July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 1

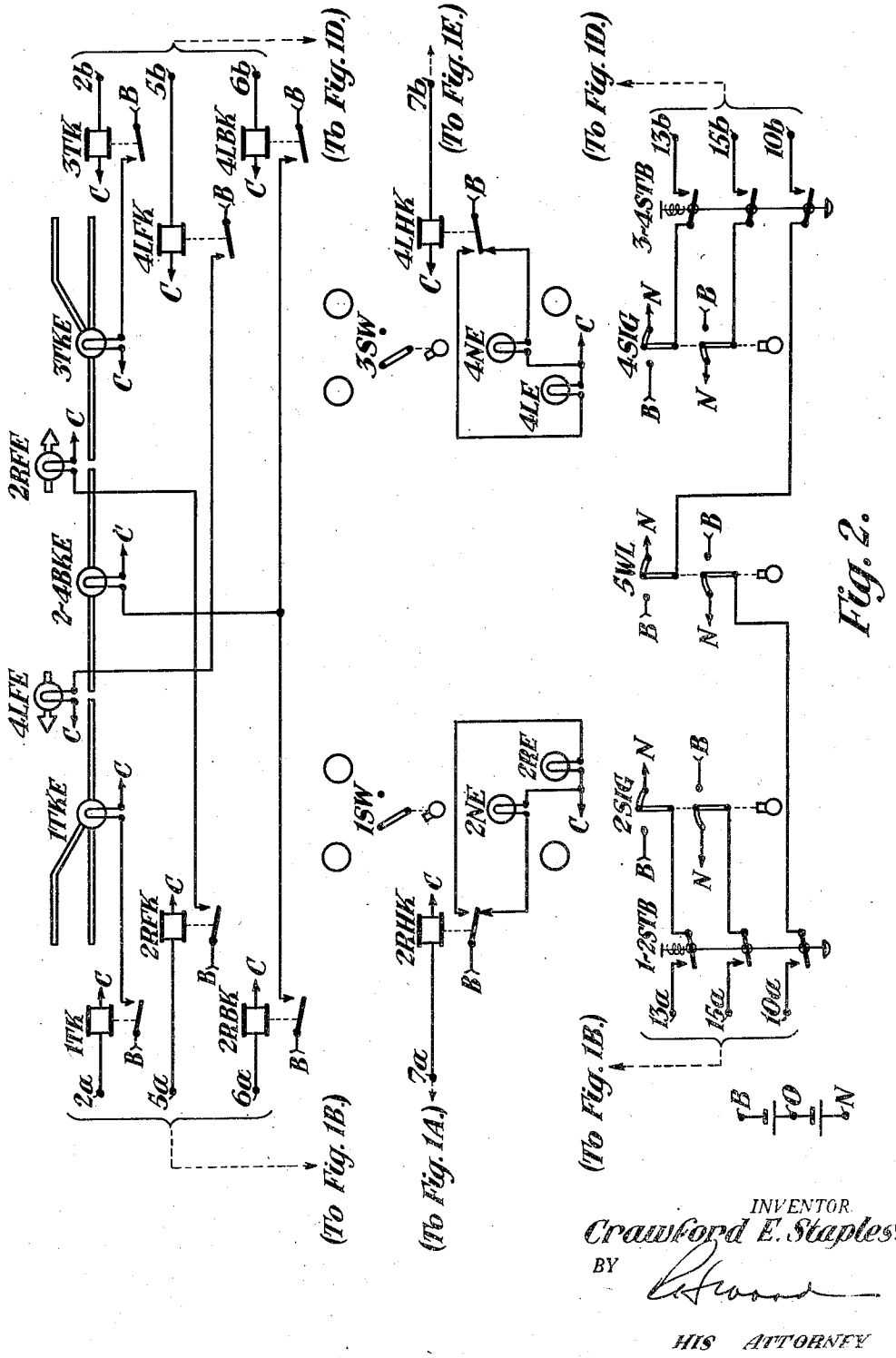


Fig. 2.

INVENTOR.
Crawford E. Staples.
BY

HIS ATTORNEY

July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 2

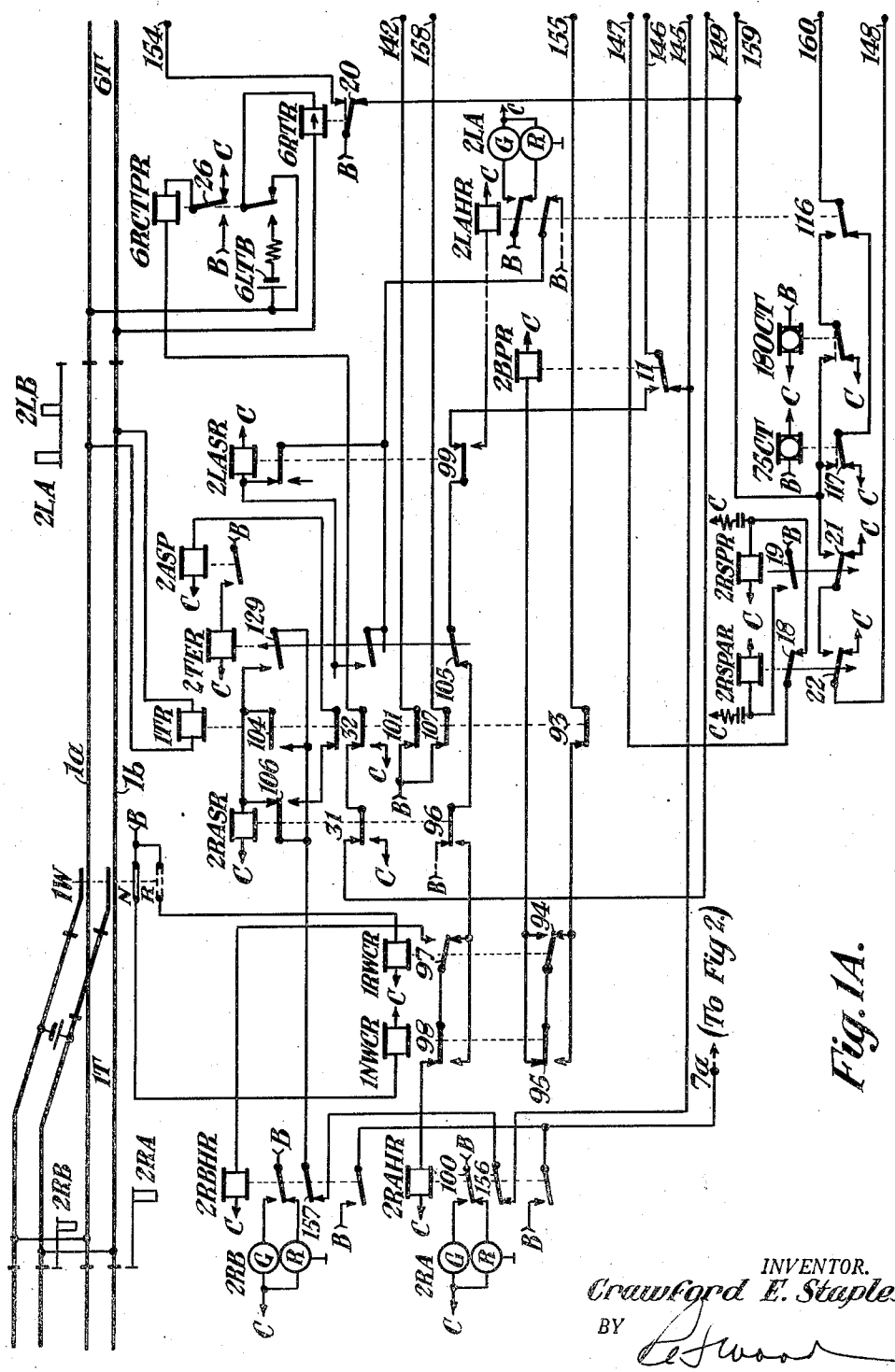


Fig. 1A.

INVENTOR.
Crawford E. Staples.
BY

HIS ATTORNEY

July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 3

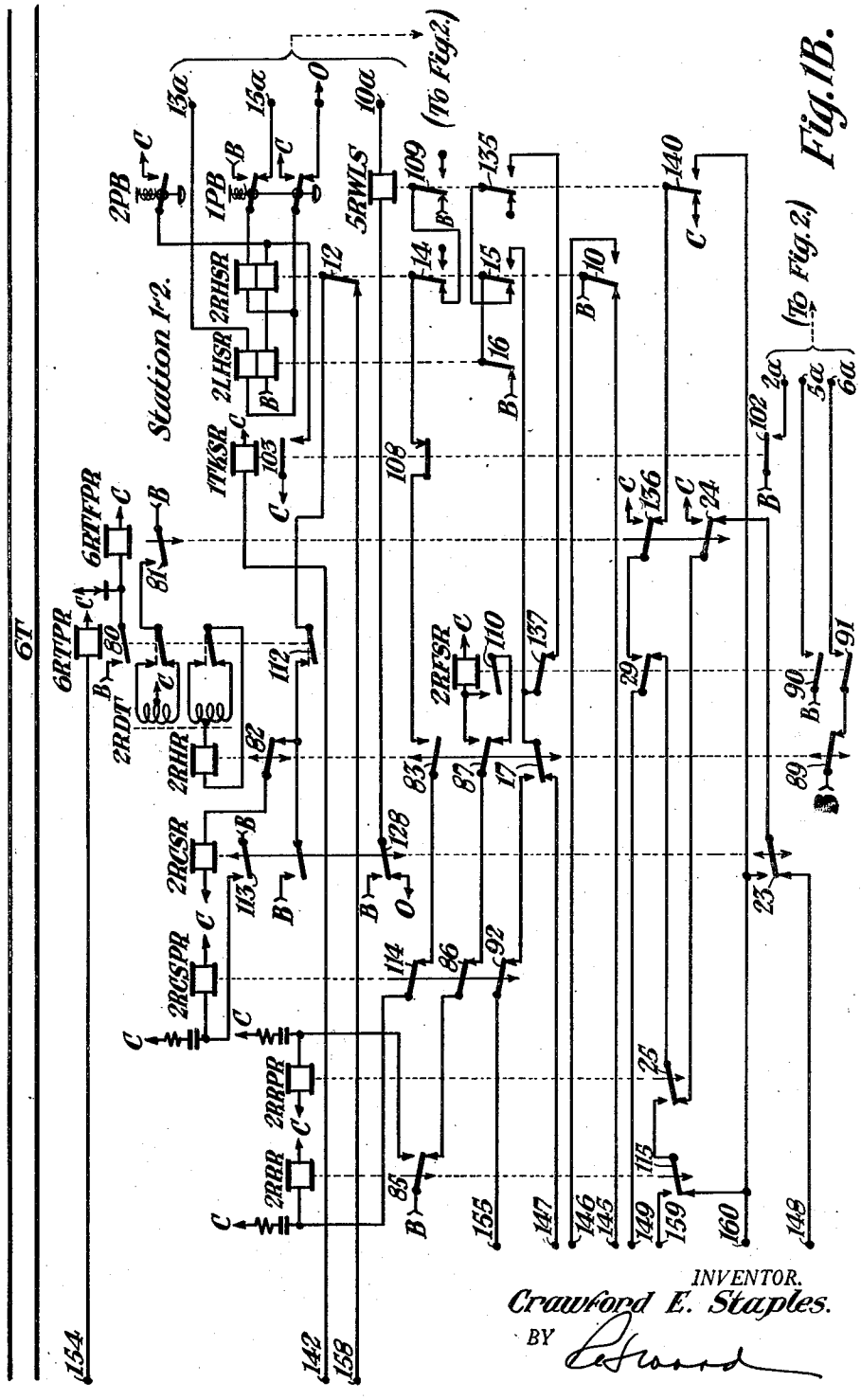


Fig. 1B.

