figs. 6 and 8) are provided for each field field station for causing the respective normal and reverse power operation of the track switch at that field station, and relays RGZ and LGZ are provided for causing the clearing of east bound and west bound signals respectively for each field station. Each of the field stations also has a relay B for the purpose of causing the restoration to stop of a signal in accordance with the transmission from the control office of a stop code for that field station.

In order that the direction of traffic may be established in the coded track circuits in accordance with the direction of traffic allowed for by signal controls transmitted from the control office, a code responsive traffic direction relay RFZ is provided for east bound traffic and a code responsive relay LFZ is provided for west bound traffic for each of the field stations.

Each of the field stations instead of having an SO and SOS relay as shown in the above mentioned Judge et al. patent for selecting only one station to remain in communication with the control office during a control cycle, is allowed to step throughout the cycle, and the selection of the station to receive the controls transmitted is selected by the decoding bank of relays. The stepping of all of the field stations throughout a control cycle is provided for the purpose of traffic direction control in a manner to be hereinafter described.

If it is desired that the system of elimination of field stations upon the reception of controls as described in the above mentioned Judge et al. patent by the use of SO and SOS relays be employed, it can be provided that instead of all stations being eliminated but one, that all stations will be eliminated but two, namely, the field station for which the signal controls are intended and the next field station in advance of such signal. Such an arrangement could be provided by the use of additional SO relays for each station, each controlled in a manner comparable to that shown for the SO relay of the above mentioned Judge et al. patent. Under such conditions one of the additional SO relays would be maintained energized upon the reception of the station code for the next station to the left, and another additional SO relay would be maintained energized upon the reception of the station code for the next station to the right. Each of such additional relays when maintained energized throughout a control cycle would cause the proper conditioning of the traffic direction storage means at that field station. The use of SO and SOS relays for station selection of course eliminates the necessity of decoding the impulses used for station selection.

Track circuit and signal control devices.—Two track relays are provided for each coded track section. A track relay TR is provided for the left end of each track section and a track relay TRA is provided for the right end. The polar structure of the track relays is such that they are picked up only when energized with a certain polarity, thus minimizing the possibility of improper energization from an extraneous source.

Each signal location has two traffic direction relays RF and LF (see Fig. 7A), the relay RF being energized when east bound traffic is established and the relay LF being energized when west bound traffic is established. Inasmuch as one of these relays is normally maintained energized in accordance with the last direction established, the relays RF and LF for each signal location can be said to constitute a traffic direction storing means.

A track repeater relay TP is provided for each signal location, and such relay repeats the track relay for the track circuit to the left if west bound traffic is called for by the traffic storing means, and it repeats the track relay for the track section to the right if east bound traffic is established by the traffic establishing means at that location. Such is true of automatic signal locations in the stretch of track between sidings, but the track repeater relay TP for the ends of track sections at the ends of the sidings repeat only for one direction of traffic. At the sidings directional track repeater relays RTP and LTP are employed, the relays RTP being energized only when traffic direction is established for east bound traffic, and the relays LTP being energized only when traffic is established in a west bound direction.

A normally energized approach control relay AR is provided for each signal location, such relay being energized when either a driven or an inverse code is received from either direction at that signal location. Such approach relay is used in providing track occupancy indications and in providing approach control.

A relay H is provided for each of the signal locations for controlling the signals at that location in accordance with the reception of code through the track circuits from the next signal in advance, one H relay being sufficient, even for a double signal location, because of the use of the traffic direction relays LF and RF for selecting the signal to be cleared. Each of the H relays is energized responsive to either a code of 75 impulses per minute or a code of 180 impulses per minute. Although specific code rates of 180 and 75 impulses per minute are employed in this embodiment of the present invention it is to be understood that different code rates could be used.

Each of the H relays is energized by a decoding transformer TF, such transformer having its primary winding energized during the "on" period of the code with one polarity, and being energized with the opposite polarity during the "off" periods of the code. An alternating current is therefore induced in the secondary winding of the transformer, and such alternating current is rectified so that a direct current relay can be used for each of the H relays by the use of a contact in the circuit for such H relay of the code following relay TP for that signal location.

A relay D is provided for each signal location for use in selecting a clear or a caution indication to be displayed by the signals at that location, such relay being energized by a tuned circuit to be responsive only to the reception of a track circuit code at a rate of 180 impulses per minute.

A decoding transformer TFA having a primary circuit tuned to the 180 code is provided for each signal location for the energization of the D relay at that location. The primary winding of each of the transformers TFA is energized by the induced voltage set up upon the collapse of the flux in the primary winding of the transformer TF at that signal location whenever the primary winding of such transformer TF is de-

energized. Inasmuch as the primary winding of the transformer TF is energized first in one direction and then the other, the primary winding of the transformer TFA for that signal location is energized first in one direction and then the other and therefore induces an alternating current in the circuit for the secondary winding of that transformer, such alternating current being rectified so that a standard type direct current relay can be used for each of the D relays.

Code transmitter relays 75CT and 180 CT are provided for certain of the signal locations for measuring the driven impulses to be applied to the coded track circuits. Such code transmitting relays can be, for example, of the motor driven type, or the oscillating type. The coders illustrated for this embodiment of the present invention are of the oscillating type having a magnetically rotated balance acting in opposition to a clock spring to provide an oscillating operation. By using balances of different weights, the different desired codes are produced.

Two code repeater relays are provided for each coded track section. A code repeater relay CP is provided for impulsing each track circuit at the left end of the track section, and a code repeater relay CPA is provided for impulsing each track circuit at the right end of that track section. The structure of each of the relays CP and CPA is similar to the structure of the relays TR and TRA in that energization of a certain polarity is required to pick up the relay as indicated by arrows in the drawings. Each relay CP or CPA when following the impulses of a code transmitter 75CT or 180CT, impulses the track circuit to transmit a driven code, and each relay CP or CPA when energized by the secondary winding of the transformer TF for that signal location upon the collapse of flux in such winding impulses the track circuit to transmit an inverse code.

A stick relay S is provided for each of the automatic signal locations for purposes in accordance with the general principles of absolute-permissive-block signalling systems. Only one S relay is required for each location even if it is a double location because of the use of direction selecting means at that location.

Signal clear and signal stop repeater relays YGP and RGP respectively (see Fig. 8) are provided in the usual manner for repeating the condition of the various search light signals.

Normal and reverse correspondence relays NCR and RCR respectively are provided for each track switch for repeating the correspondence of the track switch with the position of such track switch last called for by switch controls received from the control office.

An approach locking relay AS is provided for each direction of traffic for each field station in order to provide approach locking for the signals at such field station that are subject to manual control of an operator at the control office.

Having considered the apparatus provided for this embodiment of the present invention together with the general function of the various devices, it is believed that further description of the present invention can best be set forth from the standpoint of operation.

Operation

General.—The switch and signal control system provided by this invention allows traffic to be estiblished in only one direction at a time over a stretch of track extending between sidings. Such arrangement prevents the simultaneous entry of opposing trains into that stretch of track on clear or caution signals, as the signals for but one direction can be cleared at a time. Thus, with reference to Fig. 1, for example, if traffic is established for west bound trains, the signals for west bound traffic can be cleared for the stretch of track extending between passing sidings 21 and 22, but the signals for east bound traffic over that stretch of track must remain at stop.

It is further provided that approach locking is effective to prevent a change in direction when a train is about to enter a stretch of track between sidings, as, for example, when a train is about to enter the stretch of track extending between sidings 21 and 22 upon accepting signal 13A (it being assumed such signal to be cleared by an operator at the control office). If the track section in advance of signal 13A has been entered by the train, the clearing of an opposing signal is prevented according to the principles of automatic permissive block signalling systems, and if the train comes to a stop after an operator attempts to change the direction of traffic by first restoring the signal 13A to stop without passing that signal the reversal in direction of traffic can safely become effective at the end of the time interval provided by the approach locking.

The coded track circuit system provided in this embodiment of the present invention is of the normally energized type. That is, code is normally applied to the track for one direction of traffic or the other, the direction last established being maintained until the opposite direction is called for. Thus, it is provided that if a signal control is transmitted from the control office for clearing a signal for the direction of traffic already established by the traffic direction storage means, the signal is cleared as soon as the controls are received because a driven code is already being fed through the rails from the opposite end of the block in advance of that signal. However, if a signal control is transmitted from the control office for a direction opposite to that already established by the traffic direction storage means, the reception of such control stops the transmission at that signal location of the driven code for the opposite direction providing an inverse code is being received, and conditions the entering end of the block governed by that signal to receive a driven code transmitted from the opposite end of the block. At the same time, the signal clearing code is also received at the next field station in advance of that signal, and the reception of such code at that signal location causes the picking up of a traffic direction relay to correspond with the direction to be established. The picking up of that relay conditions traffic at that location in accordance with the direction of traffic called for in order to clear the desired signal so as to cause the transmission of a driven code back toward that signal.

It is therefore provided that each signal clearing code transmitted from the control office is not only received at the field station of the signal to be cleared, but is also received at the next station in advance of that signal as a traffic direction establishing code. More specifically, with reference to the code chart for field station No. 3 in Fig. 1, a code transmitted for clearing signal 8A consists of the characters (+) (−) (+) (+) (+) (−) respectively. The reception of such code at field station No. 3 causes the clearing of signal 8A as soon as the direction of code transmission in the coded track circuits is prop-

erly established. With reference to the code chart for field station No. 4, it will be noted that the same code as used for the clearing of signal 8A is also received at field station No. 4 for establishing the traffic direction for the stretch of single track between the sidings 21 and 22. That is, at field station No. 4 the relay RFZ4 (see Fig. 2B) is picked up for traffic to the right, and the picking up of that relay causes the transmission of a driven code through the track circuits toward signal 8A which is to be cleared.

In a similar manner, if traffic is to be set up in the opposite direction as for the clearing of signal 9A, when the conditions of traffic are such that passage of a west bound train can be effected, a signal control code is transmitted to field station No. 3 for the clearing of signal 9A consisting of the characters (+) (−) (+) (+) (−) (+). The reception of such control code at field station No. 3 causes the clearing of signal 9A when traffic direction is properly established for the coded track circuits associated with the control of such signal. Such code is received at field station No. 2 in order to establish the direction of coding in the track section in advance of signal 9A. Thus, the reception of that code at field station No. 2 establishes traffic from signal 9A to signal 7A by the energization of the relay LFZ2. The picking up of such traffic direction relay causes the transmission of a driven code through the track elements back toward signal 9A for the clearing of that signal.

The mode of operation just described in general with respect to the establishment of direction is typical of the mode of operation when signal clearing controls are transmitted to each of the other field stations in that a signal clearing code is always received at the next field station in advance as well as at the field station where the signal to be cleared is located for the purpose of establishing the proper direction of coding in the track circuits to effect the clearing of such signal in accordance with traffic conditions in advance.

Normal conditions.—It can be said that normal conditions of the system exist when the track layout is unoccupied by trains, when all signals subject to control by an operator at the control office are at stop, and when the track switches and traffic direction storing means are conditioned in accordance with the conditions which were required for the last train movement through the track layout. The normal conditions illustrated in Fig. 2A and in Figs. 7A, 7B, 7C, 7D, 7E, 7F, 7G and 7H are in accordance with the assumption that the last train to pass through the track layout was a west bound train and that such train passed on the main track requiring all of the track switches to be normal.

Under such conditions the relays LFZ and LF for each of the field stations and the relays LF for the automatic signal locations are normally energized in accordance with the traffic direction established for west bound traffic to the left. For example, the relays LFZ2, LFZ3 and LFZ4 are maintained energized by obvious stick circuits closed at back contacts 30, 31 and 32 of relays RGZ2, RGZ3 and RGZ4 respectively. The initial energization of each of the relays LFZ has been effected to cause the picking up of the relay LF for that signal location, and each of the relays LF is maintained energized by a stick circuit corresponding to the obvious stick circuit closed for the energization of relay 9LF at back contact 33 of relay 9RF. The relays LF for the automatic signal locations between sidings are also maintained energized by similar stick circuits so that the last direction established is maintained effective until a new direction has been designated.

The energization of a relay LF is essential to allow the pulsing of a code repeater relay CP for that signal location to apply a driven code to the west end of the track circuit to the right of that signal location at a selected rate. For example, the energization of relay 9LF (see Fig. 7C) with relay 9RF deenergized closes a circuit to cause the pulsating of relay 9CP, extending from (+), including contact 34 of code transmitter 15CTA, back contact 35 of relay 7AYGP, front contact 36 of relay 9LF, winding of relay 9CP, and back contact 37 of relay 9RF, to (−). The pulsing of relay CP energizes the track relay 9TRA (see Fig. 7D) for the right end of block 9T when code repeater relay 9CPA for that end of the block is deenergized, by a circuit closed from the positive terminal of battery 38 (see Fig. 7C) including the winding of relay 9TRA, back contact 39 of relay 9CPA, and front contact 40 of relay 9CP, to the negative terminal of battery 38. The energization of such circuit causes the track relay 9TRA to follow the code, and, inasmuch as the relay 9LFA is also energized, the track repeater relay 9LTP also follows the code as a repeater of relay 9TRA because of the energization of a circuit closed from (+), including front contact 41 of relay 9TRA, front contact 42 of relay 9LFA, and winding of relay 9LTP, to (−).

As a result of the relay 9LTP following the driven code applied to the track circuit, the primary winding of the transformer 9TF is energized in first one direction and then the other. Energization, when relay 9LTP is energized, is effective from (+), including front contact 43 of relay 9LFA, front contact 44 of relay 9LTP, and lower portion of the primary winding of transformer 9TF, to (−). When the relay 9LTP is dropped away a circuit is closed for the energization of the primary of the transformer 9TF in the opposite direction extending from (+), including front contact 43 of relay 9LFA, back contact 44 of relay 9LTP, and upper portion of the primary winding of transformer 9TF, to (−).

When relay 9LTP is picked up during the "on" periods of the code, energy flows in the secondary winding of the transformer 9TF from the lower terminal thereof through a circuit including front contact 45 of relay 9LTP and winding of relay 9H to the center terminal of the secondary winding of transformer 9TF. The dropping away of relay 9LTP during the "off" periods of the code shifts the polarity of the primary winding of the transformer 9TF as has been described, and the closing of back contact 45 of that relay makes a shift in the circuits for the relay 9H to provide that a circuit is closed when relay 9LTP drops for the energization of relay 9H by the same polarity as when relay 9LTP picked up, such circuit extending from the upper terminal of the secondary winding of transformer 9TF including back contact 45 of relay 9LTP, and winding of relay 9H to the center terminal of the secondary winding of transformer 9TF. Relay 9H is therefore maintained energized whenever code is recevied by the track relay 9TRA of any rate employed in the system provided by the present invention.

The relay 9CPA is also connected across the secondary winding of the transformer 9TF when a driven code is being received by relay 9TRA, but its structure characteristics as have been described are such that it is picked up only upon energization by a particular polarity. Therefore,

although a circuit is closed for that relay upon the closing of front contact 44 of relay 9LTP, the polarity of energization is such as not to effect its picking up, but the collapse of the flux in the transformer upon the opening of front contact 44 of relay 9LTP causes the energization of relay 9CPA with the proper polarity to pick it up in a circuit extending from the upper terminal of the secondary winding of relay 9TF including back contact 46 of relay 9RFA, winding of relay 9CPA, and front contact 47 of relay 9LFA, to the lower terminal of the secondary winding of transformer 9TF. The closing of back contact 44 of relay 9LTP also induces a voltage in the secondary winding of transformer 9TF of a polarity to aid in the picking up and sustaining of relay 9CPA. As soon as the flux is built up in the transformer, however, the relay 9CPA becomes deenergized and is dropped away. The induced voltage in the secondary winding of the transformer 9TF upon the collapse of the flux due to the picking up of relay 9LTP is of a polarity such as not to effect the picking up of relay 9CPA. It is thus provided that the relay 9CPA under normal conditions is picked up and dropped away during each "off" period of the driven code in order to transmit an inverse code of the same rate as the driven code back to the other end of the track circuit.