INVENTOR.
Crawford E. Staples.
BY

HIS ATTORNEY

July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 4

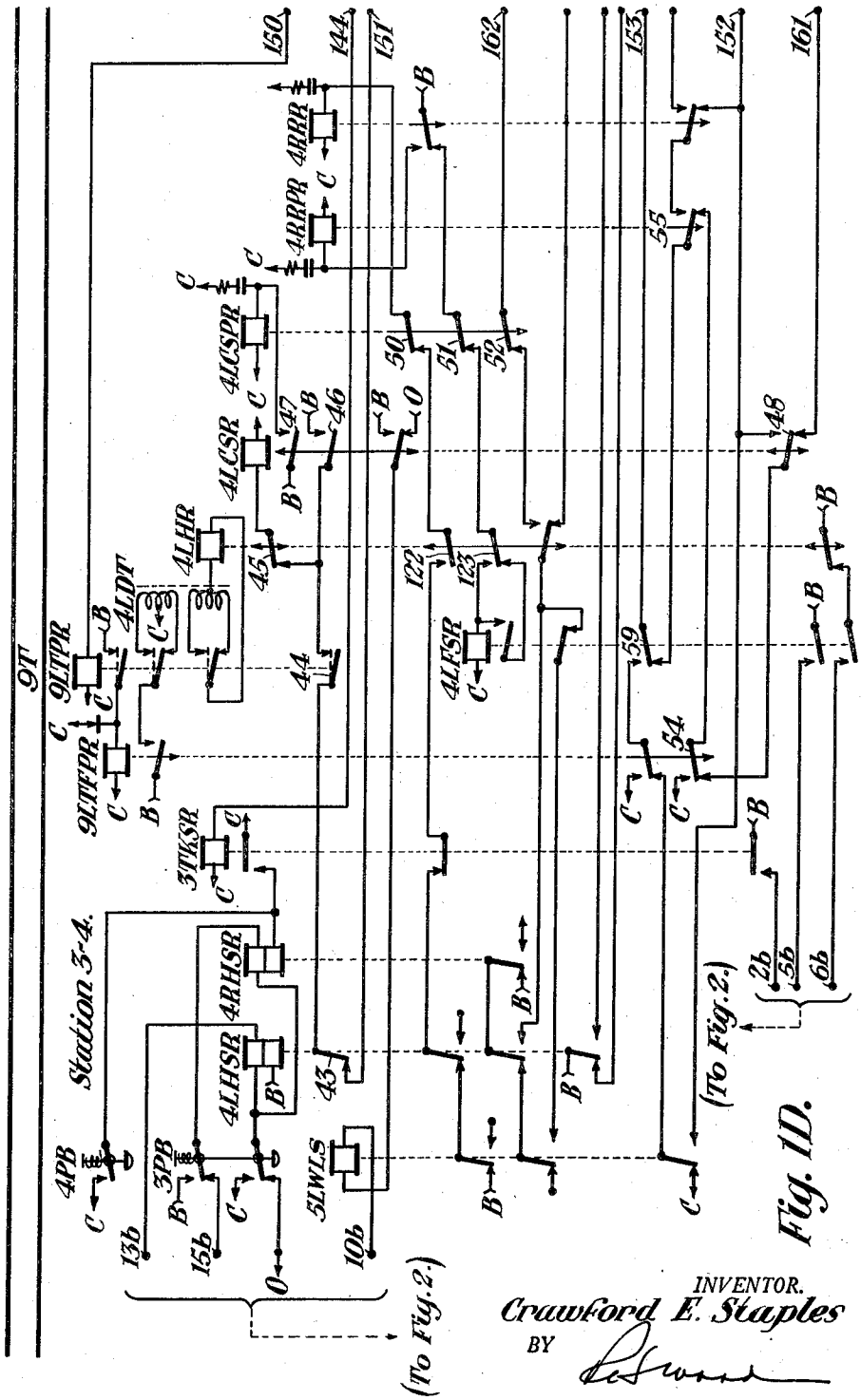


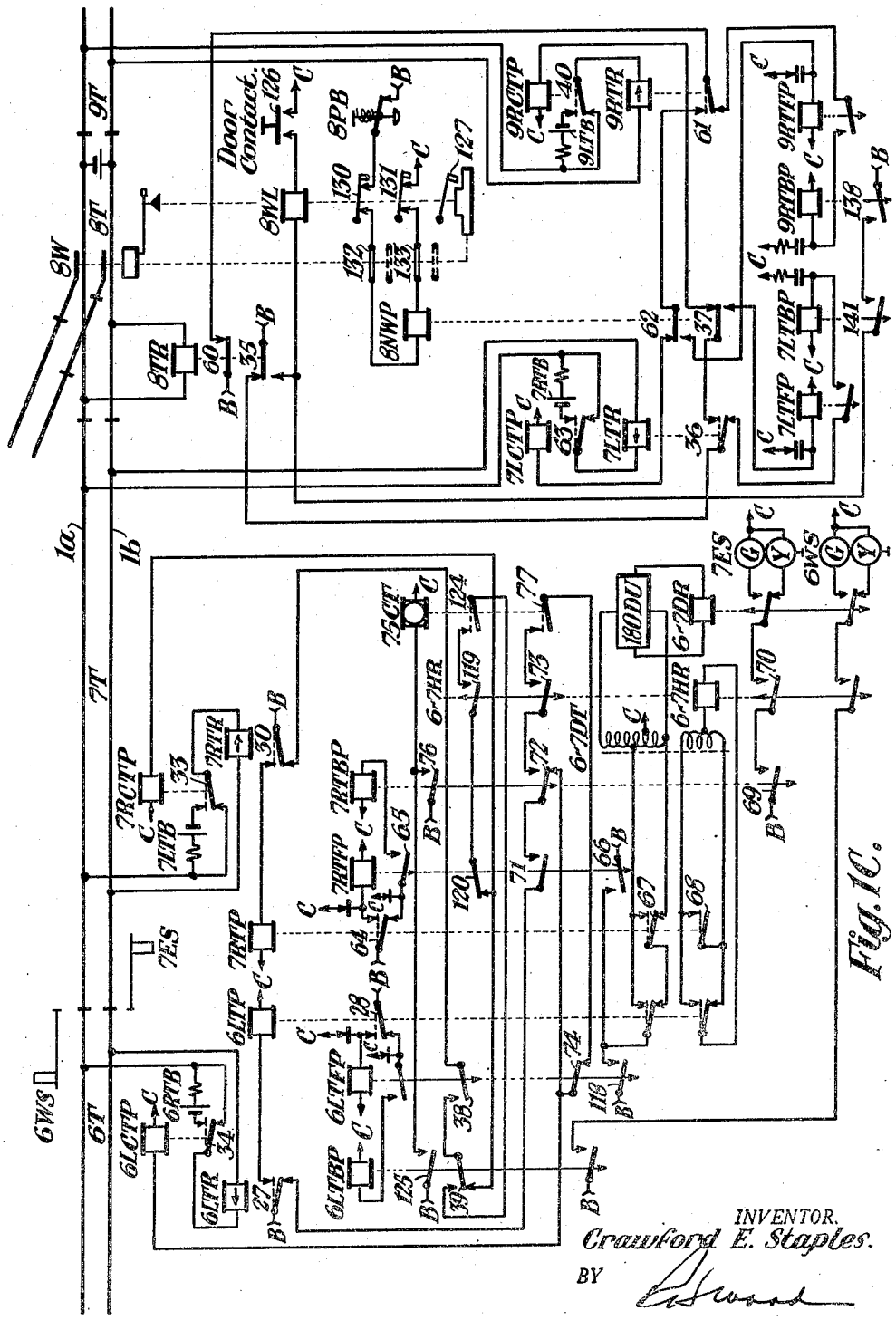
Fig. 1D.

INVENTOR.
Crawford E. Staples
BY
HIS ATTORNEY

July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 5



INVENTOR.
Crawford E. Staples.
BY
HIS ATTORNEY

July 24, 1951 C. E. STAPLES 2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Filed April 6, 1948 6 Sheets-Sheet 6

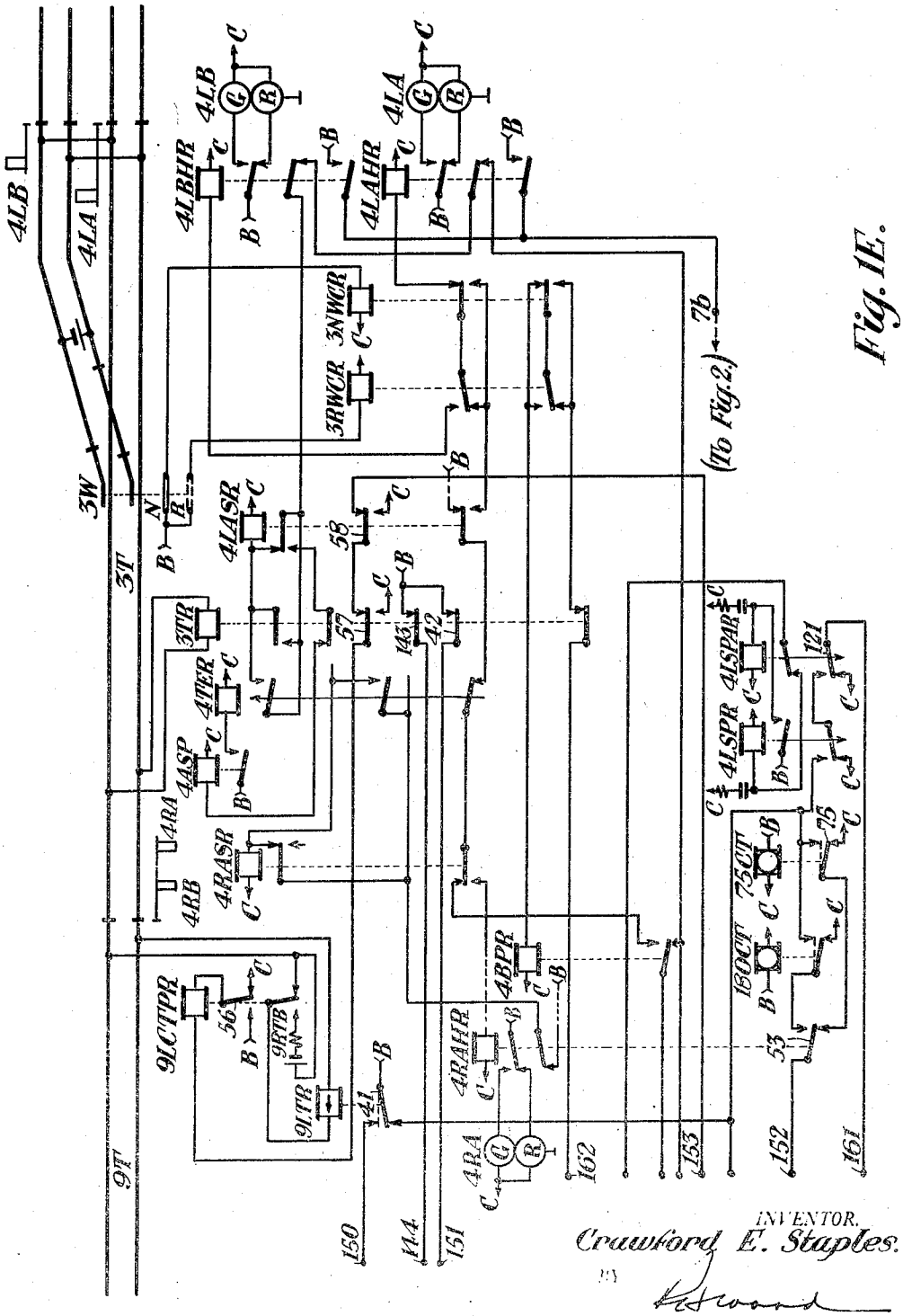


Fig. 1E.

INVENTOR.
Crawford E. Staples.
BY
HIS ATTORNEY

Patented July 24, 1951 2,561,956

UNITED STATES PATENT OFFICE

2,561,956

NORMALLY DEENERGIZED CODED TRACK CIRCUIT SIGNALING SYSTEM

Crawford E. Staples, Pittsburgh, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application April 6, 1948, Serial No. 19,366

8 Claims. (Cl. 246—3)

1

My invention relates to a centralized traffic control system for railroads embodying a block signaling system of the reversible coded track circuit type.

In Letters Patent of the United States No. 2,353,421, granted to me on July 11, 1944, which patent was reissued as No. Re. 22,931 on November 4, 1947, there is shown a normally deenergized coded track circuit signaling system for single track railroads. The system of this patent is adapted to be governed manually from a remote control office, and is arranged so that when a control for clearing the signal governing entrance of traffic into the stretch at either end is exercised, an impulse of actuating energy is supplied to the rails of the stretch at the end at which the signal is located. This impulse is repeated or cascaded to the opposite end where it operates a code sending relay to cause coded track circuit energy to be supplied over the rails of the stretch toward the signal which is to be cleared. In addition, the system of my patent is arranged so that when the coded track circuit equipment is operating and the head block signal for the corresponding traffic direction is held at stop, feed-back code is supplied to the entrance end of the stretch, and, when the stretch is vacated, is cascaded or repeated to the exit end of the stretch where it restores the code sending relay to normal to discontinue the supply of coded energy to the stretch and thereby restore the coded track circuit equipment to its normally deenergized condition.

An object of this invention is to provide an improved system of the type described in my patent, which is suitable for use with track circuits of much greater length and of more variable characteristics. Although the present system uses the same code frequencies of 75 and 180 impulses per minute as heretofore, the 180 code is used to but a limited extent and only the lower code frequency of 75 impulses per minute is used in the longer intermediate track circuits and for the control of the head block signals.

The principal feature of the present invention is the provision of improved actuating and restoring means not requiring the use of feed-back impulses, which being relatively short, are more subject to distortion and cannot be reliably transmitted over track circuits of the length contemplated.

The improved actuating means provided in accordance with the present invention comprises a pair of actuating relays at each end of the stretch, which are set into operation by the

2

manual control of the associated signal control relay to its signal clearing position, to supply to the rails a code of very low frequency impulses, each of which is substantially longer than any impulse of a signal control code. Each code sending relay, the operation of which initiates the operation of the system, is of the slow pick-up type, and is arranged so that it assumes its energized position when the associated track relay is energized by an actuating impulse but not when such relay is operated by signal control code impulses. The code detecting relay governed by the same track relay does not respond to an actuating code but only to a signal control code requiring a plurality of movements of the contacts of the track relay within a predetermined time interval to cause it to assume its energized position. The actuating means is also arranged so that if the first impulse of actuating energy supplied to an end of the stretch does not initiate operation of the coded track circuit equipment, other impulses of actuating energy will be supplied to the stretch at suitable intervals until operation of the coded track circuit equipment is initiated or until the control for clearing the head block signal is cancelled. In addition, the actuating code is arranged so that the intervals between the impulses of actuating energy supplied to an end of the stretch are long enough to permit coded energy to be cascaded throughout the stretch to thereby indicate whether one actuating impulse has been effective before another is supplied to the stretch.

The improved restoring means provided in accordance with the present invention operates by supplying a distinctive restoring code of widely spaced long impulses of current, each followed by a plurality of 75 codes impulses, to the rails of the stretch at the entrance end. This restoring means is set into operation, like the feed-back apparatus of my patent, by the reception of coded signaling current from the exit end of the stretch at a time when the entrance end signal control relay is in its normal position. However, the track circuit apparatus of the present case differs from that of the patent in that it is not adapted to transmit impulses over the rails concurrently in two directions, but on the contrary, it is so arranged that the energization of any track relay during an interval between impulses supplied to the rails of its section by the associated transmitter stops its further operation. Due to this arrangement, the long impulse transmitted by the restoring means of my invention is able to override the signal control code and to reverse

the direction of code transmission over the rails of the stretch, this code therefore being effective to operate the code detecting relay at the exit end of the stretch and thereby release the operated code sending relay.

A feature of the present invention is the provision of a slow acting repeater relay for the code sending relay at each end of the stretch, which functions in such a manner as to prevent the associated code detecting relay from causing an undesired operation of either the signal or the restoring means at that end of the stretch, as long as the adjacent code sending relay is energized and for a substantial time interval following its release.

Since only low frequency impulses are used it will be evident that the means for restoring the coded track circuit equipment to its normally deenergized condition operates in such manner that it does not limit or reduce the length of the track sections which may be employed in a track stretch equipped with this signaling system.

Another object of the invention is to provide a system of the type described which is arranged so that the means for restoring the coded track circuit equipment to its normal deenergized condition is positive in operation so that it is certain to operate when its operation is required, and so it will not operate to deenergize the coded track circuit apparatus improperly.

A further object of the invention is to provide a system of the type described which incorporates improved means for governing indication means at a central control office for indicating occupancy of the track stretch.

This feature of my invention includes the provision of an indication control relay at each end of the stretch which is picked up by the associated code detecting relay when the stretch is prepared for traffic in the corresponding direction, and which is released upon the operation of the associated restoring means to discontinue the operation of the stretch. When picked up, the indication control relay enables the associated code detecting relay to govern a block indicator at the central office to indicate block occupancy, in such manner that the indicator is controllable only when the system is active and then only from the entrance end for the direction established.

Another object of the invention is to provide a system of the type described and incorporating improved means for governing electric locks on hand-throw switches at intermediate points in a track stretch.

Figs. 1A, 1B, 1C, 1D and 1E, when placed together in the order named with Fig. 1A at the left are a diagram of a stretch of single track railway equipped with signaling apparatus embodying my invention, and

Fig. 2 shows the apparatus at the control office employed in connection with the system shown in Figs.1A to 1E, inclusive.

In practicing my invention I provide each track section in a single track stretch with two sets of coded track circuit apparatus, one for each direction of traffic.

Each set of this apparatus comprises a transmitter relay such as the relay 6LCTP, Fig. 1C, which is adapted to supply energy to the rails of its section and to periodically interrupt such energy at a selected code rate such as 75 or 180 times per minute, for signal control purposes, together with a code following track relay at the opposite end of the section, such as the relay 6RTR, Fig. 1A. Each track relay at a signal location is provided with a code following repeater such as the relay 6RTPR, Fig. 1B, which responds to the pulses of signal control energy repeated by the track relay and governs a code detecting relay such as relay 2RHR by means of which the head block signals 2RA and 2RB are controlled in accordance with traffic conditions in the single track stretch. Each code detecting relay is energized in a conventional manner by rectified pulses supplied through a decoding transformer such as 2RDT, which is supplied with energy by a slow release repeater relay 6RTFPR of the code following repeater of the track relay. As shown, the head block signals indicate proceed or stop, and require control by 75 code only, but each signal in the rear of a high speed signal, such as the signal 7ES or 6WS, Fig. 1C, serves as a distant signal therefor and is arranged to indicate proceed only when the signal in advance indicates proceed or caution. For this purpose 180 code is supplied to the rails of the section which energizes a second code detecting relay such as the relay 6—7DR, Fig. 1C, which relay is controlled through a resonant decoding unit 180DU so as to respond to 180 code only. At each end of the stretch I provide actuating impulse generating means of a novel type for setting the coded track circuit system into operation by "entrance end" control, embodied in the actuating relays 2RSPR and 2RSPAR, in Fig. 1A, and in the similar relays 4LSPR and 4LSPAR, in Fig. 1E, which is rendered active on operation of the adjacent signal control relay 2RHSR or 4LHSR to its reverse position for the purpose of clearing the head block signal at the corresponding end of the stretch. Each actuating impulse generating means, when rendered active, governs the associated transmitter relay to cause energy to be supplied to the rails of the stretch for a relatively long period and to thereafter discontinue the supply of energy to the rails of the stretch for a similar period after which the cycle is repeated indefinitely unless coded energy is received over the stretch to show that an actuating impulse has been effective, or the signal control relay is restored showing that the operator no longer wishes to clear the head block signal. These impulses thus constitute an "actuating code" in which the impulses recur at a relatively slow rate such as five cycles per minute. The coded track circuit equipment is arranged so that on the supply of an impulse of actuating energy to an end of the stretch it is repeated or cascaded to the opposite end of the stretch where it causes the track relay to operate a code sending relay 4LCSR, in Fig. 1D, or 2RCSR, in Fig. 1B, the energization of which sets the adjacent transmitter relay into operation at the 75 or 180 code rate to cause coded energy to be supplied to the track stretch, whereupon the coded track circuit apparatus for the successive sections becomes energized in cascade to clear the head block signal at the other end of the stretch.

When a train enters the stretch, the head block signal is put to stop and the control relay therefore is restored to normal, and, when the coded track circuit equipment shows that the stretch has been vacated, the equipment at the entrance end of the stretch operates restoring means of a novel type at the entrance end, embodied in the restoring relays 2RRR and 2RRPR, in Fig. 1B, and in the similar relays 4RRR and 4RRPR, in Fig. 1D, which serve to supply to the rails of the stretch deenergizing current which is cascaded or repeated to the exit end of the stretch where it restores the code sending relay to normal to cut

off the supply of coded energy to the stretch. The deenergizing current comprises a long impulse of steady energy which is supplied at the entrance end of the stretch and over-rides or feeds through the coded energy supplied from the exit end of the stretch and cuts off the supply of this coded energy. The long impulse of steady energy supplied to the entrance end of the stretch by the restoring means is followed by a short period of coded energy which is cascaded or repeated throughout the stretch and restores the code sending relay to normal so that the coded track circuit equipment is restored to its normally deenergized condition when the coded energy portion of the deenergizing current ceases.

The equipment at each end of the stretch includes an indication control relay 2RFSR or 4LFSR which is operated when the stretch is prepared for traffic and controls the transmission of indication codes to the office to show that the stretch has been prepared for traffic and to also show whether the stretch is occupied.

The equipment at each end of the stretch also includes means governed by a switch lock control relay RWLS or 5LWLS for converting an end from an entrance to an exit end to govern the release of locks on hand-throw switches at intermediate points in the stretch and to also govern the indication control means.

Referring to Fig. 2 of the drawings there is shown therein an illuminated diagram of the stretch of track shown in Figs. 1A to 1E, together with two panels of the control machine at the office, which panels are operatively associated with two field stations identified as station 1—2, in Fib. 1B, and stations 3—4, in Fig. 1D, located at opposite ends of the single track stretch equipped with the signaling apparatus provided by this invention.

It is to be understood that the office and field stations are connected over a pair of line wires, not shown, by a code communication system which may be of the type shown in Letters Patent of the United States No. 2,229,249, issued January 21, 1941, to Lloyd V. Lewis, or in Letters Patent of the United States No. 2,411,375, issued November 19, 1946, to Arthur P. Jackel and described in Manual 506A of The Union Switch and Signal Company.

Consideration of the detailed mode of operation of the code communication system is not needed for an understanding of this invention and it is deemed sufficient to point out that a field station is provided at each end of each track stretch to be controlled and that coding units are provided at the office and at each field station and are connected by a pair of line wires, not shown, over which control codes are transmitted at times from the office to a selected field station, as the result of pressing a starting button 1—2STB or 3—4STB on the corresponding panel, and that at other times indication codes are transmitted over the same line wires from the different field stations to the office without interference. Transmission of each code includes the temporary establishment of a plurality of communication channels, such for example, as seven, between the office and a station to position a group of relays.