The relay 9TR follows the inverse code, it being energized when relay 9CPA is picked up by a circuit closed from the positive terminal of battery 48 including front contact 39 of relay 9CPA, back contact 40 of relay 9CP, and winding of relay 9TR to the negative terminal of battery 48. The pulsing of the track relay 9TR causes the energization of the approach relay 7AR by an obvious circuit closed at front contact 49, but the track repeater relay 9RTP remains deenergized because the established direction of traffic is to the left. The relay 7AR is slow acting so as not to follow the code and it is used for approach locking and indication purposes in a manner to be hereinafter described more in detail. In a similar manner and for similar purposes the approach relay 8AR for the other end of the track circuit is also energized by an obvious circuit closed at front contact 41 of relay 9TRA.

Having considered in detail the manner in which the impulses of a driven code and an inverse code are applied to the track circuit for track section 9T, and how they are transmitted and received at the ends of the track section, it is believed to be readily apparent how codes are applied and received in a similar manner at the ends of the other coded track circuits.

With reference to the double automatic signal location illustrated in Fig. 7A, it will be noted that the relay 6LF is normally energized and maintained by a stick circuit closed at back contact 50 of relay 7RF. The energization of relay 6LF provides that the relay 6—7TP follows the driven code transmitted from the left end of track section 6T (circuits not shown). The relay 6—7TP is energized during each "on" period of the driven code by a circuit extending from (+), including front contact 51 of relay 6TRA, front contact 52 of relay 6LF, back contact 72 of relay 7RF, and winding of relay 6—7TP, to (—).

The pulsing of the relay 6—7TP is assumed to be at a rate of 75 impulses per minute because of the nature of the track layout to the left of track section 6T as illustrated in Fig. 1, and the pulsing of the relay 6—7TP at such rate causes the energization of the relay 4—5H because of the energization of circuits comparable to the circuits just described in detail for the energization of relay 9H. The primary winding of the transformer 4—5TF is energized first in one direction and then the other in accordance with the closing of circuits selected at contact 53 of relay 6—7TP, and in accordance with energy being applied to such circuits by front contact 54 of relay 6LF.

The relay 4—5D is maintained deenergized at the location of signals 4 and 5 because the driven code received from the west end of track section 6T is of a 75 rate.

An inverse code is transmitted back through the rails of track section 6T resulting in the energization of the relay 6CPA during the "off" periods of the driven code. Such relay is energized during each "off" period upon the opening of front contact 53 of relay 6—7TP by the energization of a circuit extending from the upper terminal of the secondary winding of transformer 4—5TF including front contact 55 of relay 4—5AR, back contact 56 of relay 7RF, winding of relay 6CPA, and front contact 57 of relay 6LF to the lower terminal of the secondary winding of transformer 4—5TF.

Signal 5 is energized with a polarity to cause the display of a yellow caution indication when a 75 code is received under the above described conditions. The signal is energized by a circuit extending from (+), including back contact 58 of relay 4—5D, front contact 59 of relay 4—5H, back contact 60 of relay 7RF, front contact 61 of relay 6LF, winding of signal 5, front contact 62 of relay 6LF, back contact 63 of relay 7RF, front contact 64 of relay 4—5H, and back contact 65 of relay 4—5D, to (—).

In accordance with the direction of traffic being established to the left, the relay 7CP acts as an impulsing relay to transmit a driven code through the track circuit for track section 7T. On account of signal 5 being at caution, the code transmitter 180CT is active because of the energization of a circuit extending from (+), including front contact 66 of signal clear repeater relay 5YGP, winding of relay 180CT, and back contact 67 of relay 180CT, to (—). The relay 7CP follows the 180 code rate because of energization during the "on" periods by a circuit extending from (+), including contact 68 of code transmitter 180CT, front contact 69 of relay 5YGP, front contact 70 of relay 6LF, winding of relay 7CP, and back contact 71 of relay 7RF, to (—). The pulsing of relay 7CP effects the transmission of a driven code at the rate of 180 impulses per minute through the track section 7T in a manner comparable to that described with reference to the transmission of a driven code through the track circuit of track section 9T.

The reception of the 180 code by relay 7TRA (see Fig. 7B) at the exit end of track section 7T causes the relay 7LTP to follow the code because of an obvious circuit closed during the "on" periods at front contact 80 of relay 7TRA, and the pulsing of relay 7LTP with the traffic direction relay 7LF energized causes the energization of relay 7H by the energization of circuits comparable to those described in detail with reference to the energization of relay 9H.

The relay 7D is also energized because the driven code received is of a 180 rate. The primary winding of transformer 7TFA is energized

each time the circuit for the primary winding of transformer 7TF is opened by the contact 81 of relay 7LTP under conditions similar to those described by which a relay CP can be energized for the transmission of an inverse code. The primary winding of transformer 7TFA becomes energized upon the opening of front contact 7LTP by an induced voltage from the primary transformer 7TF applied to a circuit extending from the upper terminal of the primary winding of transformer 7TF including the primary winding of transformer 7TFA, and condenser 82, to the lower terminal of the primary winding of transformer 7TF. When the relay 7LTP is picked up at the end of each of the "off" periods of the code received, the opening of back contact 81 causes current to flow in the opposite direction in the primary winding of transformer 7TFA, and therefore an alternating current flows in the secondary winding of transformer 7TFA through a full-wave rectifier so as to cause the direct current energization of the relay 7D. It will be noted that although the relays 7H and 7D are picked up, neither of the signals 7A or 7B can be cleared because of the deenergized condition of the code controlled signal control relay LGZ².

The relay 7CPA impulses the track circuit for track section 7T at front contact 83 during the "off" periods to transmit an inverse code to the opposite end of the track section in the manner comparable to that which has been described with reference to the operation of the code repeater relay 9CPA.

The relay 7TR receives the inverse code at the double signal location (see Fig. 7A), and the pulsing of that relay causes the energization of the approach relay 4—5AR by a circuit closed during the "on" periods of the inverse code extending from (+), including front contact 84 of relay 7TR, back contact 85 of relay 7RF, front contact 86 of relay 6LF, and winding of relay 4—5AR, to (—). The relay 4—5AR is sufficiently slow acting to be maintained picked up during the "off" periods of the inverse code received.

Under normal conditions the track circuit for track section 8T (see Fig. 7B) provides for the steady energization in an obvious manner of the relays 8TR and 8TRA, and the energization of such relays causes the track repeater relay 8TP to be normally energized by a circuit extending from (+), including front contact 87 of relay 8TRA, front contact 88 of relay 8TR, and winding of relay 8TP, to (—). In a similar manner the detector track section for each of the other track switches is steadily energized under normal conditions to maintain normally energized a track repeater relay TP.

The normally energized condition of the traffic direction relay 11LF (see Fig. 7E) at the right end of siding 21 causes the code repeater relay 11CP to follow the code transmitter 75CTB. Relay 11CP is normally energized during the "on" periods by a circuit extending from (+), including contact 89 of code transmitter 75CTB, back contact 90 of relay 9AYGP, front contact 91 of relay 11LF, winding of relay 11CP, and back contact 92 of relay 11RF, to (—). The pulsing of relay 11CP transmits a driven code at at rate of 75 impulses per minute through track section 11T, and the relay 11TRA at the location of the east bound signal 10 (see Fig. 7F) following the code applies energy to the code following track repeater relay 11—12TP in a manner comparable to that described with reference to the relay 6—7TP, such enerby being applied at front contact 94 of relay 11TRA. The pulsing of contact 95 of relay 11—12TP with the traffic direction relay 11LFA energized causes the energization of the relay 10H, but the 75 rate prevents the energization of the relay 10D because of its circuit being tuned for the 180 rate.

With the relay 10H energized, the code repeater relay 12CP is pulsed as a repeater of the driven code received by track relay 11TRA because of energization during the "on" periods of a circuit extending from (+), including front contact 94 of relay 11TRA, front contact 96 of relay 10H, front contact 97 of relay 11LFA, winding of relay 12CP, and back contact 98 of relay 12RF, to (—). The pulsing of contact 99 of relay 12CP in the track circuit for track section 12T causes the relay 12TRA (see Fig. 7G) to receive the 75 code.

The code repeater relay 11CPA acts as an inverse code transmitter in a manner comparable to that which has been described with reference to the relay 9CPA, and impulses the track circuit for track section 11T during the "off" periods of the driven code by the pulsing of contact 100. The track relay 11TR (see Fig. 7E) follows the inverse code, and the pulsing of that relay causes the energization of the approach relay 9AR by an obvious circuit closed at front contact 101.

The pulsing of front contact 102 of relay 12TRA (see Fig. 7G) in accordance with the 75 code received causes the relay 12—13TP to follow the code by the energization of an obvious circuit. The pulsing of contact 103 of relay 12—13TP causes the energization of relay 11H, and the energization during each "off" period of the relay 12CPA for the transmission of an inverse code in a manner comparable to that which has been described under similar conditions with reference to the control apparatus associated with track section 9T.

The relay 12TR (see Fig. 7F) at signal 10 receives the inverse code transmitted by relay 12CPA, and energizes the approach relay 9ARA during each "on" period of the inverse code by a circuit extending from (+), including front contact 104 of relay 12TR, back contact 105 of relay 12RF, front contact 106 of relay 11LFA, and winding of relay 9ARA, to (—).

With relay 11H (see Fig. 7G) energized and relay 11D deenergized, signal 11 displays a yellow caution indication in accordance with the energization of a circuit for that signal extending from (+), including back contact 107 of relay 11D, front contact 108 of relay 11H, back contact 109 of relay 13RF, front contact 110 of relay 12LF, winding of signal 11, front contact 111 of relay 12LF, back contact 112 of relay 13RF, front contact 113 of relay 11H, and back contact 114 of relay 11D, to (—).

A 180 driven code is transmitted through the track section 13T in accordance with the energization of the signal clear repeater relay 11YGP and is received at the right end of the track section in a manner comparable to that described with respect to the transmission of a 180 code through the track section 7T.

Inasmuch as the communication system is normally at rest, most of the relays associated therewith are normally deenergized. At each of the field stations, however, a change relay CH (see Fig. 5) is normally energized to provide a means for initiating the transmission of indications, and a relay WN or WR is normally energized in accordance with the last position

called for of the track switch at that station. Thus, for example, under normal conditions the relay 3WN (see Fig. 6) is normally energized by its stick circuit extending from (+), including back contact 120 of relay 3WR, front contact 121 of relay 3WN, and lower winding of relay 3WN, to (—).

With reference to the application circuits shown in Fig. 8, the correspondence relay 3NCR is normally energized by a circuit closed from (+), including front contact 122 of relay 3WN, back contact 123 of relay 3WR, winding of relay 3NCR, polar contact 124 of relay 3WP in a right hand position, and front contact 125 of relay 3WP, to (—). The approach locking relays 6AS and 7AS are also normally energized. Relay 6AS is normally energized by a circuit closed from (+), including front contact 126 of relay 6RGP, winding of thermal relay 6TH, front contact 127 of relay 6AS, and winding of relay 6AS, to (—). Relay 7AS is normally energized by a circuit closed from (+), including front contact 128 of relay 7RGP, winding of thermal relay 7TH, front contact 129 of relay 7AS, and winding of relay 7AS, to (—). The relay 6RGP for repeating the stop condition of the signals 6A and 6B is normally energized by a circuit closed from (+), including contacts 130 and 131 of the mechanism of signal 6A in its deenergized condition, contacts 132 and 133 of the mechanism of signal 6B in its deenergized condition, and winding of relay 6RGP, to (—).

Control office transmitter.—The transmission of controls from the control office to the field station is effected by the impulsing of the control line circuit comprising the line wires 134 and 135 (see Fig. 4) connecting the control office with each of the field stations. The impulsing of such line circuit during a control cycle with impulses of selected polarity is provided in a manner very similar to that shown and described in detail in the patent to Judge et al., Patent No. 2,082,544, to which reference can be made for a more detailed description of the manner in which the impulsing at the control office is accomplished.

The composite code transmitted during a single control cycle can be said to have three different components. The first group of impulses (including the first three impulses in this disclosure) constitutes a station selecting code, a different code being provided for each field station insofar as switch and signal controlling at such station is concerned. The next impulse following the first group of impulses is used for causing the operation of the track switch at the field station called to a normal or a reverse position only if the field station is called for switch and signal control purposes. If that impulse is (+) in this embodiment of the present invention the track switch will be operated to a normal position, and if that impulse is (—) the track switch will be operated to a reverse position. The polarity of the impulse for the control of the track switch is of course determined by the operator in accordance with the position to which he actuates the switch control lever SML for the track switch prior to the depression of a start button SB for initiating the transmission of controls.

The two impulses following the switch position selecting impulse form a third component of the composite code and are used for signal controls at the field station called for switch control and signal control purposes. If the first of these two impulses is (+), and the second of these two impulses is (—), a signal is to be cleared for traffic to the right, and if the first of the two impulses is (—) and the second of such impulses is (+), a signal is to be cleared for traffic to the left. If both impulses of the third component of the composite code are (—), the control transmitted is for the restoration of a signal to stop. The selection of the code for the control of the signals is of course effected by a three-position signal control lever provided for the group of signals at each of the field stations.

It is therefore provided that each time an operator wishes to clear a signal he positions the lever for that signal accordingly, and the lever for the track switch involved is properly positioned and then he depresses the start button for the transmission of the controls thus selected to the field station involved. A control cycle of operation is thus initiated during which the selected impulses are transmitted as described in the above mentioned Judge et al. patent. It is of course to be understood that instead of transmitting a code made up of impulses of selected polarities, the code could be provided in accordance with some communication systems as being made up of impulses of selected lengths.

In addition to providing for initiation of the system as provided in the above mentioned Judge et al. patent, it is provided in the circuit selections for the CH relays that there is an interlock to prevent the energization of a CH relay for the transmission of controls if the switch and signal levers have been erroneously positioned to call for the passage of opposing trains into the same siding. Such a circuit interlock is shown in the application of Hailes and Albrighton, Ser. No. 266,802, filed April 8, 1939, to which reference is to be made for a more detailed description.

Field station reception of controls.—The field station reception of controls is effected in a manner comparable to that disclosed in the above mentioned Judge et al. patent with the principal exception that the relays SO and SOS of that patent are not used. The function of such relays in that patent is to drop out, so to speak, all field stations but the station being called when the first component of the control code has been received at the field stations, and in that way the selection of the field station to receive the controls is effected.

It is desired in accordance with the present invention that the next field station in advance of the signal to be cleared also receive the control code to be used for traffic direction purposes, so it is provided that each field station of this embodiment of the present invention steps all of the way through each control cycle, and by decoding each impulse including the station code, and executing the controls at the end of the cycle, the composite control code transmitted during any one cycle of operation actually is used at only two field stations, namely, the field station for which the controls are intended and the next field station in advance for the purpose of establishing the proper direction of coding in the track circuits.

Inasmuch as the code receiving apparatus shown in Fig. 5 is similar to that disclosed in the above mentioned Judge et al. patent except for the elimination of the relays SO and SOS, it is believed that the reception of controls can be readily understood upon reference to the description as set forth in detail in that patent.

Application relay controls.—Upon reception of each impulse of the control code a PS or NS

relay is energized (see Figs. 5 and 6) dependent upon whether the impulse is respectively positive or negative. The PS and NS relays can readily be associated with the various impulses of the control code by the numeral prefixes of the letter reference characters which correspond with the impulse numbers. It is provided that the controls for the application relays are executed at the end of a cycle after all six impulses have been received, the relays PS and NS being maintained energized by obvious stick circuits until the end of the execution period.

To consider as a specific example, how the application relays are energized during the execution period, assume that a code has been transmitted from a control office for the clearing of signal 6A, such code consisting of the characters (+) (+) (−) (+) (+) (−) respectively. In accordance with the reception of that code at field station No. 2 the relays 1PS², 2PS², 3NS², 4PS², 5PS² and 6NS² are energized, and upon the dropping away of the relay SA² subsequent to the picking up of the last step relay LV² an execution circuit is closed for the upper winding of the relay 3WN for the normal position of the track switch 3W. Such circuit is closed from (+), including back contact 136 of relay SA², front contact 137 of relay LV², back contact 138 of relay 6PS², back contact 139 of relay 5NS², back contact 140 of relay 4NS², back contact 141 of relay 3PS², back contact 142 of relay 2NS², back contact 143 of relay 1NS², front contact 144 of relay 1PS², front contact 145 of relay 2PS², front contact 146 of relay 3NS², front contact 147 of relay 4PS², upper winding of relay 3WN, back contact 148 of relay LGZ², and back contact 149 of relay RGZ², to (−).