Each code includes a distinctive code call by means of which one station only is selected to effect temporary establishment of seven communication channels between the office and the station. The different stations have different code calls, consequently the different stations, or the different panels on the office machine, are not selected at the same time, and the same channels provide communication at different times with all of the stations.

The explanation of this invention requires only five channels employed in the transmission of control codes and four channels employed in the transmission of indication codes, and in order to simplify the disclosure, these channels are illustrated herein as separate direct wire circuits extending between the office and the field stations, with normally open contacts of the starting buttons included in the control channels, and the other channels and related apparatus have not been shown.

The office and field stations are each provided with a suitable source of direct current such as a storage battery, not shown, the terminals of which are designated B and C in the drawings.

To illustrate the operation of the signal and switch lock control relays at the stations by control code pulses of reversible polarity, a second source of current is shown in Fig. 2, having a position terminal B, a center terminal O, and a negative terminal N.

Referring to Figs. 1A to 1E of the drawings, there is shown therein a stretch of single track railroad between the ends of two passing sidings. It is assumed that the track switches 1W and 3W at the ends of the passing sidings are power operated in the usual manner by switch machines under the control of the operator through the C.T.C. system. This control is carried out by the operation of the switch levers 1SW and 3SW of Fig. 2, which govern switch control relays at the field stations, not shown here. Each of the switches 1W and 3W is provided with normal and reverse switch indication relays NWCR and RWCR, shown in Figs. 1A and 1E, and the circuits of these indication relays are governed by a contact which is controlled in accordance with the position of the associated switch so that the contact establishes the circuit of one of the indication relays when and only when the switch is in the corresponding normal or reverse position and is locked in that position.

Entrance of traffic moving from left to right, that is, eastbound, into the stretch, is governed by the head block signals 2RA and 2RB, while entrance of traffic moving from right to left, that is, westbound, into the stretch is governed by the head block signals 4LA and 4LB. Movement of eastbound and westbound traffic through the track stretch is governed by the intermediate signals 7ES and 6WS. The signals may be of any suitable type and are here shown as being of the color light type. Each of the head block signals is capable of displaying either a red or stop indication or a green or proceed indication, while each of the intermediate signals is capable of displaying either a yellow or caution indication or a green or clear indication. As shown, the head block signals are continuously lighted, while the lamps of the intermediate signals are controlled so that when the track stretch is prepared for traffic the lamps of the intermediate signal for the corresponding traffic direction are lighted. Although the head block signal lamps are shown as being continuously lighted, it should be understood that the lamp circuits may be governed in any manner well known in the art so that the lamps of a signal are lighted only on the approach of a train.

At each siding end there is a detector track section each of which includes the associated

track switch, and each of which is provided with a track circuit employing steady energy and including a track relay TR.

The track rails 1*a* and 1*b* of the single track stretch are divided into a plurality of track sections. As shown, these include a section 6T which extends from the detector track section 1T at the left-hand or west end of the stretch to the intermediate signals. The portion of the stretch between the intermediate signals and the detector section 3T at its right-hand end is divided into sections 7T, 8T, and 9T. The section 8T includes a hand-throw switch 8W which leads to a siding or branch track. The section 8T is usually only about 150 feet in length and is provided with a track circuit employing steady energy and including a track relay 8TR. The switch 8W is normally locked in its normal position and may be moved therefrom when and only when the switch lock 8WL is energized, while the supply of energy to the winding of the lock 8WL is governed by the track circuit apparatus of the track sections in the main track so that the switch can be unlocked only when it is safe for it to be moved.

Each of the track sections 6T, 7T, and 9T is provided with two sets of coded track circuit apparatus, one for each direction of traffic.

As shown, the equipment is in its normal condition in which the head block signals are at stop, and in which the coded track circuit apparatus for both directions of traffic is deenergized so that both intermediate signals are dark.

By reference to Figs. 1B and 1D, it will be seen that the indication control relays 2RFSR and 4LFSR at the ends of the stretch are both released and interrupt the circuits including the channel wires 5*a*, 6*a*, 5*b* and 6*b* which extend to Fig. 2, so that indication relays 2RBK, 4LBK, 2RFK and 4LFK at the office are released and extinguish the block indication lamp 2—4BKE, and also extinguish the traffic direction lamps 2RFE and 4LFE.

As the head block signals are at stop, the signal relays 2RAHR and 2RBHR in Fig. 1A, and 4LAHR and 4LBHR in Fig. 1E are released and interrupt the circuits including the wires 7*a* and 7*b* so that the signal indication relays 2RHK and 4LHK at the office are released with the result that they establish the circuits of the signal indication lamps 2NE and 4NE and interrupt the circuits of the other signal indication lamps.

In addition, the track relays 1TR and 3TR for the detector track sections are picked up and their repeater relays 1TKSR and 3TKSR are also picked up so they interrupt the circuits which include the channel wires 2*a* and 2*b* extending to Fig. 2. Accordingly, the detector section indication relays 1TK and 3TK at the office are released and extinguish the detector section indication lamps 1TKE and 3TKE.

To simplify the drawings, the circuit for relay 1TKSR as shown includes only contact 101 of relay 1TR and wire 142, and the circuit for relay 3TKSR includes only contact 143 of relay 3TR and wire 144, but it is to be understood that the relays TKSR are storage relays which may be arranged like relay TKS of the Jackel patent so that when released, they remain released even though the associated track relay becomes energized until a code is transmitted for energizing the associated indication relay TK.

If the operator wishes to prepare the stretch for traffic in either direction, he may do so by positioning the signal lever for the signal at the corresponding entrance end of the stretch and transmitting a control code to clear that signal. For purposes of illustration it will be assumed that the operator desires to prepare the stretch for an eastbound train. In order to do so he moves the lever 2SIG, Fig. 2, to the right and presses the associated starting button 1—2STB to cause the C. T. C. equipment to transmit a control code to station 1—2. As lever 2SIG is in its right-hand position the operation of button 1—2STB establishes a connection from terminal B to channel 15*a* and from terminal N to channel 13*a* so that, in Fig. 1B energy is supplied to the upper winding of the polar signal control relay 2RHSR and its contacts move to their right-hand or reverse position, while the contacts of the signal control relay 2LHSR are maintained in the normal position as shown.

The circuit of the upper winding of signal control relay 2RHSR includes contacts of the push button 1PB. These contacts are biased to a position in which they connect the winding of the relay 2RHSR to the terminals of the field station unit so that the relay 2RHSR is normally governed through the C. T. C. equipment. When the push button 1PB is pressed, energy is supplied from a local source of energy to the upper winding of relay 2RHSR and is of the polarity effective to move the relay contacts to their reverse position. This provides means to reverse the relay locally in the event the C. T. C. system is not functioning.

A second push button 2PB is provided and controls the supply of energy to the lower windings of relays 2RHSR and 2LHSR so that these may be restored to normal locally if desired.

On this movement of the contacts of signal control relay 2RHSR, regardless of whether this movement is effected locally or remotely, its contact 10, Fig. 1B, interrupts the circuit including wire 145, for energizing relay 2RASR and establishes a circuit including wire 146 and back contact 11 of a block repeating relay 2BPR so relay 2RASR remains picked up and maintains its own stick circuit. Relay 2RASR is an approach locking relay which must be released to enable signal 2RA or 2RB to be cleared and must be picked up to enable switch 1W to be operated or to enable an opposing signal such as 2LA or 4LA to be cleared. Relay 2RASR releases when relay 2BPR picks up, and is picked up over a back contact 104 of the track relay 1TR when signal 2RA or 2RB is put to stop by a train entering section 1T. Relay 2RASR may also be picked up by restoring the signal control relay 2RHSR to normal when section 1T is not occupied, in which case energy is supplied from terminal B over wire 145 and back contact 106 to relay 2ASP, which picks up and energizes the time element relay 2TER. After an appropriate time interval of several minutes, relay 2TER closes its contact 129 to complete a pick up circuit for relay 2RASR.

On the movement of the contacts of relay 2RHSR to their reverse position as described above, its contact 12 interrupts the circuit of the code sending relay 2RCSR to thereby prevent picking up of the contacts of this relay on subsequent operation of the relay 6RTPR.

Furthermore, on movement of the contacts of relay 2RHSR to their reverse position, contact 14 interrupts the circuit of the restoring relay 2RRR to prevent energization of this relay on subsequent energization of the code detecting relay 2RHR.

On movement of the contacts of relay 2RHSR to their reverse position, contact 15 establishes

a circuit including normal polar contact 16 of relay 2LHSR for supplying energy over back contact 17 of relay 2RHR, wire 147 and back contact 18 of relay 2RSPAR to actuating impulse generating relay 2RSPR. Accordingly, the contacts of relay 2RSPR pick up and its contact 19 establishes the circuit of relay 2RSPAR with the result that its contacts pick up and contact 18 interrupts the circuit of relay 2RSPR. The relay 2RSPR is snubbed by a condenser which is of such size that the contacts of relay 2RSPR remain picked up for a substantial time interval, such as 6 seconds, after the supply of energy to the relay winding and to the associated condenser is interrupted. Accordingly, after relay 2RSPAR picks up, the contacts of relay 2RSPR remain picked up and maintain the circuit of the relay 2RSPAR for a considerable time interval. The relay 2RSPAR is also snubbed by a condenser which is of such size as to maintain the relay contacts picked up for approximately 6 seconds after the supply of energy to the relay winding and to the condenser is interrupted.

Accordingly, on the supply of energy to relay 2RSPR, its contacts pick up and establish the circuit of relay 2RSPAR so that its contacts pick up to interrupt the supply of energy to relay 2RSPR. Thereafter the relay 2RSPR remains picked up for approximately 6 seconds and maintains the supply of energy to relay 2RSPAR so that the release time of relay 2RSPAR does not start until relay 2RSPR releases, while the relay 2RSPAR does not release until about 6 seconds subsequent to release of relay 2RSPR.

When the relays 2RSPAR and 2RSPR are both picked up, a circuit is established for supplying energy to the transmitter relay 6RCTPR and is traced from terminal B of the local source of energy over back contact 20 of relay 6RTR, front contact 21 of relay 2RSPR, front contact 22 of relay 2RSPAR, wire 148, back contact 23 of relay 2RCSR, back contact 24 of relay 6RTFPR, back contact 25 of relay 2RRPR, back contact 29 of relay 2RFSR, wire 149, front contact 31 of relay 2RASR, and front contact 32 of relay 1TR, to the left-hand terminal of the winding of relay 6RCTPR. The relay 6RCTPR is a polar stick relay the contacts of which are moved to one position or the other depending on the polarity of the energy supplied to the relay winding and which remain in their last operated position when the supply of energy to the relay winding is interrupted. As shown, the contacts of relay 6RCTPR are in their right-hand or reverse position in which contact 26 connects the right-hand terminal of the relay winding to terminal C of the source. Accordingly, on completion of the circuit for connecting terminal B of the source to the left-hand terminal of the relay winding, energy flows through the relay winding from the left to the right-hand terminal and causes the relay contacts to move to their left-hand or normal position. On movement of contact 26 away from its reverse position, the circuit of the relay winding is interrupted but the construction of the relay is such that the relay contacts continue their movement to their normal position. When the contacts complete their movement to their normal position, the right-hand terminal of the relay winding is connected to terminal B of the source, and, since both terminals of the relay winding are connected to terminal B of the source, energy ceases to flow in the relay winding and the relay contacts remain in their normal position.

When the contacts of relay 6RCTPR are in their normal position, the track battery 6LTB is connected across the rails of section 6T in series with the winding of relay 6RTR. The relay 6RTR, as well as the other code following track relays, is of the polar biased neutral type, the contact of which picks up only in response to energy of a selected polarity, and the equipment is arranged so that the polarity of the energy supplied to the relay winding from battery 6LTB is of the wrong polarity to pick up the relay contact.

The energy supplied from battery 6LTB to the rails of section 6T feeds over back contact 34 of transmitter relay 6LCTP, Fig. 1C, to the winding of track relay 6LTR and relay 6LTR picks up its contact 27 to supply energy to the code following repeater relay 6LTP so that its contacts pick up and energy is supplied over its front contact 28 to the slow release front contact repeater relay 6LTFP.

When relay 6LTFP picks up, energy is supplied to the transmitter relay 7RCTP over the circuit which includes back contact 30 of the track relay 7RTR, front contact 38 of relay 6LTFP, and back contact 39 of a slow release relay 6LTBP so the contact of relay 7RCTP picks up and connects track battery 7LTB across the rails of section 7T in series with the winding of relay 7RTR. The energy supplied to the left-hand end of the rails of section 7T picks up the track relay 7LTR with the result that energy is supplied from terminal B over front contact 35 of the track relay 8TR, front contact 36 of relay 7LTR, and front contact 37 of a normal switch indication relay 8NWP to the transmitter relay 9RCTP and its contact 40 picks up to connect the track battery 9LTB across the rails of section 9T in series with the winding of track relay 9RTR.

The energy supplied from the battery 9LTB to the left-hand end of the rails of section 9T feeds over reverse polar contacts of the transmitter relay 9LCTPR, Fig. 1E, to the winding of the track relay 9LTR which picks up its contact 41 so that energy is supplied over wire 150 to the repeater relay 9LTPR and its contacts pick up. When the contacts of relay 9LTPR pick up, it energizes the slow release repeating relay 9LTFPR, and in addition, energy is supplied from terminal B over front contact 42 of relay 3TR, wire 151, normal polar contact 43 of the signal control relay 4LHSR, front contact 44 of relay 9LTPR, and back contact 45 of the code detecting relay 4LHR to the code sending relay 4LCSR. The relay 4LCSR is of a type the contacts of which are slow to pick up and slow to release. As hereinafter explained the supply of energy to relay 4LCSR is maintained for a substantial time interval so the relay contacts pick up and its contact 46 establishes the relay stick circuit which includes back contact 45 of relay 4LHR. In addition, when relay 4LCSR picks up, its contact 47 establishes the circuit for the slow release repeater relay 4LCSPR and its contacts pick up. Furthermore, when relay 4LCSR picks up, a circuit is prepared over its front contact 48 for supplying coded energy to relay 9LCTPR on release of relay 9LTR.

When relay 4LCSPR picks up, its contact 50 interrupts the circuit for supplying energy to the restoring relay 4RRR so it is certain to remain released and prevent energization of relay 4RRPR, while contact 51 of relay 4LCSPR interrupts the circuit for supplying energy to the

indication control relay 4LFSR and it is certain to remain released.

Furthermore, at this time, as relay 4LCSPR is picked up, its contact 52 interrupts the circuit including wire 162 for supplying energy to the block repeating relay 4BPR and thereby insures that it remains released at this time and prevents interruption of the circuit for the approach locking relay 4LASR.

As explained above, when signal control relay 2RHSR is reversed, the relays 2RSPR and 2RSPAR, Fig. 1A, are picked up and supply energy to relay 6RCTPR to move its contacts to their normal position in which energy is supplied from the track battery 6LTB to the rails of section 6T with the result that energy is supplied to each of the other sections in the track stretch. The supply of energy from battery 6LTB to the rails of section 6T, as well as from the other track batteries to the rails of the associated sections, is maintained as long as the contacts of relay 6RCTPR remain in their left-hand or normal position. In addition, as explained above, the relay 2RSPR, when picked up, remains picked up for a substantial time interval, such as 6 seconds, and as long as relay 2RSPR is picked up the circuit for connecting terminal B of the source to the left-hand terminal of the winding of relay 6RCTPR is maintained and the contacts of relay 6RCTPR remain in their left-hand or normal position.

Accordingly, energy is supplied over the rails of the track stretch for a period substantially equal to the length of the picked-up period of relay 2RSPR, and the track relay 9LTR energizes relay 9LTPR to establish the circuit for the code sending relay 4LCSR long enough to insure that the relay contacts pick up.

After the expiration of the release time of relay 2RSPR, its contacts release with the result that contact 19 interrupts the circuit of relay 2RSPAR but, as explained above, its contacts remain picked up for a substantial time interval and its contact 18 interrupts the circuit of relay 2RSPR. In addition, on release of contact 21 of relay 2RSPR, the previously traced circuit for connecting the left-hand terminal of the winding of relay 6RCTPR to terminal B of the source is interrupted and this terminal of the winding of relay 6RCTPR is now connected to terminal C of the source. As the contacts of relay 6RCTPR are in their left-hand or normal position, contact 26 connects the right-hand terminal of the relay winding to terminal B of the source, and when the left-hand terminal of the relay winding is connected to terminal C of the source, energy flows through the relay winding in the direction to cause the relay contacts to move to their right-hand or reverse position so that contact 26 transfers the right-hand terminal of the relay winding from terminal B to terminal C of the source, thereby interrupting the flow of energy through the relay winding. However, the relay contacts, after movement to their reverse position, remain in that position.

On this movement of the contacts of relay 6RCTPR, the circuit for supplying energy from the battery 6LTB to the rails of section 6T is interrupted and the relay 6RTR is connected across the track rails.

When the supply of energy to the left-hand end of the rails of section 6T is interrupted, the relay 6LTR, Fig. 1C, releases and its contact 27 interrupts the circuit of the repeater relay 6LTP with the result that it releases and its contact 28 interrupts the circuit of the slow release relay 6LTFP. Accordingly, relay 6LTBP picks up to interrupt at back contact 39 the previously traced circuit for supplying energy to relay 7RCTP, and relay 7RCTP releases and interrupts the supply of energy from battery 7LTB to the rails of section 7T. After a short time interval, relay 6LTFP releases and its contact 38 additionally interrupts the circuit for supplying energy to the transmitter relay 7RCTP. Accordingly, the relay 7LTR releases and its contact 36 interrupts the circuit for supplying energy to relay 9RCTP and its contact 40 releases to interrupt the circuit for supplying energy from battery 9LTB to the rails of section 9T.

After release of relay 9RCTP, the relay 9LTR, Fig. 1E, releases and its contact 41 interrupts the circuit of relay 9LTPR so that its contacts release with the result that contact 44 interrupts the pick-up circuit for relay 4LCSR, but at this time the relay 4LCSR is energized by current supplied over its stick circuit so the relay contacts remain picked up after release of relay 9LTPR. In addition, on release of relay 9LTPR one of its contacts interrupts the circuit of relay 9LTFPR and it releases.

When relay 9LTR releases, a circuit is completed for supplying coded energy to the transmitter relay 9LCTPR and is traced from terminal B over back contact 41 of relay 9LTR, over front contact 75 of the code transmitter 75CT, over back contact 53 of a signal relay 4RAHR which governs the indication displayed by signal 4RA, wire 152, front contact 48 of code sending relay 4LCSR, over back contact 54 of relay 9LTFPR, over back contact 55 of relay 4RRPR, over back contact 59 of relay 4LFSR, wire 153, front contact 58 of relay 4LASR, and front contact 57 of relay 3TR, to the left-hand terminal of the winding of relay 9LCTPR, while at this time the right-hand terminal of the winding of this relay is connected over reverse polar contact 56 of the relay to terminal C of the source. Accordingly, during the picked-up periods of contact 75 of the code transmitter 75CT, energy is supplied to the relay 9LCTPR to move the relay contacts to their normal position in which the right-hand terminal of the winding of the relay is connected to terminal B of the source, thereby interrupting the supply of energy to the relay winding. On subsequent movement of contact 75 of the code transmitter 75CT to its released position, and consequent connection of the circuit leading to the left-hand terminal of the windingof relay 9LCTPR to terminal C of the source, energy is supplied to the winding of relay 9LCTPR and is of the polarity effective to move the contacts of the relay to their reverse position. It will be seen, therefore, that after release of relay 9LTR the transmitter relay 9LCTPR is governed by one of the code transmitters 75CT or 180CT, depending upon whether relay 4RAHR is released or picked up, and the contacts of relay 9LCTPR are operated between their reverse and normal positions at the rate determined by the code transmitter. On movement of the contacts of relay 9LCTPR to their left-hand or normal position, a circuit is established to connect the track battery 9RTB across the rails of section 9T in series with the winding of relay 9LTR.

On the supply of energy from battery 9RTB to the rails of section 9T, this energy feeds over back contact 40 of the transmitter relay 9RCTP to the track relay 9RTR which picks up its con-

tact 61 with the result that energy is supplied over front contact 60 of relay 8TR, front contact 61 of relay 9RTR, front contact 62 of relay 8NWP, to the transmitter relay 7LCTP and its contact 63 establishes a circuit for connecting the track battery 7RTB across the rails of section 7T in series with the track relay 7LTR.

The energy supplied from battery 7RTB to the rails of section 7T feeds over back contact 33 of relay 7RCTP to relay 7RTR, which picks up its contact 30 so that energy is supplied to the code following repeater relay 7RTP and its contact 64 established the circuit for the slow release repeater relay 7RTFP.

During the periods in which the contacts of relay 9LCTPR are in their right-hand or reverse position, the supply of energy from battery 9RTB is interrupted and the relay 9RTR releases so that contact 61 interrupts the circuit of relay 7LCTP and it releases with the result that contact 63 interrupts the circuit of battery 7RTB. Accordingly, relay 7RTR releases and contact 30 interrupts the circuit of relay 7RTP so that contact 64 releases to interrupt the circuit of relay 7RTFP and establish a circuit including front contact 65 of relay 7RTFP for supplying energy to the slow release relay 7RTBP. The relays 7RTFP and 7RTBP, as well as the corresponding similarly designated relays, are snubbed by rectifiers so as to be slow enough in releasing to remain picked up during the periods in which the supply of energy to the relay windings is interrupted. Accordingly, these relays remain picked up as long as the associated track relay is responding to coded energy.

When relay 7RTBP picks up its contact 76 establishes a circuit for energizing the code transmitter 75CT at this location.

When relay 7RTFP picks up, its contact 66 establishes the circuit governed by contact 67 of relay 7RTP for supplying energy to the primary winding of the decoding transformer 6—7DT, and on continued operation of relay 7RTP its contact 68 rectifies energy induced in a secondary winding of the transformer and supplies it to the winding of the slow release code detecting relay 6—7HR and its contacts pick up. Energy induced in a secondary winding of transformer 6—7DT as a result of operation of relay 7RTP is supplied to through a resonant decoding unit 180DU to a second code detecting relay 6—7DR but is of sufficient value to cause relay 6—7DR to pick up its contacts only when the relay 7RTP is operated by energy of 180 code frequency.

When relay 7RTBP picks up, its contact 69 in the circuit of the lamps of signal 7ES is closed so that energy is supplied over front contact 70 of relay 6—7HR to the yellow or the green lamp of this signal according as relay 6—7DR is released or picked up.

When relay 6—7HR picks up, a circuit is completed for supplying coded energy to transmitter relay 6LCTP and is traced from back contact 27 of relay 6LTR over front contact 71 of relay 7RTFP, front contact 72 of relay 7RTBP, front contact 73 of relay 6—7HR, contact 77 of the code transmitter 75CT, and back contact 74 of relay 6LTFP. Accordingly, the transmitter relay 6LCTP is operated by energy of 75 code frequency and causes energy of this frequency to be supplied from the battery 6RTB to the rails of section 6T. This energy feeds over reverse polar contacts of relay 6RCTPR to the track relay 6RTR and operates it so that during the picked-up periods of contact 20 energy is supplied to over wire 154 to the code following repeater relay 6RTPR and its contacts pick up and release with the result that energy is supplied over its front contact 80 to the slow release repeater relay 6RTFPR to pick up its contacts.