Upon the picking up of relay 3WN (if such relay is not already up) a circuit is closed to cause the picking up of the relay RGZ² (in accordance with the signal control component of the code) extending from (+), including the portion of the circuit just described for relay 3WN up to the winding of that relay, front contact 150 of relay 3WN, back contact 151 of relay 3WR, front contact 152 of relay 5PS², front contact 153 of relay 6NS², back contact 154 of relay LGZ², and upper winding of relay RGZ², to (−). The picking up of that relay closes a stick circuit for its lower winding extending from (+), including front contact 155 of relay 8TP, back contact 156 of relay B², front contact 157 of relay RGZ², and lower winding of relay RGZ², to (−). The picking up of relays 3WN and RGZ² causes the power operation of the track switch 3W to its normal position and the clearing of signal 6A in a manner to be hereinafter considered.

With reference to the general layout shown in Fig. 1, if a control cycle is transmitted from the control office for the clearing of the east bound signal 2A at field station No. 1, the control code transmitted during that cycle consists of the characters (+) (+) (+) (+) (+) (−), the first three characters of the code being characteristic of the field station No. 1 for the reception of the switch and signal controls. With reference to the code chart for field station No. 2, which is the field station having its circuits illustrated in detail as a typical station in this embodiment of the present invention, it will be noted that the code corresponding to the code transmitted for the clearing of signal 2A is received at field station No. 2 for establishing traffic direction for east bound traffic for the single track stretch from 2 to 6. Thus, with reference to the application circuits shown in Fig. 6, the relay RFZ² for establishing traffic to the right is picked up at field station No. 2 during an execution period at the same time that the switch and signal control application relays are energized during the execution period at field station No. 1. Thus, during the execution period at the end of the cycle of operation the relay RFZ² is picked up by the energization of a circuit extending from (+), including back contact 136 of relay SA², front contact 137 of relay LV², back contact 138 of relay 6PS², back contact 139 of relay 5NS², back contact 140 of relay 4NS², back contact 158 of relay 3NS², back contact 142 of relay 2NS², back contact 143 of relay 1NS², front contact 144 of relay 1PS², front contact 145 of relay 2PS², front contact 159 of relay 3PS², front contact 160 of relay 5PS², front contact 161 of relay 6NS², and upper winding of relay RFZ², to (−). The picking up of that relay closes a stick circuit for its lower winding extending from (+), including back contact 162 of relay LGZ², front contact 163 of relay RFZ², and lower winding of relay RFZ², to (−). The picking up of relay RFZ² establishes a direction in accordance with the signal to be cleared, and causes the transmission of a driven code through the coded track circuits back toward signal 2A in a manner to be hereinafter considered more in detail.

In a similar manner for the opposite direction of traffic, if, for example, during a cycle of operation impulses are transmitted from the control office for the clearing of the west bound signal 9A (see Fig. 1) at field station No. 3, the code transmitted is received for traffic direction purposes at field station No. 2 (see Fig. 1), such code consisting of the characters

(+) (−) (+) (+) (−) (+)

the first three characters being characteristic of the station code assigned to field station No. 3 for the reception of switch and signal controls and being the station code assigned to stations No. 2 and No. 4 for establishing a traffic (track circuit coding) direction.

At station No. 3 this code (+ − + + − +) will cause the picking up of relays 4WN and LGZ³ for reasons explained in connection with relays 3WN and RGZ³ above. When the code is received at field station No. 2, during the execution period at the end of the control cycle, the relay LFZ² is picked up by the energization of a circuit closed from (+), including back contact 136 of relay SA², front contact 137 of relay LV², back contact 164 of relay 6NS², back contact 165 of relay 5PS², back contact 140 of relay 4NS², back contact 158 of relay 3NS², back contact 166 of relay 2PS², back contact 143 of relay 1NS², front contact 144 of relay 1PS², front contact 167 of relay 2NS², front contact 168 of relay 3PS², front contact 169 of relay 4PS², front contact 170 of relay 5NS², front contact 171 of relay 6PS², and upper winding of relay LFZ², to (−). A stick circuit is closed upon picking up of relay LFZ² extending from (+), including back contact 30 of relay RGZ², front contact 172 of relay LFZ², and lower winding of relay LFZ², to (−). The picking up of relay LFZ² establishes west bound traffic at field station No. 2 so as to cause the transmission of a driven code back toward the signal 9A.

By referring to Fig. 8 of the Judge et al. Patent No. 2,082,544 above referred to it is readily understood that the order of the three-impulse station selecting codes there illustrated (see Fig. 8 of the Judge patent) are as follows:

+ + +, + + −, + − +, + − −, − + +, − + −, − − + and − − −. Referring now to Fig. 1 of this application it will be seen that station selecting codes, for signal control purposes + + −, + − + and + − −, which are the second, third and fourth code of the above complete code table, only have been used for signal control purposes in this table. From this it is readily understood that the particular construction illustrated in this application enables eight different field stations to be used, that is, a six step code has enough capacity to control apparatus such as illustrated in Fig. 6 of the drawings at each of eight field stations. Referring now to Fig. 6 of the application it is readily seen that contacts **144**, **145** and **146** together constitute station selection means for signal control purposes, that contacts **144**, **145** and **159** together constitute station selecting means for causing a driven track circuit code to be sent toward the west (namely, for traffic to the right) and that contacts **144**, **167** and **168** together constitute station selecting means for causing a driven track circuit code to be sent toward the east (namely traffic toward the left). In other words, there may be said to be three station selecting means at each field station, one of which is used for controlling signals (switch also), and the other two of which are used to control track circuit coders for creating driven codes. Referring now to Fig. 1 it will be seen that the station selecting code + − + for controlling signals at station No. 3 is also used at station No. 2 to initiate a track circuit coder which sends a driven code toward the east to contribute to the clearing of signal **9A** or **9B** and that this same station selecting code of + − + also causes station selecting means at station No. 4 to be rendered effective to initiate a track circuit coder which sends a driven code toward the west to contribute to the clearing of signals **8A** or **8B**. It is thus seen that the same station selecting code renders a station selecting means active at three stations although only the station selecting means at two stations is effective to control signalling apparatus at one time. For instance, as just pointed out the station selecting code + − + is effective to cause station selecting means to become effective at each of stations 2, 3 and 4, but if the 5th and 6th step of the complete code are (+) and (−), respectively, nothing will transpire at station No. 2, whereas if the 5th and 6th step of the complete code are (−) and (+), respectively, no traffic controlling apparatus will be operated at station No. 4. From this consideration it is readily understood that there may be just as many field stations as there are code combinations for the three steps used for station selecting purposes, and that the codes have been used very efficaciously. Another way of viewing the apparatus is that there are four code responsive means at each station, namely, two signal controlling code responsive means LGZ and RGZ, and two coder controlling code responsive means LFZ and RFZ with the codes to these code responsive means so chosen that one of each of these pairs of devices at two adjacent field stations is controlled by the same code.

Set-up for a following train.—It is believed to be readily apparent from the description as it has been set forth upon considering the assumed normal conditions with respect to the establishment of west bound traffic in the coded track circuits, that the system is so conditioned for west bound traffic that merely the picking up of the code responsive relays LGZ for the various field stations is essential to the clearing of the centralized traffic controlled signals at such field stations. Thus, for example, under the conditions described as normal, if the relay LGZ^2 is energized and the track switch **3W** is called for to be in its normal position, the signal **7A** is cleared immediately upon the energization of that relay. This is true because there is a driven code at a 180 rate being transmitted in the track section **7T** back toward that signal under the conditions that have been described as normal. If the track switch **3W** were called for in its reverse position instead of in its normal position, the signal **7B** would be cleared instead of the signal **7A**.

In a similar manner the clearing of signal **9A** or signal **9B** can be effected, and the signal **13A** or the signal **13B** can likewise be cleared. It is not essential that the controls for clearing the signals at the various field stations be designated in any particular order. That is, although it is probable that the operator at the control office would designate for clearing the signals most immediate in advance of the approaching train first, it is not essential that such order should be maintained. In fact, should he follow such order in designating the controls, and designate several controls while the communication system is in operation, the controls will be transmitted in a predetermined order which may differ from the order in which such controls are originally designated.

To consider more specifically how a route can be set up for west bound traffic, assume that it is desired to set up a route for a train approaching signal **13A** on the main track to take such train into the passing siding **21** as illustrated in Fig. 2C. Upon the reception of proper switch and signal controls transmitted from the control office the relay LGZ^4 is picked up in a manner comparable to that described for the energization of the relay LGZ^2, and the picking up of that relay closes a circuit for the clearing of signal **13A** because the relays **13H** and **13D** (see Fig. 7H) are already energized in accordance with the reception of a 180 code transmitted through the track section **13T**. The energization of signal **13A** under such conditions is effected by a circuit closed from (+), including front contact **190** of relay **13D**, front contact **191** of relay **14TP**, front contact **192** of relay **5NCR**, back contact **193** of relay **5RCR**, front contact **194** of relay **13H**, front contact **195** of relay LGZ^4, front contact **196** of relay **13LF**, winding of signal **13A**, front contact **197** of relay **13LF**, front contact **198** of relay LGZ^4, front contact **199** of relay **13H**, and front contact **200** of relay **13D**, to (−). The energization of signal **13A** by the circuit which has been described with the relay **13D** energized causes the display of a green clear indication.

The reception of a control cycle at field station No. 3 for the operation of the track switch **4W** to its reverse position and for the clearing of signal **9B**, causes the picking up of the code responsive signal control relay LGZ^3, and also causes the picking up of the switch control relay **4WR** (not shown) in a manner comparable to similar conditions shown with respect to the reception of controls at field station No. 2. After the track switch has been operated to its reverse position, the reverse correspondence relay **4RCR** is picked up, and the picking up of that relay closes a circuit for signal **9B** extending from (+), including front contact **201** of relay **10TP**, back contact **202** of

relay 4NCR, front contact 203 of relay 4RCR, front contact 204 of relay LGZ³, winding of signal 9B, and front contact 205 of relay LGZ³, to (—). The energization of the mechanism of signal 9B by such circuit causes the display of a yellow caution indication for governing traffic into the siding 21. The energization of signal 9B does not effect the clearing of signal 11 which, under the assumed normal conditions, is at caution, because the change in the rate of coding in track section 11T from a 75 to a 180 code is effected only when the relay 9AYGP is picked up for repeating the clear and caution condition of signal 9A.

Change in direction of traffic.—After having considered how the signals are normally conditioned in accordance with the direction of traffic last established, such direction having been assumed to be for west bound traffic, consideration will be given to the reversal of traffic direction in accordance with controls transmitted from the control office for the clearing of east bound signals. To illustrate such condition, it will be assumed that an operator desired to cause the passage of an east bound train through the track layout on the main track, and with reference to Fig. 1, it is assumed either the signal 2A or the signal 2B is cleared for passage of an east bound train into the stretch of single track between sidings 20 and 21. Under such conditions, the reception of the signal clearing code for clearing either of such signals for east bound traffic causes the relay RFZ² at field station No. 2 to be picked up in a manner which has been described, and the picking up of that relay closes its stick circuit at back contact 162.

The picking up of relay RFZ² conditions the traffic direction storage relay 7RFA so that such relay can be picked up upon the dropping away of the relay 7H when the tumble-down through the stretch of single track extending between sidings 20 and 21 has become effected. For the conditions to be considered at field station No. 2 it will be assumed that such tumble-down becomes effective because of the reception of the signal control at field station No. 1, as the circuits for such field station are not shown. It will be hereinafter explained more in detail with reference to a similar condition at field station No. 3 how the tumble-down is effected.

After the relay 7H (see Fig. 7B) has dropped away, a circuit is closed to cause the picking up of the traffic direction storage relay 7RFA for east bound traffic extending from (+), including front contact 206 of relay 7AS, back contact 207 of relay 7H, front contact 208 of relay RFZ², and upper winding of relay 7RFA, to (—). The picking up of that relay opens the stick circuit which is normally energized for relay 7LF at back contact 209, and the relay 7LF drops away because its pick-up circuit is open at that time at back contact 210. The dropping away of relay 7LF closes a stick circuit for relay 7RFA to maintain such relay energized until traffic is next established for the opposite direction, such stick circuit being closed at back contact 211 of relay 7LF.

Upon the dropping away of relay 7LF, the relay 7CPA becomes active to repeat the 75 code of the code transmitter 75CTA to transmit a 75 driven code through the track section 7T to cause signal 4 (see Fig. 7A) to display a caution indication.

At the location of signal 4 the track relay 7TR receives the 75 driven code, and a circuit is closed during the "on" periods of that code to cause the picking up of the traffic direction storage relay 7RF by the energization of a circuit extending from (+), including front contact 84 of relay 7TR, back contact 212 of relay 4—5H, back contact 213 of relay 4—5S, and upper winding of relay 7RF, to (—). The picking up of that relay causes the dropping away of relay 6LF by opening the stick circuit for that relay at back contact 50, the pick-up circuit for that relay being open because of the deenergized condition of the relay 6TRA on account of the tumble-down effected from field station No. 1.

The relay 6—7TP follows the 75 code received by relay 7TR by the energization of a circuit during the "on" periods closed from (+), including front contact 84 of relay 7TR, front contact 85 of relay 7RF, back contact 73 of relay 6LF, and winding of relay 6—7TP, to (—). The pulsing of contact 53 of relay 6—7TP with front contact 59 of relay 7RF closed causes the energization of the relay 4—5H, and the energization of such relay causes the display of a caution indication by signal 4. The energization of signal 4 to display a caution indication is effected by a circuit closed from (+), including back contact 58 of relay 4—5D, front contact 59 of relay 4—5H, back contact 214 of relay 6LF, front contact 215 of relay 7RF, winding of signal 4, front contact 216 of relay 7RF, back contact 217 of relay 6LF, front contact 64 of relay 4—5H, and back contact 65 of relay 4—5D, to (—). It will be noted with reference to the circuits just described that the same H and D relays are used for clearing both of the signals at the double signal location, one signal or the other being selected to be cleared by the traffic direction storage relays 6LF and 7RF.

The energization of signal 4 causes the picking up of the signal repeater relay 4YGP, and the picking up of that relay causes the code repeater relay 6CPA to transmit a driven code at a 180 rate through the track section 6T. The relay 6CPA is energized during the "on" periods of such code by a circuit closed from (+), including contact 68 of the code transmitter 180CT, front contact 218 of relay 4YGP, front contact 56 of relay 7RF, winding of relay 6CPA, and back contact 57 of relay 6LF, to (—). It will be noted that the code transmitter 180CT is active only when energized by an obvious circuit closed when either of the relays 5YGP or 4YGP is energized in accordance with the energization of signal 5 or signal 4 respectively.

The relay 7CP is active to transmit an inverse code at a 75 rate through the track section 7T because of the energization, whenever the primary winding of the transformer 4—5TF is opened, of a circuit closed from the upper terminal of the secondary winding of transformer 4—5TF including front contact 55 of relay 4—5AR, back contact 70 of relay 6LF, winding of relay 7CP, and front contact 71 of relay 7RF, to the lower terminal of the secondary winding of transformer 4—5TF. The relay 7TRA (see Fig. 7B) at field station No. 2 receives the inverse code and causes the energization in an obvious manner of the approach relay 6AR, such approach relay being slow enough in dropping away to be maintained energized during the shift in direction of transmission of codes through the track circuits.

It will be noted at field station No. 2 that the track repeater relay 7LTP does not follow the inverse code received because the relay 7LF is dropped away at that time, and in accordance with the deenergized condition of the re-

lay 7LTP, the relays 7H and 7D are deenergized under such conditions.

So far in the change in the direction of traffic it is provided that east bound traffic is set up as far as signals 6A and 6B, but west bound traffic is still maintained established to signal 7A. If controls are transmitted from the control office, however, for the clearing of signal 6A, the direction of traffic is reversed for the transmission of coded track circuits through track section 9T. This is accomplished in a manner comparable to that which has been described; namely, the reception of switch and signal controls for the clearing of signal 6A at field station No. 2 stops the transmission of the driven code from that end of track section 9T, and conditions that end of the track section for the reception of a driven code transmitted from the opposite end of that track section.

During the same cycle of operation in which those controls are received at field station No. 2, the traffic direction at field station No. 3 is established whereby that end of the track section 9T is conditioned to transmit a driven code back toward the signal 6A to be cleared.

Upon comparing the diagrammatical illustrations, Figs. 2A and 2B, it will be noted that the picking up of the relay RGZ^2 at field station No. 2 causes the release of the traffic direction storage relay LFZ^2. The dropping away of relay LFZ^2 conditions that end of the track section 9T to receive a driven code.

At the same time that relay RGZ^2 is picked up at field station No. 2, the relay RFZ^3 is picked up by code at field station No. 3, and the picking up of that relay conditions that end of the coded track circuit for track section 9T to transmit a driven code back toward signal 6A.

To consider in detail the circuits involved in the above described mode of operation, when the relay RGZ^2 at field station No. 2 is picked up upon the reception of a code transmitted from the control office for the clearing of signal 6A, the relay LFZ^2 is dropped away by the opening of its stick circuit at back contact 30 (see Fig. 7C). This, however, is the case only if the track switch 3W assumes its normal position (relay 3WN up) at this time.

The dropping away of relay LFZ^2 at field station No. 2 closes a circuit to cause the picking up of relay 9RF extending from (+), including front contact 181 of relay 7AS, back contact 182 of relay 6H, front contact 183 of relay 7AR, back contact 184 of relay LFZ^2, and upper winding of relay 9RF, to (—). The picking up of relay 9RF causes the dropping away of relay 9LF by opening the stick circuit of that relay at back contact 33, and the dropping away of relay 9LF closes a stick circuit at back contact 185 of relay 9RF.

The picking up of relay 9RF and the dropping away of relay 9LF opens the circuit by which relay 9CP follows a driven code at contacts 37 and 36 respectively, and upon the shifting of those contacts the relay 9CP is conditioned to transmit an inverse code when a driven code is received by the relay 9TR. It will be noted that the condition of the relays 9RF and 9LF can be changed, only when the approach relay 7AR is energized, thus providing that the picking up of relay LFZ^2 cannot be effective to stop the transmission of code in the track circuit 9T for a westbound train approaching signal 7A in track section 9T. Such mode of operation is particularly desirable when cab signals are employed to avoid removal of the driven track code from the track circuit ahead of the train.

When the driven code ceases to be applied to the track section 9T in accordance with the deenergization of the relay 9CP, the pulsing of contact 41 of relay 9TRA (see Fig. 7D) ceases, and the relay 9H is dropped away because the pulsing is stopped of the contact 44 of relay 9LTP. Prior to the dropping away of relay 9H, the relay RFZ^3 has been picked up, and therefore the dropping away of relay 9H closes a circuit to cause the picking up of the relay 9RFA. Such circuit extends from (+), including front contact 220 of relay 9AS, back contact 221 of relay 9H, front contact 222 of relay RFZ^3, and upper winding of relay 9RFA, to (—). Front contact 186 of relay 4RCR is connected in multiple with front contact 220 of relay 9AS in that circuit to provide that a change in direction can be effected if a route has been set up to cause the clearing of signal 9B and the dropping away of relay 9AS.

The picking up of relay 9RFA opens the stick circuit for relay 9LFA at back contact 223 and causes that relay to drop away as the pick-up circuit for that relay is open at that time at back contact 187 of relay RFZ^3. The dropping away of relay 9LFA closes a stick circuit at back contact 43 to maintain relay 9RFA picked up.

With relay 9RFA picked up and the relay 9LFA dropped away, the relay 9CPA repeats the code transmitter 75CTB by the energization during each "on" period of the code of a circuit closed from (+), including contact 89 of code transmitter 75CTB, back contact 224 of relay 8AYGP, front contact 46 of relay 9RFA, winding of relay 9CPA, and back contact 47 of relay 9LFA, to (—). The pulsing of contact 39 of relay 9CPA causes the transmission of a 75 driven code in the track section 9T, and the reception of such code by the track relay 9TR (see Fig. 7C) at field station No. 2 causes the relay 9RTP to follow the code because relay 9RF is energized at that time, and the pulsing of contact 225 of relay 9RTP, with relay 9RF energized causes the picking up of the relay 6H. With relay 6H energized under such conditions the signal 6A displays a yellow indication because of the energization of a circuit for the mechanism of that signal closed from (+), including back contact 226 of relay 6D, front contact 227 of relay 6H, front contact 228 of relay RGZ^2, front contact 229 of relay 9RF, winding of signal 6A, front contact 230 of relay 9RF, front contact 231 of relay RGZ^2, front contact 232 of relay 6H, back contact 233 of relay 3RCR, front contact 234 of relay 3NCR, front contact 235 of relay 8TP, and back contact 236 of relay 6D, to (—). The pulsing of contact 225 of relay 9RTP causes the transmission of an inverse code back through the track section 9T in a manner comparable to that which has been described for the transmission of inverse codes when the other direction of traffic is established. The reception of the inverse code by the track relay 9TRA (see Fig. 7D) maintains the energization of the approach relay 8AR at field station No. 3. Such approach relay is sufficiently slow in dropping away as not to be dropped away during the shift in direction of coding.

At field station No. 2 the energization of the mechanism of signal 6A causes the picking up of the signal repeater relay 6AYGP (see Fig. 7B), and the picking up of that relay closes a circuit to cause the relay 7CPA to follow a 180 code, such circuit being closed during each "on" period of

the code from (+), including front contact 237 of code transmitter 180CTA, front contact 238 of relay 6AYGP, front contact 239 of relay 7RFA, winding of relay 7CPA, and back contact 240 of relay 7LF, to (—). The impulsing of the track circuit of track section 7T at a 180 code rate causes the energization of the relay 4—5D (see Fig. 7A), and the energization of that relay reverses the polarity of the mechanism of signal 4 to cause such signal to display a green clear indication.

With reference to Fig. 2C it will be noted that the conditions which have just been described are the conditions illustrated in that figure for the setting up of the route for train A up to the signal 8A as would be the condition if a meeting were to be effected between trains A and B. It has also been pointed out how the clearing of signal 9B can be effected for entrance of the train B into the siding 21. It will be noted in connection with the meeting of the two trains, that the reception of the control for the clearing of signal 9B from the control office at field station No. 3 does not cause a change in direction for the transmission of codes through the track section 9T, as the picking up of relay LGZ^3 does not effect the dropping away of relay RFZ^3 for a change in direction because energy is supplied to the stick circuit for relay RFZ^3 under such conditions at back contact 241 of relay 4WN which is dropped away prior to the picking up of relay LGZ^3 when controls are received for clearing the signal 9B. It will also be noted that the transmission under such conditions of controls for the relay LGZ^3 does not change the traffic direction at field station No. 2 because the fourth impulse of the code is (—) (see Fig. 1), and the fourth impulse must be (+) in order to change the traffic direction at that field station.

Tumble-down.—To consider how the tumble-down of the circuits through a stretch of single track becomes effective in the reversal of traffic, it will be assumed that an operator proceeds to establish a route through the track layout for an east bound train as shown in Fig. 2B it being assumed that a route is established up to signal 8A as described above, and that the conditions described as normal exist east of that point. When the relay RGZ^3 (see Fig. 7E) is picked up upon reception of a code for the clearing of signal 8A, relay LFZ^3 is dropped away by the opening of back contact 31, and the dropping away of that relay causes the picking up of relay 11RF by the energization of a circuit closed from (+), including front contact 242 of relay 9AS, back contact 243 of relay 8H, front contact 244 of relay 9AR. back contact 245 of relay LFZ^3, and upper winding of relay 11RF, to (—). The picking up of that relay opens the normally energized stick circuit for relay 11LF at back contact 246, and the dropping away of relay 11LF closes an obvious stick circuit at back contact 247 for relay 11RF. The picking up of relay 11RF opens the circuit for the code repeater relay 11CP, and therefore stops the transmission of a driven code through the track section 11T.

At signal location 10 (see Fig. 7F), when the relay 11TRA is deenergized because of having no code to follow, the relaw 11—12TP is also deenergized, and the relay 10H is dropped away because the pulsing of contact 95 of relay 11—12TP has ceased.

Inasmuch as the code repeater relay 12CP follows the code received in track section 11T, and is therefore dependent upon the pulsing of contact 94 of track relay 11TRA, the transmission of code in track section 12T is stopped because of the deenergization of relay 12CP. The deenergization of the track circuit for track section 12T causes the deenergization respectively of the code following relays for the righthand end of that track section, and the relay 11H (see Fig. 7G) is dropped away because the pulsing ceases of contact 103 of relay 12—13TP.

When the relay 11H drops away, the circuit which has been described for signal 11 is opened at front contacts 113 and 108, and therefore the signal 11 is restored to its deenergized position. The restoration of signal 11 causes the dropping away of the signal repeater relay 11YGP, and the dropping away of that relay opens the circuit for the code repeater relay 13CP at front contact 248. The circuit for relay 13CP including back contact 248 is also open at that time at front contact 249 of the stick relay 11S. It will be noted at this point that the primary purpose of the relay 11S and all of the other S relays is to provide code for a following train but yet provide means for effecting the tumble-down through to the next location. When the track circuit of track section 13T becomes deenergized, the pulsing ceases of the relays 13TRA and 13TP (see Fig. 7H), and the relay 13H is dropped away because the pulsing ceases of contact 250 of relay 13TP. The tumble-down has thus been completed all the way through the single track section extending between sidings 21 and 22.

To consider other conditions effective at the time the control cycle for the clearing of signal 8A is received, at field station No. 4 the relay RFZ^4 is picked up, and the picking up of that relay conditions for energization the relay 13RFA, but such relay cannot be energized until the tumble-down has been completed all of the way through the single track section as has been described to cause the release of the relay 13H. After the relay 13H has been dropped away the relay 13RFA is picked up by the energization of a circuit closed from (+), including front contact 251 of relay 13AS, back contact 252 of relay 13H, front contact 253 of relay RFZ^4, and upper winding of relay 13RFA, to (—). The picking up of relay 13RFA causes the dropping away of relay 13LF by opening its stick circuit at back contact 254, and the dropping away of relay 13LF closes an obvious stick circuit for relay 13RFA at back contact 255.

The dropping away of relay 13LF causes the code repeater relay 13CPA to follow a 75 driven code, and the impulsing of the track circuit of track section 13T causes the track relay 13TR at signal location 11 (see Fig. 7G) to follow the code. The pulsing of contact 256 of relay 13TR with the relay 11H deenergized causes the picking up of the traffic direction relay 13RF by the energization during the "on" periods of the code of a circuit extending from (+), including front contact 256 of relay 13TR, back contact 257 of relay 11H, back contact 258 of relay 11S, and upper winding of relay 13RF, to (—). The picking up of that relay causes the dropping away of relay 12LF by opening the stick circuit for that relay at back contact 259. The dropping away of relay 12LF closes a stick circuit for relay 13RF at back contact 260. The pulsing of contact 103 of relay 12—13TP causes the energization of relay 11H, and causes the relay 13CP to transmit an inverse code in a manner comparable to that which has been described for the other direction of traffic.

The relay 12CPA is impulsed as a repeater of the code received by the relay 13TR to transmit a driven code through the track section 12T. Such relay is energized during each "on" period of the code by a circuit closed from (+), including front contact 256 of relay 13TR, front contact 257 of relay 11H, front contact 261 of relay 13RF, winding of relay 12CPA, and back contact 262 of relay 12LF, to (—).

At signal location 10 (see Fig. 7F) the pulsing of contact 104 of relay 12TR in accordance with the driven code applied to track section 12T causes the picking up of the traffic direction relay 12RF at that signal location by the energization during each of the "on" periods of a circuit closed from (+), including front contact 104 of relay 12TR, back contact 263 of relay 10H, back contact 264 of relay 10S, and upper winding of relay 12RF, to (—). The picking up of relay 12RF causes the dropping away of relay 11LFA by opening the stick circuit for that relay at back contact 265, and the dropping away of relay 11LFA closes an obvious stick circuit at back contact 266 for relay 12RF. After the relay 12RF has been picked up, the pulsing of contact 95 of relay 11—12TP becomes effective to cause the energization of the relay 10H, and the picking up of that relay causes the energization of the mechanism of signal 10 to display a yellow caution indication in a manner comparable to that heretofore described with reference to signal 11.

The energization of the mechanism of signal 10 causes the picking up of the signal repeater relay 10YGP, and the picking up of that relay initiates the operation of the code transmitter 180CTC in an obvious manner, and causes the relay 11CPA to transmit a 180 code in track section 11T by the energization during each "on" period of the code of a circuit closed from (+), including contact 267 of relay 180CTC, front contact 268 of relay 10YGP, front contact 269 of relay 12RF, winding of relay 11CPA, and back contact 270 of relay 11LFA, to (—).

Having established the traffic direction at field station No. 3 in accordance with the reception of the signal control for signal 8A, the relay 11RF is energized and the relay 11LF deenergized at the time that the track relay 11TR (see Fig. 7E) receives the 180 driven code transmitted in track section 11T. Therefore the following of that code by the track repeater relay 11RTP causes the energization of the relay 8H by the pulsing of contact 271 because front contact 246 of relay 11RF is closed at that time, and inasmuch as the code received is at a 180 rate, the relay 8D is picked up because of the energization of its tuned circuit. Upon the picking up of those relays the clearing of signal 8A is effected by the energization of its signal mechanism by a circuit closed from (+), including front contact 272 of relay 8D, front contact 273 of relay 10TP, front contact 274 of relay 4NCR, back contact 275 of relay 4RCR, front contact 276 of relay 8H, front contact 277 of relay RGZ[3], front contact 278 of relay 11RF, winding of signal 8A, front contact 279 of relay 11RF, front contact 280 of relay RGZ[3], front contact 281 of relay 8H, and front contact 282 of relay 8D, to (—).

It is believed obvious how the signal 12A can be cleared in accordance with the reception of controls for clearing that signal and in accordance with the coded track circuits in advance thereof in a manner comparable to that described with reference to the clearing of the signal 6A under similar conditions.

Passage of a train.—To consider the passage of a train through the track layout, assume, for example, the conditions to exist as diagrammatically illustrated in Fig. 2C. Such conditions have been heretofore described except for the passage of the trains through the track layout.

When the train B accepts signal 13A, the dropping away of the relay 14TP for the track section 14T causes the restoration of the relay LGZ[4] because of the opening of a stick circuit comparable to the stick circuit shown as typical in Fig. 6 for the relay LGZ[2]. That is, the relay 14TP in dropping away opens the stick circuit for the relay LGZ[4] to cause that relay to be dropped away in the same manner that the opening of front contact 155 of relay 8TP (see Fig. 6) would cause the dropping away of the relay LGZ[2] if that relay were energized. The dropping away of relay 14TP opens the circuit for signal 13A at front contact 191 to cause its restoration, and the dropping away of relay LGZ[4] shunts the winding of signal 13A in an obvious manner. When the train enters track section 13T, the deenergization of relay 13TRA causes the deenergization of the code following track repeater relay 13TP and therefore the relay 13H is deenergized. The dropping away of relay 13H opens the signal control circuits at front contacts 194 and 199. When the pulsing of contact 250 ceases, the relay 13D is also dropped away.

At signal 11 (see Fig. 7G), the presence of the train in track section 13T causes the deenergization of relay 13TR, and when the pulsing ceases of contact 256 of relay 13TR the approach relay 12ARA is dropped away to provide an indication at the control office as hereinafter considered more in detail.

When relay 12ARA is dropped away the circuit for relay 12CPA which is active as an inverse code transmitter at that time is opened, and as a result the relay 12TR (see Fig. 7F) becomes inactive so as to cause the dropping away of relay 9ARA. Upon the dropping away of relay 9ARA the relay 11CPA ceases to transmit an inverse code because its circuit is open at front contact 297 and therefore the relay 11TR (see Fig. 7E) becomes inactive and causes the release of relay 9AR.