When relay 6RTFPR picks up, its contact 81 establishes the circuit governed by a contact of relay 6RTPR for supplying energy to the primary winding of the decoding transformer 2RDT so that on continued code following operation of relay 6RTPR energy is induced in the transformer secondary winding and is rectified by a contact of relay 6RTPR and supplied to the code detecting relay 2RHR to cause that relay to pick up its contacts.

In addition, when relay 6RTFPR picks up, its contact 24 disconnects the wire 149 leading from the left-hand terminal of the winding of relay 6RCTPR to wire 148 and connects wire 149 to terminal C of the source to thereby insure that the contacts of relay 6RCTPR remain in their right-hand or reverse position and maintain the circuit of relay 6RTR.

When relay 2RHR picks up, its contact 17 interrupts the previously traced circuit for supplying energy over wire 147 to the actuating impulse generating relay 2RSPR to thereby prevent picking up of the contacts of this relay on expiration of the release time of the relay 2RSPAR and consequent release of the relay contacts.

In addition, when relay 2RHR picks up, its contact 82 interrupts the pick-up circuit for the code sending relay 2RCSR and insures that this relay remains released and does not establish the circuit for its repeating relay 2RCSPR.

When relay 2RHR picks up, its contact 83 in the circuit for supplying energy to the restoring relay 2RRR is closed, but at this time the circuit is open at contact 14 of relay 2RHSR so the relay 2RRR remains released. Accordingly, when relay 2RHR picks up, energy is supplied over back contact 85 of relay 2RRR, back contact 86 of relay 2RCSPR, and front contact 87 of relay 2RHR to the indication control relay 2RFSR, and its contacts pick up. When relay 2RFSR picks up its contact 29 removes contacts 25 and 24 from the circuit over wire 149 leading from the left-hand terminal of the winding of relay 6RCTPR and connects wire 149 over front contact 136 of relay 6RTFPR to terminal C of the source to thereby insure that the contacts of relay 6RCTPR remain in their reverse position and maintain the circuit of relay 6RTR.

In addition, when relay 2RFSR picks up, its contact 90 supplies energy to the indication channel 5a to energize the traffic indication relay 2RFK, Fig. 2, and its front contact 91 connects channel 6a to contact 89 of relay 2RHR which is now open, and at the office, relay 2RFK picks up and its contact establishes an obvious circuit to light lamp 2RFE to show that the stretch has been prepared for eastbound traffic, but relay 2RBK remains released and does not establish the circuit of the block lamp 2—4BKE.

Referring again to Fig. 1B, it will be seen that when relay 2RHR picks up, its front contact 17 establishes the circuit including back contact 92 of relay 2RCSPR, wire 155, front contact 93 of track relay 1TR for the detector track section 1T, back contact 94 of relay 1RWCR, and front contact 95 of relay 1NWCR for supplying energy to the block repeating relay 2BPR so that its contact 11 picks up to interrupt the stick circuit of relay 2RASR and its contacts release. After

release of relay 2RASR energy is supplied over reverse polar contact 10 of relay 2RHSR, wire 146, front contact 11 of relay 2BPR, a front contact 99 of the approach locking relay 2LASR, a back contact 105 of a time element relay 2TER, back contact 96 of relay 2RASR, back contact 97 of relay 1RWCR, and front contact 98 of relay 1NWCR to relay 2RAHR, and its contacts pick up so that contact 100 interrupts the circuit of the red lamp of signal 2RA and establishes the circuit of the green lamp of this signal. The relay 2LASR, a contact of which is included in the circuit of relay 2RAHR, is similar to the approach locking relay 2RASR and is governed over similar circuits, not shown, so as to be picked up when and only when the signals 2LA and 2LB are at stop.

When switch 1W occupies its reverse position, relay 1RWCR is energized in place of relay 1NWCR and in this case, relay 2RBHR becomes energized to clear signal 2RB in place of signal 2RA, as will be clear from the drawing. When signal 2RA or 2RB is at clear, terminal B is connected over a front contact of relay 2RAHR or 2RBHR to the indication channel 7*a* to pick up the signal indication relay 2RHK in Fig. 2, and thereby extinguish the lamp 2NE and to light lamp 2RE to inform the operator that the signal has been cleared.

When relay 2RASR releases, its contact 31 connects the wire leading from the left-hand terminal of relay 6RCTPR to terminal C of the source to hold the contacts of relay 6RCTPR in their reverse position in which they establish the circuit of relay 6RTR.

As previously stated, when actuating impulse generating relay 2RSPR releases, its contact 19 interrupts the circuit of relay 2RSPAR and the release time of relay 2RSPAR begins. The release time of this relay is such that its contacts remain picked up for a substantial time interval, and as long as relay 2RSPAR remains picked up its contact 18 interrupts the circuit of relay 2RSPR. After the expiration of the release time of relay 2RSPAR and consequent closing of its back contact 18, energy is not supplied to relay 2RSPR if coded energy has been received over the track rails as manifested by picking up of contact 17 of relay 2RHR. Hence, if the first impulse of actuating code energy has been effective and has caused the code sending relay 4LCSR at the exit end of the stretch to be picked up and thereby cause coded signal control energy to be supplied to the exit end of the stretch so that it is cascaded to the entrance end of the stretch to pick up relay 2RHR, the circuit of relay 2RSPR is interrupted and this relay will remain released. This is proper since there is no reason for the relay to be picked up again. However, if for any reason the first impulse of actuating code energy supplied to the rails of the track stretch has not been effective, as shown by the fact that relay 2RHR is released at the expiration of the release time of relay 2RSPAR, energy will be supplied to the relay 2RSPR and its contacts will pick up to establish the circuit of relay 2RSPAR and thereby cause another impulse of actuating code energy to be supplied to the rails of the track stretch.

This second impulse of actuating code energy will be repeated or cascaded throughout the stretch to the exit end to pick up the track relay 9LTR and thus pick up the code sending relay 4LCSR to cause coded energy to be supplied to the rails of the track stretch on termination of the actuating impulse and consequent release or relay 9LTR. This coded energy will be repeated to the entrance end of the stretch to pick up the relay 2RHR and prevent subsequent supply of actuating code impulses to the entrance end of the stretch.

As long as relay 2RHSR remains reversed and the relay 2RHR remains released, the cycle of operation of the actuating impulse generating relays 2RSPR and 2RSPAR continues so that the relay 6RCTPR causes energy to be supplied to the rails of section 6T for periods which are separated by periods long enough to enable coded energy supplied at the exit end of the stretch to be cascaded throughout the stretch to the entrance end to pick up relay 2RHR and interrupt the cycle of operation of the actuating impulse generating relays.

It will be seen, therefore, that on reversal of relay 2RHSR to clear the entering signal, the actuating impulse generating relays are placed in operation to cause energy to be supplied over the track rails of the stretch from the entrance to the exit end. The cycle of operation of the actuating impulse generating relays is interrupted as soon as the relay 2RHR picks to show that further operation of these relays is unnecessary. The actuating impulse generating relays will continue to operate, however, until relay 2RHR picks up to show that their operation is no longer required. This insures that if for any reason the first actuating impulse is not repeated throughout the stretch to the exit end, subsequent actuating impulses will be supplied to the stretch until traffic is established in the desired direction or until the operator restores the relay 2RHSR to normal to show that this direction of traffic is no longer desired.

As explained above, when coded energy is received at the entrance end of the stretch if the head block signal is cleared, an indication code is sent to the office to show that the signal has been cleared and to show that traffic has been established in the desired direction .

If an eastbound train now accepts signal 2RA and enters the single track stretch, the train first enters the detector section 1T and releases track relay 1TR so that its contact 101, Fig. 1A, interrupts the circuit of relay 1TKSR and it releases with the result that its contact 102 connects terminal B to the indication channel 2*a* so that the track indication relay 1TK, Fig. 2, picks up to light lamp 1TKE in the track diagram. In addition, on release of relay 1TKSR, its contact 103 connects terminal C to the circuit which includes the lower windings of signal control relays 2LHSR and 2RHSR in series with the result that energy is supplied to the lower winding of relay 2RHSR to move the relay contacts to their normal position.

In addition, on release of relay 1TR, its contact 93, Fig. 1A, interrupts the previously traced circuit for supplying energy to relay 2BPR and this relay releases, while contact 104 of relay 1TR prepares a pick-up circuit for the approach locking relay 2RASR.

As a result of movement of the contacts of relay 2RHSR to their left-hand or normal position, and also as a result of release of contact 11 of relay 2BPR, the circuit of relay 2RAHR is interrupted and its contact 100 releases to interrupt the circuit of the green lamp of signal 2RA and to establish the circuit of the red lamp of this signal.

In addition, as a result of movement of contact

10 of relay 2RHSR to its left-hand or normal position, energy is supplied over contact 10, wire 145, back contact 156 of relay 2RAHR, back contact 157 of relay 2RBHR, back contact 104 of relay 1TR to the approach locking relay 2RASR and its contacts pick up so that contact 106 establishes the stick circuit to maintain the relay contacts picked up after section 1T is vacated and relay 1TR picks up. When relay 2RASR picks up, its back contact 96 additionally interrupts the circuit of relay 2RAHR to insure that it remains released and holds signal 2RA at stop.

When relay 1TR releases, its contact 32 connects the left-hand terminal of the winding of relay 6RCTPR to terminal C of the source and this holds the relay contacts in their reverse position.

On movement of the contacts of relay 2RHSR to their left-hand or normal position, contact 12 in the circuit leading over wire 158 to relay 2RCSR is closed, but at this time this circuit is open at contact 107 of relay 1TR so the relay 2RCSR remains released. In addition, on this movement of the contacts of relay 2RHSR, its contact 14 in the circuit of relay 2RRR is closed, but at this time this circuit is open at contact 108 of relay 1TKSR so the relay 2RRR remains released.

Furthermore, on movement of the contacts of relay 2RHSR to their normal position, contact 15 interrupts the circuit leading over wire 147 to relay 2RSPR so that energy is not supplied to this relay on subsequent release of relay 2RHR.

When the train under consideration advances into section 6T, the track relay 6RTR is shunted and remains released so that its contact 20 no longer establishes the circuit of the repeater relay 6RTPR and it releases with the result that its contact 80 interrupts the circuit of relay 6RTFPR and it releases after a short time interval. As a result of cessation of code following operation of relay 6RTPR, energy ceases to be supplied through the decoding transformer 2RDT to the relay 2RHR and its contacts release so that contact 87 interrupts the pick-up circuit of the relay 2RFSR and establishes for this relay a stick circuit which includes its own front contact 110. Hence, the contacts of relay 2RFSR remain picked up.

As a result of release of relay 2RHR its contact 83 in the circuit for supplying energy to relay 2RRR is opened and energy will not be supplied to relay 2RRR upon subsequent picking up of the contacts of relay 1TKSR. Furthermore, on release of relay 2RHR, its contact 17 interrupts the circuit including wire 155 over which energy is supplied to relay 2BPR to insure that relay 2BPR remains released. At this time back contact 17 of relay 2RHR in the circuit for supplying energy over wire 147 to relay 2RSPR is closed, but at this time this circuit is open at contact 15 of relay 2RHSR so the relay 2RSPR remains released.

As explained above, relay 2RFSR is maintained picked up at this time so its contact 90 maintains the supply of energy to the indication channel 5*a*, and relay 2RFK is picked up to maintain the circuit of lamp 2RFE. In addition, as relay 2RFSR is picked up, energy is supplied over back contact 92 of relay 2RHR and front contact 91 of relay 2RFSR to the indication channel 6*a*, and relay 2RBK picks up so that its contact establishes an obvious circuit for the lamp 2—4BKE and this lamp is lighted to show that the single track stretch is occupied.