The dropping away of relay 9AR insures that any attempt to change the direction of traffic in the stretch of track between sidings 21 and 22 by an operator at the control office, when such stretch of track is occupied by a train, will be ineffective to stop the code transmission back toward the train from field stations No. 3. Such is the mode of the operation because the dropping away of relay 9AR opens the pick-up circuit for relay 11RF at front contact 244, and the picking up of that relay is essential to stop the transmission of code for west bound traffic in that stretch of track.

When the train accepts signal 11 (see Fig. 7G), the pulsing ceases of contacts 102 and 103 of relays 12TRA and 12—13TP respectively, and accordingly, the relay 11H is dropped away. The dropping of that relay causes the restoration to stop of signal 11 by the opening of front contacts 113 and 108 of relay 11H.

Upon dropping away of relay 11H when the approach relay 12ARA is dropped away, and the signal repeater relay 11YGP has not yet been dropped away because of the restoration of signal 11, the stick relay 11S is picked up. Relay 11S is energized under such conditions by a circuit closed from (+), including front contact 290 of

relay 11YGP, back contact 291 of relay 12ARA, back contact 292 of relay 11H, and winding of relay 11S, to (—). The relay 11S is maintained energized as long as relay 11H is dropped away, or as long as the signal repeater relay 11YGP is deenergized, by a stick circuit including back contacts 290 and 293 of relays 11YGP and 11H respectively.

When relay 11S is energized, the code transmitter 75CTD is active by the energization of an obvious circuit, and the picking up of relay 11S causes the code repeater relay 13CP to follow a 75 code because of the energization during the "on" periods of that code of a circuit closed from (+), including contact 294 of relay 75CTD, front contact 249 of relay 11S, back contact 248 of relay 11YGP, front contact 295 of relay 12LF, winding of relay 13CP, and back contact 296 of relay 13RF, to (—). Thus, as soon as the train leaves the track section 13T, the tranmission of a 75 code through that track section causes the energization of the relay 13H (see Fig. 7H) at field station No. 4 to provide that the signal 13A or the signal 13B can display a yellow caution indication if such signal is called for to be cleared by a code received at that field station from the control office.

When the train B enters track section 11T, the relay 11TRA (see Fig. 7F) ceases to follow the driven code of that track section, and when the pulsing stops of contact 94 of relay 11TRA the relay 12CP ceases to transmit a code in the track section 12T because the circuit by which such relay is energized under such conditions during the "on" periods of the driven code received by relay 11TRA is opened when relay 11TRA becomes inactive. When the pulsing ceases of contact 95 of relay 11—12TP because of the entrance of the train in the track section 11T, the relay 10H is deenergized and the deenergization of that relay also opens the circuit for relay 12CP at front contact 96. It is therefore provided that the presence of a train in track section 11T is effective to prevent the transmission of a code through track section 12T even though that track section may be unoccupied in the rear of the train in accordance with the general mode of operation required when staggered signals are used.

When the train enters track section 10T (see Fig. 7E), the dropping away of the relay 10TP causes the restoration of relay LFZ^3 (see contact 155 of relay 8TP of Fig. 6) and of signal 8A, and after the track section 11T has become unoccupied in the rear of the train, the pulsing of the code repeater relay 11CP which is following the code of the 75 code transmitter 75CTB is effective to transmit a driven code of a 75 rate through track section 11T to cause the picking up of relay 10H (see Fig. 7F), and the picking up of that relay closes a circuit which has been described during each "on" period of the code for the code repeater relay 12CP which repeats the 75 code back through track section 12T to cause the picking up of the relay 11H (see Fig. 7G). When relay 11H is picked up, the mechanism of signal 11 is energized to provide a yellow caution indication, and the picking up of relay 11YGP causes the dropping away of relay 11S by opening the circuit for that relay at back contact 290, back contact 293 of relay 11H being open at that time. The picking up of relay 11YGP also starts the code transmitter 180CTD for that signal location, and causes the relay 13CP to transmit a 180 driven code through the track section 13T to provide for the energization of relay 13D (see Fig. 7H) and therefore condition the signals 13A and 13B so that they can be cleared upon reception of a corresponding control code transmitted from the control office.

The pulsing of contact 258 of relay 13TP in accordance with the reception of a driven code at field station No. 4 causes the relay 13CPA to transmit an inverse code in track section 13T to cause the picking up of the approach relay 12ARA (see Fig. 7G). When that relay is picked up, the closing of front contact 283 of relay 12ARA causes the relay 12CPA to transmit a driven code in track section 12T to effect the picking up of the approach relay 9ARA (See Fig. 7F). In a similar manner the picking up of relay 9ARA closes front contact 297 to cause the relay 11CPA to transmit an inverse code in track section 11T and thereby cause the picking up at field station No. 3 of the approach relay 9AR (see Fig. 7E).

When the train leaves the detector or OS track section 10T, the restoration to normal of the relays associated with that track section completes the restoration to normal conditions of the part of the system affected by the passage of the train B.

Approach locking.—In accordance with the general principles of approach locking it is provided that a route can be changed upon restoration of a signal to stop only after a time if there is a train approaching that signal. Such mode of operation is effective in the system provided by the present invention. For example, with reference to Fig. 2C, in which a meet is provided for between trains A and B at siding 21, a condition will be considered in which the operator after having conditioned the system as illustrated decides to change the routes and cause the train A to take the siding 21, and the train B to stay on the main track.

To initiate such a change, the operator causes the transmission of a stop code for the restoration of signal 6A, such code being effective (see Fig. 6) to cause the picking up of the stop relay B^2 to open the stick circuit for the relay RGZ^2 to cause it to be dropped away. The dropping away of relay RGZ^2 causes the restoration of the signal 6A in an obvious manner, and the restoration of that signal causes the picking up of the signal-at-stop repeater relay 6RGP (see Fig. 8). The relay 6AS is of course dropped away at that time, but the picking up of relay 6RGP would cause the picking up of relay 6AS immediately if it were not for the fact that the train A is in approach of signal 4. If the train A were not in approach of signal 4, the relay 6AS would be picked up by the energization of a circuit extending from (+), including front contact 126 of relay 6RGP, front contact 310 of relay 6AR, and winding of relay 6AS, to (—). It is provided, however, that the presence of the train A in track section 6T has caused the release of the approach relay 4—5AR in accordance with the shunting of the code following track relay 6TRA, and the dropping away of such approach relay opens the circuit by which the relay 7CP is energized during "on" periods for the transmission of an inverse code at front contact 55. It is therefore provided that the entrance of a train into track section 6T stops the transmission of an inverse code in track section 7T, and thus causes the dropping away of the approach relay 6AR at field station No. 2. When relay 6AR is dropped away, the circuit for relay 6AS just described cannot be closed, and therefore such relay can be picked up only after

the thermal relay 6TH has had time to operate by the energization of an obvious circuit for its winding and close contact 311 to effect the picking up of relay 6AS by the energization of a circuit closed from (+), including front contact 126 of relay 6RGP, contact 311 of relay 6TH, and winding of relay 6AS, to (—). The picking up of the relay 6AS of course closes a normally energized stick circuit which has been described for that relay.

In a much similar manner the restoration of signal 9B in accordance with the transmission of a stop code for that signal from the control office causes the picking up of relay 9AS, such relay being picked up immediately if the train B is well in the rear of signal 9A as illustrated in Fig. 2C.

If the operator causes the transmission immediately following the restoration of signal 9B of controls for the clearing of signal 9A and the power operation of the track switch 4W to its normal position, such transmission is effective in a manner which has been described to cause a change in traffic direction at field station No. 2 in order that a driven code may be transmitted through track section 9T back toward the signal 9A which is to be cleared. Therefore, the reception of that signal clearing code at field station No. 2 for the establishment of the direction of coding causes the picking up of the relay LFZ^2 (see Fig. 7C) in a manner which has been described, but the closing of front contact 312 of that relay can not cause the picking up of the relay 9LF to change the direction of coding in the track section 9T until sufficient time has been taken since the restoration of signal 6A to cause the relay 6AS to be picked up and close front contact 313. Front contact 314 of relay 3RCR in multiple with front contact 313 of relay 6AS is open at that time because the last position called for for the track switch 3W was normal. The picking up of the relay 9LF at the end of a time period causes the dropping away of relay 9RF, and effects the transmission of a driven code through track section 9T in a manner which has heretofore been described.

The track switch 3W of course cannot be operated from its normal position until after the relay 6AS is picked up (see Fig. 8) to close front contacts 315 and 316 of the switch operating circuit. Thus, it is provided that the reception of a control cycle at field station No. 2 for the clearing of signal 6B governing entrance to the siding 21 prior to the picking up of relay 6AS cannot effect the power operation of the track switch until the required time has been taken, and at the end of such time the power operation of the track switch 3W to its reverse position will cause the picking up of the correspondence relay 3RCR for that track switch to effect the clearing of the signal 6B governing entrance into the siding.

It is to be understood that other types of locking could as well be used with the system as provided by the present invention, and that time locking can be provided for each of the signals if approach locking is not required. If time locking is to be provided, the circuits can be used as illustrated except that the contacts of the approach relays AR as shown in Fig. 8 will of course be eliminated from the circuits for the relays AS.

Indications.—Inasmuch as the indications provided in the system according to the present invention are similar in many respects to those disclosed in the patent to Judge et al., Patent No. 2,082,544, reference is to be made to that patent for the manner in which the indications are communicated from the various field stations to the control office as to the conditions of the signals, track switches and track sections. The presence of a train in each of the detector track sections, or OS sections, is indicated at the control office in accordance with the transmission of indications as to the energized or deenergized condition of the relay TP for that track section in a manner comparable to the transmission of indications in the above mentioned Judge et al. patent, when a change in the condition of such relay is effected. For the coded track sections, the relays AR are comparable to the relays TP for indication purposes, in that they are maintained energized except when the track sections with which they are associated are occupied by trains, or are in approach sections in the advance of trains. It is therefore shown as a typical example in Fig. 5, that a change in the condition of either of the relays 6AR, 8TP, or 7AR effects a momentary opening of the obvious stick circuit for the quick acting relay CH^2 to cause such relay to be dropped away for the initiation of a cycle of operation for the transmission of indications to the control office from that field station. A portion of the stick circuit for relay CH^2 is shown dotted to illustrate that contacts of other relays which might initiate the transmission of an indication cycle are included in accordance with the requirements of practice as specifically pointed out in the above mentioned Judge et al. patent.

Due to the large number of different combinations of train movements that can be effected through the track layout, no attempt is made to describe all of such movements, but it is desired to be understood that the various conditions described can be considered as typical, and it is believed that those skilled in the art can readily understand from the description as it has been set forth the mode of operation of the system under each condition encountered in practice.

One of such conditions could be, for example, a switching movement at field station No. 3 where train B would enter siding 21 (see Fig. 2C) and leave some cars and then reverse his direction with the idea of proceeding into track section 9T. To reverse the direction of the train after it has entered siding 21 and clear signal 8B, the operator at the control office causes the transmission of proper controls in a manner similar to that described, and after passage of the train beyond signal 9A, proper controls are then transmitted for the clearing of signal 9A. The direction of coding in track section 9T is then properly established automatically in accordance with the reception of the signal clearing code for west bound traffic at field station No. 2.

Having described one embodiment of the present invention as applied to the control of switches and signals for a specific track layout, 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 in accordance with the requirements of practice, without in any manner departing from the spirit or scope of the present invention

except as demanded by the scope of the appended claims.

What I claim is:

1. In a signal control system of the character described for a stretch of track remote from a control office having signals for governing traffic in both directions, such signals being spaced to form a block between each signal and the next signal in advance, a track circuit code transmitter for each end of each block operable when initiated to transmit a code consisting of impulses at a rate selected at that end of the block through the rails to the signal governing entrance to that block at the opposite end, a communication system connecting the control office and certain of the signal locations operable when manually initiated to transmit a selected code from the office to certain of said signal locations for clearing any desired one of the signals at one of such locations and for initiating said track circuit code transmitter at the signal location at the opposite end of the block in advance of the signal to be cleared at such one signal location, code-responsive means at each end of each block effective to initiate said code transmitter at that end if such initiation is called for by said communication system, signal clearing means at each end of each block effective to clear the signal governing entrance to that block at that end when such signal is called for to be cleared by said communication system and if the track circuit code transmitter for the opposite end of that block is active, and circuit means effective to maintain each of said track circuit code transmitters active when once initiated by the code responsive means at such end of the block until a signal governing entrance to that same end of the block is called for to be cleared by the communication system.

2. In a centralized traffic control system of the character described for a track layout having a main stretch of track and a passing siding, there being a block on the main track between the ends of the siding, and signals at the ends of the siding for governing traffic in both directions, the signals adjacent the end of each siding constituting a field station; a coded track circuit for said block having a track circuit code transmitter and a track circuit code receiver at each end thereof for transmitting codes between signals at the ends of such block in either direction through the track rails of such block; a normally-at-rest code communication system connecting the control office and each of the field stations operable when initiated to transmit to the field stations a code consisting of a series of impulses characteristic of a predetermined signal to be cleared; and code responsive means at each of the field stations effective to clear the signal governing entrance to said block at that station when such signal is called for to be cleared by said series of impulses, if the track circuit code receiver is active for that end of said block in response to the reception of track circuit code transmitted through the track rails from the opposite end of the block, such code responsive means also being effective in response to the reception of a particular series of impulses to cause the track circuit code transmitter at that field station for said block to become inactive if that transmitter is active when the controls for a clearing of the signal for governing traffic into the block from that end are received from the control office.

3. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of single track between passing sidings divided into blocks which blocks are provided with signals for governing traffic in both directions, the signals adjacent the ends of the sidings constituting field stations; a coded track circuit for each of the blocks having a track circuit code transmitter and a track circuit code receiver at each end thereof for the communication of control codes between signals in either direction through the track rails of the block; circuit means for activating the track circuit code transmitters and receivers in accordance with a predetermined direction of traffic, each transmitter at the signals between the sidings being maintained active dependent upon the reception of track code at the adjacent end of the next block in advance of such signal, and the track circuit code transmitter at the field station at the leaving end of said stretch of track for said predetermined direction being at times activated to cause the transmission of code through the track circuits for clearing the automatic signals for such predetermined direction at the entrance end of said stretch; a normally-at-rest code communication system connecting the control office and each of the field stations, such communication system being effective when initiated into a cycle of operation to transmit to the field stations a series of impulses characteristic of a preselected field station and a preselected direction for clearing a signal at such station; and electro-responsive means at each of the field stations effective to clear the signal governing entrance to said stretch of track when such signal is called for to be cleared by said series of impulses if the track circuit code receiver is active at that field station in response to the reception of track circuit codes transmitted from the opposite end of the block in advance of that signal, such electro-responsive means also being effective in response to the reception of said series of impulses to cause the track circuit code transmitter at that field station for transmitting impulses into the adjacent end of the block in advance of that signal to become inactive if that transmitter is active when the controls for the clearing of the signal for governing traffic into such block are received, and thereby cause the code transmitters of each block in said stretch of track to successively become inactive.

4. In a block signalling system of the character described for a stretch of single track having intermediate signal locations spaced by blocks along the trackway for governing traffic in both directions, a right and a left traffic direction storage relay for each of the intermediate signal locations and for each end of said stretch of track, a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks, remote controlled circuit means for each end of said stretch of track for selectively energizing said right or said left traffic direction storage relay for that end of said stretch of track in accordance with the desired direction of traffic to be established, circuit means responsive to the energization of a right traffic direction storage relay for the right end of said stretch of track for rendering the track circuit code transmitter active for that end of said stretch of track, circuit means responsive to the energization of a left traffic direction storage relay for the left end of said stretch of track

for rendering the track circuit code transmitter active for that end of said stretch of track, circuit means at each intermediate signal location responsive to the reception of track circuit code for a selected direction of traffic for energizing said right or left traffic direction relay at that location for a corresponding direction of traffic, and circuit means responsive to the energization of a right or left traffic direction storage relay for an intermediate signal location for rendering the transmitter active for that location for the transmission of track circuit codes for a corresponding direction of traffic away from that intermediate signal location.

5. In a block signalling system of the character described for a stretch of single track having intermediate signal locations spaced by blocks along the trackway for governing traffic in both directions, a right and a left traffic direction storage relay for each of the intermediate signal locations and for each end of said stretch of track, a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks, circuit means for maintaining said right or left traffic direction relay for each location energized for the direction of traffic last established through the track layout so as to be dependent for deenergization upon the picking up of the traffic direction relay at that location for the opposite direction of traffic, circuit means for maintaining the track circuit code transmitters and receivers for each block active for communication of signal control codes for one direction of traffic or the other in accordance with the left or right traffic direction relays energized so as to be dependent for being rendered inactive upon a change in the condition of said traffic direction storage relays for the exit end of said stretch of track for the traffic direction then established, remote controlled circuit means for each end of said stretch of track for selectively energizing said right or said left traffic direction storage relay for that end of said stretch of track in accordance with the desired direction of traffic to be established and thereby cause the dropping away of the traffic direction relay for that location for the opposite direction of traffic, circuit means including said coded track circuits responsive to the establishment of a new direction by said direction relays at the ends of said stretch of track for causing the energization at each of the intermediate signal locations of right or left traffic relays for a corresponding direction, and circuit means rendered effective upon the shifting of the direction established by said traffic direction relays at each location for initiating the track circuit code transmitters and receivers at that location for the communication of signal controls for a direction of traffic in accordance with the newly established traffic direction.

6. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of track divided into blocks and having signals located at the ends of the blocks for governing traffic in both directions; a normally-at-rest code communication system connecting the control office and the signal locations at the ends of said stretch of track operable to transmit when initiated into a cycle of operation a code consisting of a series of selected impulses characteristic of a preselected end of said stretch of track and a preselected traffic direction; traffic direction establishing relays for each of the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a coded track circuit with the transmitter and receiver at the opposite end of that block, each transmitter being effective when rendered active to transmit a code of impulses through the track circuit of that block for a particular traffic direction when selected and rendered active by said traffic direction establishing relays; and electro-responsive means at each end of said stretch of track responsive to a code consisting of a series of impulses characteristic of that end of said stretch for selectively energizing said traffic direction relays for that location for a direction corresponding to the direction characterized in the series of impulses of the code received, and means for causing said electro-responsive means to be rendered ineffective to control such traffic direction relays if said stretch of track is occupied by a train.

7. In a block signalling system of the character described for a stretch of single track having intermediate signal locations spaced by blocks along the trackway for governing traffic in both directions; a right and a left traffic direction storage relay for each of the intermediate signal locations and for each end of said stretch of track; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a coded track circuit with the transmitter and receiver at the opposite end of the block and effective when active to communicate signal controls for a selected direction of traffic; circuit means or maintaining said right or left traffic direction relay for each location energized for the direction of traffic last established through the track layout so as to be dependent for deenergization upon the picking up of the traffic direction relay at that location for the opposite direction of traffic; circuit means for maintaining the track circuit code transmitters and receivers for each block active for communication of signal controls for a direction of traffic in accordance with the left or right traffic direction relays energized so as to be dependent for being rendered inactive upon a change in the condition of said traffic direction storage relays for the exit end of said stretch of track for the traffic direction established; remote controlled circuit means for each end of said stretch of track for selectively energizing said right or said left traffic direction storage relay for that end of said stretch of track in accordance with the desired direction of traffic to be established and thereby cause the dropping away of the traffic direction relay for that location for the opposite direction of traffic, such remote controlled circuit means being effective to change the condition of the traffic direction relays only if said stretch of track is not occupied by a train; circuit means including said coded track circuits responsive to the establishment of a new direction by said direction relays at the ends of said stretch of track for causing the energization at each of the intermediate signal locations of a right or a left traffic relay for a corresponding direction; and circuit means rendered effective upon the shifting of the direction established by said traffic direction relays at each location for initiating the track circuit code transmitters and receivers at that location for the communication of signal controls for a direction of traffic in accordance with the newly established traffic direction.

8. In a block signalling system of the character described for a stretch of single track divided

into blocks having signals located at the ends of the blocks for governing traffic in both directions; traffic direction establishing relays for the various signal locations; a code transmitter and a code receiver for each end of each of the blocks connected by a coded track circuit with the transmitter and receiver at the opposite end of the block, such transmitter being effective when active to transmit either a driven or an inverse code; circuit means for rendering each of said transmitters active for the transmission of a driven code when that end of the block is an exit point in accordance with the condition of energization of said direction establishing relays; circuit means for rendering each of said transmitters active for the transmission of an inverse code when that end of the block is an entrance point in accordance with the condition of energization of said direction establishing relays, such transmitter being rendered active for the transmission of an inverse code only when said stretch of track is unoccupied by a train; and remote controlled circuit means for each end of said stretch of track for selectively energizing said traffic direction establishing relays for that end of said stretch of track to establish a direction in accordance with the desired direction of traffic to be established, such remote control circuit means being rendered effective for the ends of said stretch of track only if the code transmitters are active to communicate an inverse code through each of the blocks from the entrance end to the exit end of said stretch of track in accordance with the prior established condition of said traffic direction establishing relays.

9. In a centralized traffic control system of the character described for a track layout remote from a control office and having a main track and a passing siding, the main track having a block extending between signals located at the opposite ends of the siding for governing traffic in both directions; a normally-at-rest code communication system connecting the control office and the signal locations at the ends of the siding operable through a control cycle of operation to transmit to the signal locations a series of impulses characteristic of a preselected end of said siding and a preselected traffic direction; traffic direction establishing relays for the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of said block connected by a coded track circuit with the transmitter and receiver at the opposite end of that block, each of the transmitters being operable when rendered active to transmit either a driven or an inverse code; circuit means for rendering each of said transmitters active for the transmission of a driven code when that end of the block is an exit point in accordance with the traffic direction established by the particular energized condition of said traffic direction establishing relays; circuit means for rendering each of said transmitters active for the transmission of an inverse code when that end of the block is an entrance point in accordance with the direction established by the condition of energization of said direction establishing relays, such transmitter being rendered active for the transmission of an inverse code only when said stretch of track is not occupied by a train; and electro-responsive means at each end of said block responsive to said series of impulses characteristic of that end for selectively energizing said traffic direction relays for that location for a direction corresponding to the direction characterized in the series of impulses received from the control office, such electro-responsive means being rendered effective only if the code transmitter for the opposite end of that block is active to transmit an inverse code.

10. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of single track extending between sidings, the trackway being divided into blocks having signals located at the ends of the blocks for governing traffic in both directions; a normally-at-rest code communication system connecting the control office and the signal locations at the ends of said stretch of track operable through a control cycle of operation to transmit from the control office a series of impulses characteristic of a preselected end of said stretch of track and a preselected traffic direction; traffic direction establishing relays for the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a coded track circuit with the transmitter and receiver at the opposite end of that block, each of the transmitters being operable when rendered active to transmit either a driven or an inverse code; circuit means for rendering each of said transmitters active for the transmission of a driven code when that end of the block is an exit point in accordance with the condition of energization of said traffic direction establishing relays for that location; circuit means for rendering each of said transmitters active for the transmission of an inverse code when that end of the block is an entrance point in accordance with the condition of energization of said direction establishing relays for that location, such transmitter being rendered active for the transmission of an inverse code only when said stretch of track is not occupied by a train; and electro-responsive means at each end of said stretch of track responsive to said series of impulses characteristic of that end for selectively energizing said traffic direction relays for that location for a traffic direction corresponding to the direction characterized in the series of impulses received, such electro-responsive means being rendered effective only if the code transmitters are active to communicate an inverse code through each of the blocks from the remote end to the near end of said stretch of track and then only if such inverse code is actually received at the near end.

11. In a centralized traffic control system of the character described for a track layout remote from a control office having a main track and a passing siding, the main track having a block extending between the ends of the siding and signals at the ends of the siding for governing traffic in both directions, there being at each end of the siding a signal for governing entrance to the siding and a signal for governing entrance to the block between the ends of the siding; a track circuit code transmitter and a track circuit code receiver for each end of said block connected by a coded track circuit with the transmitter and receiver at the opposite end of the block effective when initiated to communicate signal controls through said block in a selected direction, a normally-at-rest code communication system connecting the control office and the signals at each of the ends of the siding operable when initiated to transmit a code call characteristic of a preselected end of the siding and a preselected signal to be cleared at that end for governing en-

trance to the siding or to said block, such communication system being operable to transmit a code call characteristic of the track circuit code transmitter at the opposite end of said block from the signal to be cleared only if such signal governs entrance to that block; electro-responsive means at each end of the siding effective to initiate said track circuit code transmitter for the end of said block at that end of the siding in accordance with the reception of a code call characteristic of that transmitter; and electro-responsive means at each end of the siding effective to cause the clearing of the signal at that end governing entrance to said block or the signal governing entrance to said siding in accordance with the signal clearing code call transmitted from the control office, the signal at that end of the siding being cleared for governing entrance to said block only if the track circuit code transmitter for the opposite end of such block is active.

12. In a centralized traffic control system of the character described for a track layout remote from a control office having a main track and a passing siding connected thereto by power track switches, the main track having a block extending between the ends of the siding, and signals at the ends of the siding for governing traffic in both directions, there being at each end of the siding a signal for governing entrance to the siding and a signal for governing entrance to the block between sidings; traffic direction establishing relays for the ends of the siding for selecting the direction of track circuit code transmission in said block; a track circuit code transmitter and a track circuit code receiver for each end of said block effective when rendered active for communicating signal controls for a direction of traffic selected by said traffic direction establishing relays; a normally-at-rest code communication system connecting the control office and the track switches and signals at the ends of the sidings operable when initiated into a cycle of operation to transmit from the control office a code call characteristic of a preselected end of said siding, a preselected position for the track switch at that end, and a preselected signal to be cleared for governing traffic over that track switch; electro-responsive means at each end of the siding responsive to the code call transmitted for that end of the siding to cause the power operation of the track switch and the signal governing traffic thereover in accordance with the code call received, the clearing of the signal governing entrance to said block at that end of the siding being rendered effective only if track circuit code is received at that signal through said block from the opposite end of the siding; and circuit means at each end of the siding for selectively energizing said traffic direction relays at that end so as to cause the initiation of the track circuit code transmitter for that end of the block when a signal clearing code is received at the opposite end of the siding for clearing an entering signal, only if the track switch at that end of the siding is called for to be operated to a normal position.

13. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of single track divided into blocks and signals located at the ends of the blocks for governing traffic in both directions, the signals located at the ends of such stretch of track constituting field stations; traffic direction establishing means for the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a track circuit with the transmitter and receiver for the opposite end of that block, the transmitters and receivers being normally active to communicate signal controls for a direction of traffic selected by said traffic direction establishing means; a normally-at-rest code communication system connecting the control office and each of the field stations operable to transmit from the control office a code call characteristic of a preselected field station and a preselected signal at such station to be cleared; signal clearing means at each of the field stations responsive to the code call for that field station for clearing said preselected signal in accordance with the signal control code transmitted from the control office, such signal clearing means being effective to maintain said preselected signal clear so as to be dependent for restoration upon passage of a train past that signal, and such signal clearing means being rendered effective only if the code transmitter is active for the opposite end of the next block in advance of that signal; and circuit means responsive to the communication of signal controls from the control office to the field stations for distinctively conditioning said traffic direction establishing means for signal locations in advance of the signal to be cleared in accordance with the direction of traffic to be established, such circuit means being effective when once conditioned to maintain the track circuit code transmitter active at that location for transmission of track circuit codes for the clearing of signals for a corresponding direction of traffic until the clearing of a signal for the opposite direction of traffic is called for by a signal clearing code transmitted from the control office.

14. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of single track divided into blocks and signals located at the ends of the blocks for governing traffic in both directions, the signals located at the ends of such stretch of track constituting field stations; traffic direction establishing relays for the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a track circuit with the transmitter and receiver at the opposite end of the block effective to communicate signal controls through the track circuits for a direction of traffic in accordance with the condition of energization of said traffic direction relays; a code communication system effective when initiated into a cycle of operation to communicate selected signal clearing and traffic direction establishing controls for controlling said signals and traffic direction establishing relays respectively from the control office to the field stations, such system also being effective to communicate to the field stations a code call for the restoration to stop of a signal at a preselected field station; signal control circuit means at each of the field stations effective to clear each signal or restore to stop each signal at that field station in accordance with the code call transmitted from the control office; and circuit means for selectively energizing said traffic direction relays at each of the field stations for a direction corresponding to that defined in a traffic direction code transmitted from the control office for such

field station, such circuit means being effective subsequent to the restoration to stop of a signal at that field station for the opposite direction of traffic by a code call transmitted from the control office, only after there has been a relatively long predetermined time interval subsequent to such restoration.

15. In a centralized traffic control system of the character described for a track layout remote from a control office having a stretch of single track divided into blocks and signals located at the ends of the blocks for governing traffic in both directions, the signals located at the ends of such stretch of track constituting field stations; traffic direction establishing relays for the various signal locations; a track circuit code transmitter and a track circuit code receiver for each end of each of the blocks connected by a track circuit with the transmitter and receiver at the opposite end of the block effective to communicate signal controls through the track circuits for a direction of traffic in accordance with the condition of energization of said traffic direction relays; a code communication system effective when initiated into a cycle of operation to communicate signal clearing and traffic direction establishing controls from the control office to the field stations for controlling said signals and traffic direction establishing relays, respectively, such system also being effective to communicate to the field stations a code call for the restoration to stop of a signal at a preselected field station; signal control circuit means at each of the field stations effective to clear each signal or restore to stop each signal at that field station in accordance with the code call transmitted from the control office; and circuit means for selectively energizing said traffic direction relays at each of the field stations for a direction corresponding to that defined in a traffic direction code transmitted from the control office for such field station, such circuit means being effective only subsequent to the restoration to stop of a signal at that field station for the opposite direction of traffic by a code call transmitted from the control office, only after there has been a relatively long predetermined time interval subsequent to such restoration, such predetermined time being effective to delay the conditioning of said traffic direction establishing relays only when a train is approaching the signal which has been restored.

16. In a block signalling system of the character described for a stretch of single track divided into blocks having signals at the ends of the blocks for governing traffic in both directions, said signals for opposite directions of traffic at the point where two blocks join comprising an intermediate signal location; a left and a right traffic direction relay for each of the intermediate signal locations; a track circuit code transmitter for each end of each of the blocks; a track circuit code receiver for each of the signal locations; a track circuit for each of the blocks; manually controlled circuit means for selectively energizing said left or said right traffic direction relay by transmission of code over the track rails in accordance with the direction of traffic desired to be established and thereby deenergize the traffic direction relay then energized; circuit means at each of the intermediate signal locations controlled by said traffic direction relays for rendering the track circuit code transmitter active for transmission of a track circuit code through a block terminating at that location in a direction opposite to the direction selected by the traffic direction relay energized; circuit means at each of the intermediate signal locations controlled by said traffic direction relays for rendering the track circuit code receiver at that location active to receive a track circuit code from the track circuit of the block to the left of that location if the left traffic direcion relay is energized for that location, and for rendering that track circuit code receiver active to receive a track circuit code from the track circuit of the block to the right of that location if the right traffic direction relay is energized for that location; and signal clearing means at each of the intermediate signal locations rendered active when said track circuit code receiver is active to clear a signal for traffic to the right if said right traffic direction relay is energized, and to clear a signal for traffic to the left if said left traffic direction relay is energized.

17. In combination, a railway track divided by insulating joints from adjacent track to constitute a block, a signal at each end of said block for governing movement of traffic into such block, a code type communicating system comprising a central office and a large number of field stations including two field stations one at each end of said block, means at said office and including said communication system for transmitting a particular code consisting of a plurality of impulses of distinctive characters to said field stations, a code responsive means at each of said field stations both responsive to said particular code, a track circuit code transmitter at each end of said block, a track circuit code receiver at each end of said block, means at one of said two field stations controlled by the code responsive means at such station effective to clear the signal at such station in response to the reception of said particular code at such one field station over the communication system if the associated track circuit code receiver is then receiving a track circuit code through the track rails of said block from the track circuit code transmitter at the opposite end of such block, and means at the other of said two field stations controlled by the code responsive means at such other field station for rendering the associated track circuit code transmitter effective to transmit a track circuit code through the track rails of said block to the track circuit code receiver at said one field station upon the reception of said particular code by the code responsive means at such other field station.