As a result of release of relay 2RAHR the supply of energy to the indication channel 7*a* is interrupted and relay 2RHK releases to thereby extinguish the lamp 2RE and light the lamp 2NE to show that signal 2R is now at stop.

When the train vacates section 1T the track relay 1TR picks up so relay 1TKSR picks up and disconnects terminal B from the indication channel 2*a*, and relay 1TK releases and extinguishes lamp 1TKE.

When relay 1TR picks up, the wire leading from the left-hand terminal of the winding of relay 6RCTPR is connected over front contact 32 of relay 1TR, front contact 31 of relay 2RASR, wire 149, front contact 29 of relay 2RFSR, back contact 136 of relay 6RTFPR and normal polar contact 140 of the switch lock control relay 5RWLS to terminal C.

When the train advances into section 7T, the track relay 7RTR releases and remains released so that relay 7RTP also releases and remains released with the result that relays 7RTFP and 7RTBP release. On release of relay 7RTBP its contact 69 interrupts the circuits of the lamps of signal 7ES and this signal ceases to display a permissive indication. In addition, on release of relay 7RTBP, its contact 76 interrupts the circuit of the code transmitter 75CT and it ceases to operate. On release of relay 7RTFP its contact 66 interrupts the circuit for supplying energy to the primary winding of the decoding transformer 6—7DT and energy ceases to be supplied through this transformer to relays 6—7HR and 6—7DR and they are both released.

As a result of release of relays 7RTFP, 7RTBP, and 6—7HR the supply of energy to the transmitter relay 6LCTP is interrupted and it ceases to cause energy to be supplied from the battery 6RTB to the rails of section 6T. Accordingly, when the train vacates section 6T, energy is not supplied over the rails of this section and the relay 6RTR, Fig. 1A, remains released.

When the train under consideration advances into section 8T, the track relay 8TR releases and its contact 60 interrupts the circuit for supplying energy to relay 7LCTP so it ceases to cause energy to be supplied from battery 7RTB to the rails of section 7T.

When the train advances into section 9T, the relay 9RTR is shunted and remains released and its contact 61 interrupts the circuit of relay 7LCTP so that it remains released after section 8T is vacated and relay 8TR picks up. If signal 4RA or 4RB is now cleared to permit the train to pass out of the stretch, the train may enter section 3T, thereby releasing relay 3TR. The signals 4RA and 4RB may be controlled in any suitable manner well known in the art and the details of the control of these signals are not necessary to an understanding of this invention and therefore have been omitted to simplify this disclosure.

When the train enters section 3T and releases track relay 3TR, back contact 57 of relay 3TR connects the wire leading from the left-hand terminal of the winding of relay 9LCTPR to terminal C of the source to insure that the contacts of relay 9LCTPR remain in their reverse position as long as section 3T is occupied. Accordingly, relay 9LCTPR ceases to supply energy from battery 9RTB to the rails of section 9T, and when section 9T is vacated relay 9RTR remains released.

When the train under consideration enters section 3T and releases relay 3TR, the relay 3TKSR, Fig 1D, releases and supplies energy

to the indication channel 2b, to pick up the relay 3TK and light the lamp 3TKE to show that the detector section at this end of the stretch is occupied.

At this time relay 4LFSR is released so energy is not supplied to the indication channels 5b and 6b, and the indication relays 4LFK and 4LBK remain released.

When the train vacates section 3T, the track relay 3TR picks up and establishes the circuit of relay 3TKSR so that it picks up, disconnecting terminal B from the indication channel 2b, and relay 3TK at the office is released to extinguish the lamp 3TKE.

Referring again to Fig. 1E, it will be seen that when relay 3TR picks up its contact 57 transfers the wire leading from the left-hand terminal of the winding of relay 9LCTPR from terminal C of the source to contact 58 of relay 4LASR which is picked up at this time. Accordingly, when relay 3TR picks up, it connects the circuit of relay 9LCTPR to the previously traced circuit including wires 153 and 152 and governed by the code transmitter 75CT, with the result that relay 9LCTPR again operates to cause coded energy to be supplied from the battery 9RTB to the rails of section 9T. On the supply of coded energy to the rails of section 9T the equipment at the intermediate locations in the track stretch causes coded energy to be supplied to each of the other sections in the stretch with the result that coded energy is supplied to relay 6RTR and operates its contact to cause the repeater relay 6RTPR to follow coded energy and pick up relay 6RTFPR and to cause energy to be supplied through the decoding transformer 2RDT to relay 2RHR.

On initial code following operation of relay 6RTPR, its contact 112 establishes a circuit including back contact 82 of relay 2RHR contact 112, normal contact 12 of relay 2RHSR, wire 158 and contact 107 of relay 1TR, for supplying energy to relay 2RCSR. However, the relay 2RCSR is of a type the contacts of which are slow in picking up, and the various parts of the equipment are proportioned so that relay 2RHR picks up with the result that its contact 82 interrupts the circuit of relay 2RCSR before the contacts of relay 2RCSR become picked up. Accordingly, at this time relay 2RCSR remains released and its contact 113 does not establish the circuit of relay 2RCSPR and it remains released.

When relay 2RHR picks up, its contact 83 establishes the circuit including back contact 114 of relay 2RCSPR, contact 83, front contact 108 of relay 1TKSR, and normal polar contacts 14 and 103 of relays 2RHSR and 5RWLS for supplying energy to relay 2RRR and its contacts pick up with the result that contact 85 interrupts the circuit of relay 2RFSR and establishes the circuit of relay 2RRPR.

On interruption of the circuit of relay 2RFSR its contacts release, and contact 90 disconnects terminal B from the indication channel 5a. Terminal B was disconnected from channel 6a when relay 2RHR picked up and it follows that relays 2RBK and 2RFK now release to extinguish the lamps 2RFE and 2—4BKE.

Referring again to Fig. 1B it will be seen that when relay 2RFSR releases, its contact 29 disconnects the wire 149 leading from the left-hand terminal of the winding of relay 6RCTPR from contact 136 and connects wire 149 to contact 25 of relay 2RRPR. It will be seen that when the restoring relays 2RRR and 2RRPR are both picked up, the wire 149 leading from the left-hand terminal of the winding of relay 6RCTPR is connected over front contact 25 of relay 2RRPR and over front contact 115 of relay 2RRR to wire 159, and thence over back contact 20 of relay 6RTR to terminal B of the source. Accordingly, energy is supplied to relay 6RCTPR and causes its contacts to move to their left-hand or normal position in which the battery 6LTB is connected across the rails of section 6T. The battery 6LTB is connected across the track rails in series with the relay 6RTR and the polarity of the energy supplied from the battery through the relay winding is such as to cause the relay contacts to remain released, thereby interrupting the circuit of relay 6RTPR. Accordingly, relay 6RTPR remains released and ceases to cause energy to be supplied to relay 6RTFPR and through the transformer 2RDT to the relay 2RHR and after a short time interval the contacts of relays 6RTFPR and 2RHR release with the result that contact 83 of relay 2RHR interrupts the circuit of relay 2RRR. The relay 2RRR is snubbed by a condenser which is proportioned so that on interruption of the supply of energy to the relay winding and to the condenser, the relay contacts are maintained picked up for a substantial time interval, such as 6 seconds. Accordingly, relay 2RRR remains picked up and maintains the circuit of relay 2RRPR for a substantial time interval after relay 2RHR releases. As long as relay 2RRR remains picked up the contacts of relay 6RCTPR are caused to remain in their normal position in which the battery 6LTB is connected across the track rails. Accordingly, energy is supplied from the battery 6LTB to the rails of section 6T for a considerable time interval. The energy supplied to the rails of section 6T feeds to track relay 6LTR, Fig. 1C, during a released period of the contacts of relay 6LCTP. As soon as the contact 27 of relay 6LTR picks up it interrupts the circuit for supplying coded energy to relay 6LCTP so that the contact of relay 6LCTP is certain to remain released and maintain the circuit of relay 6LTR. When relay 6LTR picks up the relay 6LTP also picks up and establishes the circuit of relay 6LTFP, and during a released period of contact 30 of relay 7RTR energy is supplied over the previously traced circuit including back contact 39 of relay 6LTBP to relay 7RCTP which picks up its contacts to cause the battery 7LTB to be connected across the track rails in series with relay 7RTR so that the contact of relay 7RTR remains released and maintains the circuit of relay 7RCTP.

The energy supplied from battery 7LTB to the rails of section 7T feeds to relay 7LTR during a released period of the contact of relay 7LCTP and picks up relay 7LTR so that energy is supplied over the previously traced circuit including front contact 36 of relay 7LTR to relay 9RCTP, which picks up its contact 40 to connect battery 9LTB across the rails of section 9T in series with the relay 9RTR. Accordingly, relay 9RTR releases and remains released so that it interrupts the circuit of relay 7LCTP and it remains released to maintain the circuit for connecting relay 7LTR across the rails of section 7T.

The energy supplied from battery 9LTB to the rails of section 9T feeds to track relay 9LTR, Fig. 1E, during a period in which the contacts of relay 9LCTPR are in their reverse position. Accordingly, the contact 41 of relay 9LTR picks up, thereby interrupting the circuit over which the

left-hand terminal of the winding of relay 9LCTPR is connected to terminal B of the source during a picked-up period of the code transmitter which governs the relay. As a result the contacts of relay 9LCTPR remain in their reverse position to maintain the circuit of relay 9LTR and cease to cause energy to be supplied from battery 9RTB to the rails of section 9T.

From the foregoing it will be seen that when the stretch is vacated and the head block signal 2R has not been recleared, the restoring relays 2RRR and 2RRPR are picked up and operate relay 6RCTPR to cause energy to be supplied from the battery 6LTB to the rails of section 6T. This energy picks up relay 6LTR to cause energy to be repeated or cascaded through the other sections of the stretch to the right-hand or exit end of the stretch. The energy supplied from left to right over the stretch cuts off the supply of coded energy over the rails of the stretch in the opposite direction. Accordingly, the slow release and code detecting relays at the intermediate location, such as relays 7RTFP, 7RTBP and 6—7HR, release and remain released.

After the expiration of the release time of relay 2RRR its contacts release with the result that contact 85 interrupts the circuit for supplying energy to relay 2RRPR, but this relay is snubbed by a condenser which is proportioned so that it maintains the relay contacts picked up for a substantial time interval, such as 6 seconds, subsequent to the interruption of the supply of energy to the relay. Accordingly, on release of relay 2RRR, the relay 2RRPR remains picked up for a substantial time interval.

After release of relay 2RRR the wire 149 leading from the left-hand terminal of the winding of relay 6RCTPR is connected over front contact 25 of relay 2RRPR and over back contact 115 of relay 2RRR to wire 160 and back contact 116 of the signal relay 2LAHR to contact 117 of the code transmitter 75CT. During the picked-up periods of the code transmitter the wire 149 leading to the left-hand terminal of the winding of relay 6RCTPR is connected over back contact 20 of relay 6RTR to terminal B of the source, while during the relased periods of the code transmitter this wire is connected to terminal C of the source. Accordingly, relay 6RCTPR is now operated periodically to cause coded energy to be supplied from battery 6LTB to the rails of section 6T in place of steady energy. During the first off period in the coded energy supplied from battery 6LTB to the rails of section 6T the relay 6LTR, Fig. 1C, releases and its repeater relay 6LTP also releases. On release of relay 6LTR its back contact 27 is closed but energy is not supplied to relay 6LCTP since relay 7RTFP is released and its contact 71 interrupts the circuit of relay 6LCTP. Accordingly, relay 6LCTP remains released and maintains the circuit of relay 6LTR so that relay 6LTR continues to respond to coded energy supplied over the rails of section 6T. During the first off period of this code, the slow release relay 6LTBP picks up, closing its contact 125 to set the code transmitter 75CT into operation, and relay 7RCTP releases due to the opening of back contact 39 of relay 6LTR. It follows that as a result of the code following operation of relay 6LTP the relays 6LTFP and 6LTBP are both maintained picked up and contact 118 of relay 6LTFP establishes a circuit for supplying energy to the primary winding of decoding transformer 6—7DT and energy is supplied through this transformer to pick up the contacts of relay 6—7HR. As soon as the contacts of relay 6—7HR pick up coded energy is supplied to relay 7RCTP over the circuit which includes back contact 30 of relay 7RTR, front contact 38 of relay 6LTFP, front contact 39 of relay 6LTBP, contact 124 of code transmitter 75CT, front contact 119 of relay 6—7HR, and back contact 120 of relay 7RTFP. Accordingly, the relay 7RCTP is now operated to supply coded energy from battery 7LTB to the rails of section 7T.