18. In combination, a railway track divided into stretches of track, a signal at each end of each stretch for governing the movement of traffic into such stretch, a code type communicating system comprising a central office and a large number of field stations one at each junction of adjacent blocks, means at said office and including said communication system for transmitting from time to time different particular codes each consisting of a plurality of impulses of distinctive characters to said field stations, code responsive means at each of said field stations both responsive to the same one of said particular codes, a track circuit code transmitter at each end of each block, a track circuit code receiver at each end of each block, means at one of said two adjacent field stations controlled by the code responsive means at such station effective to clear the signal at such station for governing the movement of traffic in a direction toward the other of said two field sta-

tions in response to the reception of said particular code at such one field station if the associated track circuit code receiver is then receiving a track circuit code through the track rails of the block from the track circuit code transmitter at the opposite end of such block, and means at the other of said two field stations controlled by the code responsive means at such other field station for rendering the associated track circuit code transmitter effective to transmit a track circuit code through the track rails of said block to the track circuit code receiver at said one end of said block upon reception of said particular code by the code responsive means at such other field station.

19. In a railway signalling system of the single track type, the combination with a single track section connecting two multiple track sections, signals at each end of said section for governing the movement of traffic into said section, an entrance traffic relay and an exit traffic relay at each end of said single track section, a driven code track circuit code receiving means at each end of said section, an inverse code track circuit code receiving means at each end of said section, a driven code creating means at each end of said section for transmitting driven code current pulses through the rails of the section toward the other end, an inverse code creating means for inserting an inverse code current pulse between each of the current pulses of a received driven code, circuit means for operatively connecting said driven code track circuit code receiving means and the associated inverse code creating means to the track rails at one end of said single track section when the associated entrance traffic relay is in its energized condition and the associated exit traffic relay is in its deenergized condition and for operatively connecting said inverse code track circuit code receiving means and the associated driven code creating means to the track rails at said one end of said single track section when the associated exit traffic relay is in its energized condition and its associated entrance traffic relay is in its deenergized condition, means for manually controlling the energized and deenergized condition of said entrance traffic relays and exit traffic relays from a remote point, and means for preventing an exit traffic relay from being deenergized unless the associated inverse code receiving means is then receiving an inverse code.

20. In a centralized traffic controlling system employing a code type communicating system comprising, a railway track divided into blocks, a signal at the entrance to each end of each block for governing the movement of traffic into such block from that end, a coded track circuit for each block including a track circuit code transmitter at the exit end of the block for each direction of traffic and a track circuit code receiver at the entrance end of the block for each direction of traffic, a control office remote from said signals, a code type communicating system connecting said office and each of said signal locations for transmitting various codes each consisting of a plurality of impulses distinctive in character, four code responsive means at each signal location of which one when it responds to a code renders a track circuit code transmitter at that signal location active to transmit a track circuit code into the track circuit extending in one direction from said signal location, of which the second code responsive means when it responds to a code renders a track circuit code transmitter at that signal location active to transmit a track circuit code into the track circuit extending in the opposite direction from said signal location, of which the third code responsive means when it responds to a code controls a signal governing traffic in one direction at said signal location to indicate proceed subject to the reception of a track circuit code by the track circuit code receiver associated with the block in advance of such signal, and of which the fourth code responsive means when it responds to a code controls the signal for governing traffic in the opposite direction to proceed subject to the reception of a track circuit code by the track circuit code receiver associated with the block in advance of such signal, said code responsive means being so constructed that said third code responsive means at any one signal location responds to the same code as does said second code responsive means at the next signal location in advance of the signal said third code responsive means controls and of which the fourth code responsive means at any one signal location responds to the same code as does the first code responsive means at the signal location next in advance of the signal which said fourth code responsive means controls.

21. In combination, a central office and a plurality of field stations arranged successively along line wires connecting said office and stations, a pair of rails extending from each field station to the next more distant field station, a first and a second code responsive means at each field station, the second code responsive means of any field station except the last responding to the same code as does the first code responsive means of the next field station more remote from said office, a code type communicating system including said line wires for transmitting a plurality of distinctive codes one code for each of said first code responsive means from the office to said field stations one at a time, track circuit transmitting means at each field station, track circuit receiving means at each field station, and means at each field station effective if the second code responsive means at that field station responds to a code for connecting the track circuit receiving means between said rails extending to the next more remote field station and the signal at such signal location, and effective if the first code respnsive means at a field station responds to a code for connecting the track circuit transmitting means at such station to the rails extending toward the office from such field station, whereby the transmission of a single code causes code responsive means at two different field stations to respond and to connect particular devices to opposite ends of rails connecting such field stations to result in the display of a signal.

22. In combination; a single track stretch connecting two passing sidings; signals at each end of said stretch for governing the movement of traffic into such stretch; a plurality of track circuited blocks included in said stretch of track each having a coded track circuit including a driven code creating means, a driven code receiving means, an inverse code creating means for creating a code pulse between the pulses of the received driven code and having an inverse code receiving means; traffic direction relays at each end of said single track stretch which when rendered active in one active condition cause the driven code creating means to apply a track circuit driven code to the track rails of the first block of the single track stretch which code is

received by a track circuit droven code receiving means at the opposite end of that block; traffic direction relays at the junction between blocks for causing the last mentioned track circuit code receiving means in turn to cause a track circuit driven code to be applied to the track rails of the next block of said single track stretch and so on to the end of the single track stretch; means at said opposite end of each block of said single track stretch except the last block for through the medium of said traffic direction relays causing the inverse code creating means to return an inverse track circuit code constituting code pulses between the pulses of the received driven code over the track rails only if an inverse code is received at the near end of the block next in advance, said traffic direction relays at the ends of the single track stretch also causing the there located inverse code creating means to apply inverse code pulses between the received pulses of a driven code when in another active condition and to cause clearing of an associated signal subject to the reception of a driven code by the associated driven code receiving means when in such another active condition; a manually controlled code communicating system for selectively operating the traffic direction relays at the ends of said stretch to one or the other of said active conditions; means for preventing the control of said traffic direction relays at either end by said code communication system from said one to said another active condition unless inverse code pulses are being received at that end; and means for causing the traffic direction relays at said junctions to be controlled by the traffic direction relays at the end of said stretch of track through the medium of said track circuits.

23. In combination with a railway track divided by insulating joints into blocks, a passing siding of which one of said blocks comprises the main track, a track switch at each end of said passing siding, signals for each end of said passing siding for governing the movement of traffic into said main track and the side track of said passing siding respectively in accordance with the position assumed by the associated track switch, a code communicating system for transmitting control codes over a line circuit from a control office to a plurality of field stations including two field stations located at the ends of said passing siding, a line code responsive means at each of said two field stations which if it responds to a code will allow clearing of the signal governing traffic into the main track or into the siding depending on the position to which the associated track switch is controlled by such code, a coded track circuit for said main track having a driven code creating means and a track circuit code responsive means at each end thereof, means for connecting said track circuit code responsive means to the track rails of the main track when the associated line code responsive means is actuated, and another line code responsive means at each of said two field stations which if rendered active causes the associated driven code creating means to apply a track circuit code to that end of the main track of said passing siding which line code responsive means responds to the same code to which said first mentioned line code responsive means at the other end of said passing siding responds but only if the said same code is such as to control the associated track switch at said other end to the main track position.

24. In a railway signalling system of the single track type, the combination with a single track section connecting two multiple track sections, signals at each end of said section for governing the movement of traffic into said section, an entrance traffic relay and an exit traffic relay at each end of said single track section, a driven code track circuit code receiving means at each end of said section, an inverse code track circuit code receiving means at each end of said section, a driven code creating means at each end of said section for transmitting driven code current pulses through the rails of the section toward the other end, an inverse code creating means for inserting an inverse code current pulse between each of the current pulses of a received driven code, circuit means for operatively connecting said driven code track circuit code receiving means and the associated inverse code creating means to the track rails at one end of said single track section when the associated entrance traffic relay is in its energized condition and the associated exit traffic relay is in its deenergized condition and for operatively connecting said inverse code track circuit code receiving means and the associated driven code creating means to the track rails at said one end of said single track section when the associated exit traffic relay is in its energized condition and its associated entrance traffic relay is in its deenergized condition, means for manually controlling from a remote point an entrance traffic relay at one end of said section and an exit traffic relay at the other end of said section by separate code responsive means both of which respond to the same code received over line wires from the remote point, and means for preventing an exit traffic relay from being deenergized unless the associated inverse code receiving means is then receiving an inverse code.

25. In combination; a single track stretch connecting two passing sidings; signals at each end of said stretch for governing the movement of traffic into said stretch; a plurality of track circuited blocks included in said stretch of track each having a coded track circuit including a driven code creating means, a driven code receiving means, an inverse code creating means for creating a code pulse between the successive pulses of the received driven code, and an inverse code receiving means; driven code initiating means at each end of said single track stretch which when rendered active causes the driven code creating means to apply a driven track circuit code to the track rails of the single track stretch which is received by a track circuit code receiving means at the opposite end of that block and which last mentioned track circuit code receiving means in turn causes a track circuit code to be applied to the track rails of the next block of said single track section and so on to the end of the stretch; means at said opposite end of each block of said single track stretch except the last block for causing the inverse code creating means to return an inverse track circuit code constituting code pulses between the pulses of the received driven code over the track rails only if an inverse code is received at the near end in the block next in advance; control means at such opposite end of said last block for causing the there located inverse code creating means to apply inverse code pulses between the there received pulses of a driven code; a code communicating system manually governed from a central office for simultaneously clearing a signal subject to the reception of a driven code at one end of said

stretch, and rendering said driven code initiating means active at the other end of said stretch in response to the same code transmitted over such code communicating system, and means for preventing the driven code initiating means from being rendered inactive unless the associated inverse code receiving means is then receiving an inverse code.

26. In a block signalling system of the character described for a stretch of single track divided into blocks and having signals at the ends of the stretch and intermediate signals at the ends of said blocks for governing train movement in opposite directions, code transmitting means and code receiving means associated with the several signal locations, traffic direction establishing means associated with each signal location for governing the associated code transmitting means to provide driven code pulses in either selected direction and inverse code pulses in the opposite direction from said signal location dependent upon the operated condition of said traffic direction establishing means, said code transmitting means and code receiving means for the several blocks normally cooperating when a given direction of traffic has been established and the stretch is not occupied to transmit over the track rails of the several blocks driven code pulses in one direction and inverse code pulses in the opposite direction, means manually controlled from a remote point for governing said traffic direction establishing means when rendered effective to cause a reversal in the direction of transmission of driven and inverse code pulses, and means for each end of said stretch governed by said inverse code pulses when normally transmitted toward that end for rendering the associated manually controlled means effective to change said traffic direction establishing means while the stretch is unoccupied, whereby said manually controlled means is not effective after a train has entered said stretch to change the direction of code transmission.

27. In a coded track circuit centralized traffic control signalling system for single track railroads, the combination with a stretch of track between the ends of passing sidings, a signal at each end of said stretch for governing train movement into the stretch, code transmitting means associated with each end of said stretch for sending over the track rails driven code pulses toward the opposite end to govern the indication of the signal at that end, a manually operable signal lever for each signal in a remote control office, communication means connecting said remote control office with said signals to thereby provide that each lever may exercise control over its associated signal, and means effective when a control to clear either signal is exercised by its signal lever for also causing operation of the code transmitting means for the opposite end of said stretch, whereby a manual control to clear a given signal at one end of the stretch of track also determines the direction of coding in said stretch.

28. In a coded track circuit centralized traffic controlling system for single track railroads, a stretch of track between passing sidings with signals at both ends governing the entrance of traffic into the stretch, signal clearing means and code sending means for each end of said stretch, each of said code sending means acting when initiated to send driven code pulses over the rails of said stretch toward the opposite end to govern the indication of the signal at that end, a manually operable signal lever in a remote office for each of said signals, and a code type communication system for transmitting control codes over line wires extending from said remote office to a field station at each end of said stretch in accordance with the operated position of a given one of said signal levers to govern the corresponding signal clearing means and initiate the code sending means for the opposite end of the stretch, whereby the direction of a driven code through the rails of the stretch, as well as the clearing of each signal, is governed by its respective signal lever in the remote office.

29. In a coded track circuit C. T. C. system for single track railroads, a stretch of track between the ends of passing sidings with signals governing the entrance of traffic into said stretch for both directions, code transmitting means at each end of said strech for applying driven code pulses to the rails of said stretch, track circuit code receiving means at each end of said stretch responsive only to code pulses applied at the other end of the stretch for governing its signal, a remote control office having a signal lever for each of said signals, a code type communication system connecting said office and each of said signal locations, said system being operable to transmit a signal clearing control code to either signal location when the control lever for that signal is in a signal clearing position, said signal clearing control code transmitted to either one of said signal locations being also received at the other signal location and there acting to cause the operation of said code transmitting means at the opposite end of said stretch, and means at each end of the stretch controlled jointly by said signal clearing code and said track circuit code receiving means for clearing the signal at the corresponding end, whereby a single signal clearing control code transmitted from either signal lever causes code to be transmitted through the rails of said stretch in the proper direction and also effects the clearing of the signal for the corresponding lever dependent upon such track circuit code.

30. In a code track circuit centralized traffic controlling system for single track railroads, a stretch of track between passing sidings with signals at both ends of said stretch for governing train movement into the stretch, a signal clearing means and a code transmitting means for each end of said stretch, each of said code transmitting means being operable to transmit a driven code over the rails of said stretch toward the opposite end to govern the indication of the signal at such opposite end, a manually operable signal lever in a control office for each of said signals, a code type communication system having line wires connecting said control office with a field station at each signal location and operable through different cycles of operation to transmit control codes to different selected stations, and means governed by the manipulation of the signal lever for either end of the stretch for transmitting a control code to energize said signal clearing means for the corresponding signal and also during the same operating cycle cause operation of said code transmitting means at the opposite end of the stretch to transmit a driven code toward that signal, whereby manual control is exercised over the signal clearing means at one end of the stretch and over the driven code transmitting means at the other end of the stretch on the same cycle of operation of the code type communication system.

31. In a coded track circuit centralized traffic

controlling system for single track railroads, a stretch of single track between the ends of passing sidings, an entering signal at each end governing train movement into the stretch together with one or more intermediate signals for governing traffic in the opposite directions through the stretch and dividing the stretch into a plurality of blocks, code transmitting means associated with each end of the stretch for sending driven code pulses over the rails toward the opposite end to govern the indication of the entering signal at that end and each intermediate signal governing traffic in the same direction, a manually operable signal lever in a control office for each entering signal for controlling the indications of its signal depending upon the reception of a driven code from the opposite end of the stretch, means governed by the signal levers for causing operation of said code transmitting means at the exit end of the stretch for the signal to be cleared and for stopping the operation of the code transmitting means at the other end, and means responsive to the presence of a train in the stretch for preventing the manual stopping of the code transmitting means then operating, whereby no intermediate signal can be placed at stop and prevent a train from proceeding to the exit end of the stretch.

32. In a coded track circuit centralized traffic controlling system, a stretch of single track, an entering signal at each end governing train movement into the stretch together with one or more intermediate signals for governing traffic in each direction through the stretch, code transmitting means associated with each end of the stretch for sending driven code pulses over the track rails toward the opposite end of the stretch to govern the indications of the entering signal at such end and also to govern the indications of each intermediate signal for the same direction of traffic, manually operable means for selecting and causing the operation of the code transmitting means at one end or the other of such stretch and at the same time stop the operation of the transmitting means not selected to thereby establish a direction for traffic movement, and means controlled by the presence of a train in the stretch for preventing the manual stopping of the code transmitting means which operated to provide a clear indication by the entering signal for such train, whereby the presence of a train in the stretch prevents a change in the direction of traffic initially established when such train entered the stretch and thereby allows said train to proceed to the exit end of the stretch irrespective of the operation of said manually operable means.

33. In a coded track circuit centralized traffic control system, a stretch of single track, one or more signals for governing train movement into and through the stretch in each direction, code transmitting means associated with each end of the stretch for sending driven code pulses over the track rails toward the opposite end of the stretch to govern the indications of the signals provided for governing train movement from such opposite end, manually operable means for controlling the operation of the code transmitting means to cause a driven code to be transmitted in one direction or the other through said stretch at any one time to control the indication of the signals to thereby establish a particular direction of traffic, and means associated with each code transmitting means and controlled by current received over the track rails in a direction opposite to that in which its transmitting means applies a driven code for preventing said manually operable means from stopping the operation of such code transmitting means while a train is in the stretch.

34. In a coded track circuit centralized traffic control system, a stretch of single track between passing sidings, an entering signal at each end of the stretch and at least one intermediate signal for each direction of traffic, driven code transmitting means at each end of the stretch for sending driven code pulses over the track rails toward the opposite end to govern the indications of the entering signal at that end as well as the intermediate signal for the same direction, inverse code transmitting means at each end of the stretch for transmitting inverse code pulses between the pulses of a driven code received at its end of the stretch, manually governed means for controlling the operation of said driven and inverse code transmitting means at each end of the stretch so as to cause a driven code to be transmitted in one direction and an inverse code in the opposite direction or to reverse the direction for the respective codes as may be required for the direction of the traffic desired to be established, and means associated with each driven code transmitting means for permitting that transmitting means to be stopped by said manually governed means only when there is an inverse code being received from the opposite end of the stretch, whereby a train present in the stretch prevents the reception of an inverse code over the rails at the driven code transmitting end and thereby prevents the manual interruption of such driven code.

35. In a coded track circuit centralized traffic controlling system, a stretch of track with entering signals at each end, driven code transmitting means at each end for transmitting driven code pulses over the rails of the stretch, inverse code transmitting means at each end responsive to the reception of a driven code for applying inverse code pulses between the pulses of such driven code, manually governable means for causing operation of said driven code transmitting means at one end or the other, a code following track relay at each end, means associated with each code following track relay and controlled by said manually governable means for allowing the operation of its code following track relay to govern the indications of the corresponding signal only when the associated driven code transmitting means is inactive, and approach control means at each end of the stretch controlled by the operation of its code following track relay, whereby an entering signal can be cleared only by the reception of a driven code from the opposite end of said stretch.

36. In a coded track circuit centralized traffic controlling system, a stretch of track between passing sidings, an entering signal at each end for governing train movement into the stretch, an intermediate signal location having signals for governing train movement in both directions, driven code transmitting means at each end of said stretch for transmitting driven code pulses over the rails toward the opposite end to govern the indications of the entering signal at that end and any intermediate signal for the same direction of traffic, manually governable means for causing the operation of said driven code transmitting means at one end or the other of said stretch, directional control means at said intermediate signal location actuated to either of two distinctive conditions depending upon the direction of driven code initially received at said

intermediate signal location, and inverse code transmitting means at said intermediate signal location controlled by said directional control means to transmit inverse code pulses toward that end only of said stretch at which said driven code transmitting means is in operation.

37. In a coded track circuit centralized traffic controlling system, two adjoining track sections with a signal governing traffic from one section into the other, means manually controlled from a remote office for at times transmitting a driven code over the track rails of one section or the other toward said signal, and means associated with said signal responsive to the direction from which driven code is being received at such signal for applying inverse code pulses to that track section over which they are being received and driven code pulses to the other track section.

38. In a coded track circuit centralized traffic controlling system, an end track section adjacent a siding end, a head-block signal governing traffic away from said siding and an intermediate signal for the same direction of traffic, manually controlled means for transmitting a driven code toward said intermediate signal in one direction or the other, and means at said intermediate signal responsive to the direction of driven code received at such signal for transmitting a driven or an inverse code toward said head-block signal.

39. In a coded track circuit centralized traffic controlling system, a stretch of track divided into two track sections by an intermediate signal governing traffic toward a head-block signal at one end of the stretch, manually controlled means for at times transmitting a driven code from said head-block signal toward said intermediate signal to govern its indication and at other times transmitting a driven code from the opposite end of said stretch toward said intermediate signal, means at said intermediate signal responsive to said driven code from said head-block signal to transmit an inverse code toward said head-block signal, and responsive to a driven code from the opposite end of said stretch to transmit a driven code toward said head-block signal, means at said head-block signal governed by said manually controlled means to be responsive to only said driven code received at said head-block signal to control its indications, and approach control means at said head-block signal controlled by both said driven and inverse codes.

40. In a coded track circuit centralized traffic controlling system, a stretch of track between passing sidings, an entering signal at each end for governing train movement into the stretch, an intermediate signal location having a signal for governing train movement in one direction, driven code transmitting means at each end of said stretch for transmitting driven code pulses over the rails toward the opposite end to govern the indications of the entering signal at that end and at times to govern said intermediate signal, manually governable means for selectively causing the operation of said driven code transmitting means at one end or the other of said stretch, directional control means at said intermediate signal location actuated to either of two distinctive conditions depending upon the direction of driven code initially received at said intermediate signal location, inverse code transmitting means at each end of said stretch and at each side of said intermediate signal location, said inverse code transmitting means at the ends of the stretch being rendered effective when that end of the stretch receives a driven code to apply inverse code pulses across the rails to control inverse code receiving means at said intermediate signal location, said inverse code transmitting means at said intermediate signal location being controlled by said directional control means subject to the reception of an inverse code to transmit inverse code pulses toward that end only of said stretch at which said driven code transmitting means is in operation, and means at said intermediate signal location responsive to the continued reception of a driven code at that location for preventing the reception of an inverse code from affecting said directional control means after it has initially responded to a driven code.

41. In a coded track circuit centralized traffic controlling system of the character described, a track layout remote from a control office comprising a main stretch of track with a passing siding around such stretch and entering signals at the ends of the siding for governing traffic into the stretch, the signals adjacent each end of the siding constituting a field station; a track circuit code transmitter for each end of said stretch effective when initiated to transmit driven code pulses over the rails to the opposite end of said stretch; a normally-at-rest code type communication system connecting the control office with each of the field stations and operable through cycles of operation to transmit different series of distinctive impulses to said field stations from the control office; a manually operable signal control lever in the control office for each of said entering signals effective to initiate said communication system into operation and to select the distinctive impulses of a signal clearing code for the entering signal at its corresponding field station; de-coding means at each field station controlled over said communication system and effective to register each distinctive impulse during a cycle of operation; circuit means at each field station effective only at the end of a cycle of operation when a signal clearing code for the entering signal at its station is registered by said decoding means to actuate a signal clearing relay but being effective at the end of a cycle of operation when a signal clearing code for the entering signal at the field station at the opposite end of the siding is registered by said de-coding means to initiate the track circuit code transmitter at its end of the stretch to transmit driven code pulses over the rails of the stretch toward the opposite end; and signal control means at each end of the siding controlled by said signal clearing relay and the reception of driven code pulses over the rails from the opposite end of said stretch for clearing said entering signal at its end.

42. In a coded track circuit centralized traffic controlling system of the character described for a track layout comprising right and left signals for governing traffic in both directions at the ends of one or more sidings connected by stretches of single track; a driven code transmitting means at each end of each stretch effective when initiated to transmit driven code pulses over the rails of that stretch toward the opposite end; a normally-at-rest code type communication system connecting the control office with each of the field stations operable through cycles of operation to transmit different series of distinctive impulses to said field stations from the control office; a manually operable signal control lever in the control office for the signals at each of the field stations effective to initiate said communication sys-

tem into operation and to select the distinctive impulses of a signal clearing code for the right or left signal at its corresponding field station; decoding means at each field station controlled over said communication system and effective to register each distinctive impulse during a cycle of operation; circuit means at each field station controlled by said decoding means and effective only at the end of a cycle of operation when a signal clearing code for the right or left signal at its station is registered by said decoding means to actuate corresponding right or left signal clearing relay, but being effective at the end of a cycle of operation comprising a signal clearing code for a signal at the opposite end of a stretch on either side of its field station governing traffic toward its field station to initiate the driven code transmitting means for that stretch to transmit driven code pulses over the rails toward the opposite end of such stretch, and signal control means at each field station controlled by said right and left signal clearing relays for clearing their respective signals one at a time providing driven code pulses are received over the rails of the stretch in advance of the respective signal.

43. In a block signalling system of the character described for a stretch of single track between passing sidings divided into blocks and having a signal at the entrance to each block, coding means normally acting while the stretch is not occupied and a given direction of traffic has been established for transmitting driven code pulses over the track rails of the several blocks in one direction and normal inverse code pulses in the opposite direction, said coding means being responsive to the entrance of a train into said stretch to stop transmission of the normal inverse code pulses in the blocks ahead of such train, and means manually controlled from the distant control point for governing said coding means to reverse the established direction of traffic, said manually controlled means being effective only if said stretch is not occupied and normal inverse code pulses are being received at one end of the stretch.

44. In a coded track circuit block signalling system for a stretch of single track divided into a plurality of blocks and having signals at the entrance end of each block, coding means including code transmitting means and code responsive means normally acting while said stretch is not occupied and a given direction of traffic has been established for transmitting over the track rails of the several blocks driven code pulses for clearing the signals for train movement in the established direction of traffic, means for the ends of said stretch manually controlled from a distant control office for reversing the established direction of traffic, and means located adjacent the ends of said stretch and governed over the track rails of said blocks for rendering said manually controlled means ineffective to reverse an established direction of traffic while said stretch is occupied by a train.

45. In a coded track circuit signalling system for single track railroads having a passing siding with a power operated switch at each end, an entering signal at each end of said siding governing train movement over the corresponding switch in the reverse or normal position into said siding or the siding section opposite said siding respectvely; manually controlled means for governing the position of each switch and the clearing of the associated entering signal, means for normally transmitting driven code pulses over the siding section in one direction and inverse code pulses in the opposite direction; and means effective, when manual control to clear either entering signal is exercised but only if the corresponding switch is governed to assume the normal position, for stopping the transmission of driven code or inverse code respectively towards the opposite end of said siding section.

46. In a coded track circuit signalling system for a siding section opposite a passing siding having a power operated switch at each end, an entering signal at each end of said siding section for governing train movement into that section, code transmitting means for each end of said siding section, signal control means manually controlled from a distant control office for selectively conditioning said signals to clear and for determining the direction of coding in said siding section by said code transmitting means so as to provide driven code pulses in a direction to clear said selected signal, switch control means for each switch manually controlled from said control office to a normal or reverse position, and means for rendering each of said signal control means ineffective to change the direction of driven code transmission in the said siding section if the associated switch control means is in the reverse position.

47. In a coded track circuit signalling system for a main track siding section opposite a passing siding and having a track switch at each end, a signal for governing train movement into said siding section at each end, code transmitting means for each end of said siding section for at times transmitting a driven code toward the opposite end, switch position control means for each switch manually governed to a reverse or normal position from a distant control office, and signal control means for each signal selectively controlled manually from said control office for conditioning that signal to clear and for rendering the associated code transmitting means ineffective only if the associated switch position control means is governed to the normal position.

48. In a coded track circuit signalling system for a siding section on a single track railroad having a power operated track switch at each end, an entering signal governing train movement into said siding section at each end, code transmitting means for each end of said siding section for at times transmitting a driven code toward the opposite end, signal control means manually controlled from a distant control office for conditioning either selected signal to clear and for also rendering the associated code transmitting means ineffective to transmit a driven code, and switch control means for each switch manually governed from said control office to cause operation of that switch to the normal or reverse position, said siwtch control means rendering the associated signal control means ineffective to stop transmission of driven code from the corresponding end of the siding section if said switch is controlled to the reverse position.

49. In a coded track circuit signal system for single track railroads, the combination with a main track siding section adjacent the passing siding and having a power-operated track switch at each end, an entering signal at each end of said siding section for governing train movement into that section, code control means manually controlled from a distant control office for causing transmission of a driven code over the track rails of said siding section in one direction or the other for clearing a selected one of said sig-

nals, and switch control means for each of said switches manually controlled from said control office for governing the operation of that switch to the normal or reverse position, said switch control means rendering said code control means ineffective to stop transmission of driven code away from the corresponding end of said siding section if said switch is governed to assume the reverse position.

50. In a centralized traffic control system of the character described for a track layout remote from a control office and having a stretch of single track extending between passing sidings, signals at the ends of such stretch of track for governing traffic in both directions into the stretch, the signals located adjacent each siding constituting a field station; a track circuit code transmitter and a track circuit code receiver at each end of the stretch effective when initiated to communicate driven track circuit code pulses over the rails in one direction or the other through the stretch; a normally-at-rest code communication system connecting the control office and each of the field stations operable when initiated to transmit a particular code consisting of a series of impulses characteristic of a preselected field station and a preselected signalling direction for clearing a signal at that station for governing traffic into the stretch, and also characteristic to render active the track circuit code transmitter adjacent the field station at the opposite end of that stretch of track; and code responsive means at each end of said stretch responsive to said particular code and constituting part of said communicating system, one code responsive means of which when rendered active clearing the signal for governing the movement of traffic into said stretch at one end dependent upon the reception of a driven code over the rails of the stretch, and the other of said code responsive means when rendered active initiating said track circuit code transmitter at the exit end of the stretch to transmit a driven code over the rails toward the other end of said stretch.

51. In a centralized traffic control system of the character described for a main stretch of track adjacent a passing siding remote from a control office and having signals at the ends of the siding for governing traffic in both directions over the stretch of track, the location of the signal adjacent each end of the siding constituting a field station; a track circuit code transmitter at each end of the main track stretch effective when initiated to transmit a driven code over the track rails toward the opposite end of the stretch, a normally-at-rest code communication system connecting the control office with the field stations and operable when initiated to transmit different code calls to the field stations over line wires, and code receiving means at each field station responsive to said codes transmitted over the line wires of said communication system, said code responsive means at the field station at one end of the stretch being effective when rendered active by a particular code call to initiate the associated track circuit code transmitter, said code responsive means at the field station at the other end of the stretch being effective when rendered active by said particular code call to clear an associated signal dependent upon the reception of driven code over the rails of said stretch and also being effective when rendered active by a different code call to initiate the associated track circuit code transmitter, and said code responsive means at said field station at said one end of said stretch being effective when rendered active by said different code call to clear the associated signal dependent upon the reception of driven code over the rails of said stretch from said other end.

52. In a coded track circuit block signalling system for a stretch of single track divided into a plurality of blocks and having signals at the entrance ends of each block, coding means including code transmitting means and code receiving means normally acting while said stretch is unoccupied and a given direction of traffic has been established for transmitting driven code pulses over the track rails of the several blocks for clearing the signals for train movement in the established direction of traffic, means for the ends of said stretch manually controlled from a distant control office for reversing the established direction of traffic, means governed over the track rails of said blocks for rendering said manually controlled means ineffective to reverse an established direction of traffic while said stretch is occupied by a train, and other means including a time element device for at times rendering said manually controlled means ineffective to reverse an established direction of traffic for a predetermined time after a cleared signal has been restored to stop.

53. In a coded track circuit signalling system for single track railroads, a stretch of single track between two passing sidings, a power operated track switch at the entrance to each siding, headblock signals at each end of the stretch governing traffic over the power operated track switch and into the stretch from its end, manually operable means for governing the power operation of each switch, coding means including code transmitting means and code receiving means normally acting while said stretch is not occupied and a given direction of traffic has been established for transmitting over the track rails of the stretch code pulses for clearing the signals for train movement in the established direction of traffic, means for the ends of said stretch manually controlled from a distant control office for reversing the established direction of traffic, means governed over the track rails of said stretch to prevent a change in the established direction of traffic while said stretch is occupied by a train, and time locking means for at times preventing manual governing of said power operated switch and also a change in an established direction of traffic for a predetermined time after a headlock signal has been restored to stop from a clear condition.

THOMAS J. JUDGE.