On the change in the energy supplied to section 7T from steady to coded, the relay 7LTR follows coded energy and causes coded energy to be supplied to the relay 9RCTP so that it causes coded energy to be supplied from battery 9LTB to the rails of section 9T.

On the change in the energy supplied to the rails of section 9T, the relay 9LTR, Fig. 1A, releases and interrupts the circuit of relay 9LTPR so that it releases. On movement of the contact 41 of relay 9LTR to its released position, no connection is established from terminal B of the source to the left-hand terminal of the winding of relay 9LCTPR since the wire 153 leading from this terminal of the relay winding is connected over back contact 59 of relay 4LFSR, back contact 55 of relay 4RRPR and front contact 54 of relay 9LTFPR to terminal C of the source. The relay 9LTFPR is slow enough in releasing to remain picked up during the off periods in the coded energy supplied over the rails of section 9T so the relay 9LTFPR prevents operation of relay 9LCTPR by coded energy at this time and insures that its contacts will remain in their right-hand or reverse position and maintain the circuit of relay 9LTR.

As a result of code following operation of relay 9LTR, the relay 9LTPR follows code and causes energy to be supplied through the decoding transformer 4LDT to relay 4LHR to cause that relay to pick up its contacts with the result that contact 45 interrupts the circuit of relay 4LCSR and its contacts release so that contact 47 interrupts the circuit of relay 4LCSPR. The relay 4LCSPR is snubbed by a condenser which is proportioned so that the contacts of relay 4LCSPR remain picked up for a consideable time interval, such as 20 seconds, subsequent to release of relay 4LCSR and consequent interruption of the supply of energy to the winding of relay 4LCSPR and the associated condenser.

The relay 4LHR, which causes release of the code sending relay 4LCSR, is of a type the contacts of which are slow to pick up so the relay will not be picked up by the energy supplied thereto in response to a single movement of the contacts of relay 9LTR to their picked up position, but will be picked up only in response to repeated operation of the contacts of relay 9LTR.

Accordingly, after relay 4LCSR is picked up to cause coded energy to be supplied at the right-hand end of the stretch and thereby establish eastbound traffic in the stretch, the relay 4LCSR will not be released to cut off the supply of coded energy to the track rails, and thus interfere with the established traffic direction in the stretch, as a result of a single movement of the contacts of relay 9LTR to their picked-up position, such as might be caused by an irregular track circuit condition or by vibration or some other unusual condition.

On the other hand, when coded energy is supplied over the rails of the track stretch for the purpose of cutting off the supply of energy to the stretch and restoring the apparatus to its nor-

mally deenergized condition, the track relay 9LTR is repeatedly operated by the coded energy and picks up relay 4LHR to release relay 4LCSR and discontinue the supply of coded energy to the stretch. The arrangement of the apparatus, therefore, is such as to prevent inadvertent interruption of the supply of coded energy to the stretch, while at the same time making certain that the supply of coded energy will be cut off when its further supply is no longer desired.

Referring again to Fig. 1B, the relay 2RRPR releases after an appropriate interval and its contact 25 interrupts the circuit traced above for supplying coded energy from contact 117, over wire 160 to the wire 149 leading to the left-hand terminal of the winding of relay 6RCTPR and connects this wire 149 over back contact 24 of relay 6RTFPR, back contact 23 of relay 2RCSR, wire 148, and back contact 22 of relay 2RSPAR to terminal C of the source, so that the contacts of relay 6RCTPR are moved to their right-hand or reverse position and remain in that position. As a result, relay 6RCTPR ceases to cause coded energy to be supplied from battery 6LTB to the rails of section 6T, and relay 6LTR, Fig. 1C, releases and remains released so that relays 6LTFP, 6LTBP, and 6—7HR release and discontinue the supply of coded energy to relay 7RCTP. Accordingly, relay 7RCTP ceases to cause energy to be supplied from battery 7LTB to the rails of section 7T and relay 7LTR ceases to establish the circuit of relay 9RCTR and it remains released so that energy is no longer supplied from battery 9LTB to the rails of section 9T. Accordingly, relay 9LTR releases and remains released so that relay 9LTPR also releases and after a short time interval the relay 9LTFPR releases while relay 4LHR also releases.

When relay 9LTFPR releases, its contact 54 transfers the wire 153 leading from the left-hand terminal of relay 9LCTPR to terminal C of the source to a connection leading over back contact 48 of relay 4LCSR, wire 161, and back contact 121 of relay 4LSPAR to terminal C of the source.

As previously explained, the release time of relay 4LCSPR is relatively long and the various parts of the equipment are proportioned so that relay 4LCSPR remains picked up until after relay 4LHR releases. Accordingly, contact 50 of relay 4LCSPR continues to interrupt the circuit of relay 4RRR until after this circuit is interrupted at contact 122 of relay 4LHR, and the relay 4RRR is certain to remain released at this time. In addition, contact 51 of relay 4LCSPR continues to interrupt the pick-up circuit of relay 4LFSR until after this circuit is interrupted by contact 123 of relay 4LHR, so the relay 4LFSR is certain to remain released at this time.

As long as relay 4LCSPR is picked up its contact 52 interrupts the circuit including wire 162, for relay 4BPR and insures that it remains released and cannot be picked up during the period in which relay 4LHR is picked up in response to the frequency code portion of the deenergizing current supplied over the track rails. If relay 4BPR could be picked up, it might result in temporary unwarranted display of a permissive indication by signal 4LA or 4LB, but the contact 52 of relay 4LCSPR in the circuit of relay 4BPR prevents this unintended clearing of one of the signals at this time.

After the expiration of the release period of relay 4LCSPR its contacts release and the equipment is again in substantially the condition in which it is illustrated in the drawings. At this time the coded track circuit equipment is deenergized while the equipment at the office, Fig. 2, shows that the head block signals at both ends of the stretch are at stop, that the block is unoccupied, and that traffic is not established in either direction in the stretch.

The operation of the equipment when signal 4LA or 4LB is cleared to authorize movement of a westbound train through the stretch, and in restoring the equipment to its normally deenergized condition after a westbound train has vacated the stretch is substantially the same as described above in connection with eastbound traffic and need not be traced in detail.

Operation of the equipment to govern switch locks

This system provides complete control of the lock on a hand-throw switch at an intermediate point in a track stretch to permit a train on the main track to enter a siding or to permit a train on the siding to enter the main track.

If a train on the main track is to enter the siding, the train is advanced into section 8T, Fig. 1C, thereby releasing track relay 8TR for the track section which includes the switch 8W. On release of relay 8TR connection is established from terminal B of the source over back contact 35 of relay 8TR to one terminal of the winding of lock 8WL, while connection is established from the other terminal of the winding of lock 8WL to terminal C of the source by a contact 126 which is closed when the door of the cabinet enclosing the switch lock is opened.

When the winding of lock 8WL is energized, the contacts 130 and 131 which are governed thereby open the circuit for the indication relay 8NWP so that it releases and its contacts 37 and 62 prevent transmission of coded energy past the switch in either direction.

In addition, on energization of the winding of the lock 8WL, the locking dog 127 governed thereby is moved out of alignment with the associated segment so the switch 8W may now be reversed.

As soon as the hand-throw lever on switch 8W is operated the contacts 132 and 133 are opened and they remain open as long as the switch is moved away from its normal position. The contacts 132 and 133, when open, interrupt the circuit of relay 8NWP to prevent its energization and thus prevent transmission of coded energy past the switch as long as the switch is reversed.

When the train under consideration enters the siding and vacates section 8T, track relay 8TR picks up to interrupt the supply of energy to the winding of the lock 8WL and its contacts release. When the switch is restored to its normal position and is locked in that position, the contacts 132 and 133 are closed so that energy is again supplied to the winding of relay 8NWP and its contacts pick up. The equipment is now substantially in its normal condition as shown in Fig. 1C, and coded energy supplied to either end of the stretch will be repeated past the switch.

This system also operates to control energization of the winding of the lock 8WL to permit a train on the siding to enter the main track. If the train on the siding is to enter the main track, one of the train crew telephones or otherwise communicates with the operator at the central office asking him to unlock the switch. In order to unlock the switch the switch lock lever 5WL, Fig. 2, on the panel of the C. T. C. machine is moved to its right or its left-hand position de-

pending on the direction in which the train is to proceed after entering the main track. For purposes of illustration it will be assumed that a train is to proceed eastbound and that the operator moves the lever 5WL to its right-hand position.

When the lever 5WL is moved to its right-hand position and the starting button 1—2STB is operated, it establishes a connection from terminal B to the control channel 10*a*. Relay 5RWLS, Fig. 1B, which is connected to terminal O at the back contact 128 of relay 2RCSR, is thereby operated to reverse to close its right-hand contacts. It will be noted that if the operator attempts to reverse relay 5RWLS when relay 2RSCR is picked up it will be ineffective because both ends of channel 10*a* will then be connected to the same terminal B of the source. On the other hand, relay 2RWLS may be restored to normal when relay 2RCSR is picked up, by operating button 1—2ST when lever 5WL is in its center or left-hand position, since in this case channel 10*a* is connected to terminal N at the lever contact. Referring now to Fig. 1B it will be seen that contact 135 of relay 5RWLS establishes a circuit including normal polar contact 16 of relay 2LHSR and normal polar contact 15 of relay 2RHSR, contact 135, back contact 137 of relay 2RFSR, back contact 17 of relay 2RHR, wire 147 and back contact 18, for supplying energy to the actuating impulse generating relay 2RSPR. Accordingly, this relay picks up and establishes a circuit for relay 2RSPAR with the result that these relays operate as described in detail above to cause transmitter relay 6RCTPR to supply energy from battery 6LTB to the rails of section 6T for a substantial time interval. This energy is repeated or cascaded through the various sections of the stretch as described above to the exit end of the stretch and causes relay 9LTR, Fig. 1E, to pick up and to cause code sending relay 4LCSR to be energized so that on termination of the actuating impulse coded energy is supplied to the right-hand or exit end of the stretch and is thereafter repeated or cascaded through the stretch to the entrance end.

When the coded energy is received at the left-hand or entrance end of the stretch, the relay 2RHR picks up and its contact 17 interrupts the circuit of relay 2RSPR so that it thereafter remains released.

In addition, when relay 2RHR picks up, its contact 87 establishes the pick-up circuit for relay 2RFSR and its contacts pick up so that contact 110 prepares the relay stick circuit which is completed on subsequent release of contact 87 of relay 2RHR.

When contact 17 of relay 2RHR picks up, it establishes a circuit over wire 155 for relay 2BPR, but this circuit is immediately opened at the back contact 137 of relay 2RFSR, and relay 2BPR is not operated.

As long as coded energy is received at the left-hand end of section 6T the relay 6RTFPR is picked up and its front contact 136 connects the left-hand terminal of the winding of relay 6RCTPR over wire 149 to terminal C of the source.

After coded energy has been cascaded throughout the stretch so as to be received at the entrance end and the relay 2RFSR picks up, its contacts 90 and 91, in the indication channels 5*a* and 6*a* are closed. Channel 5*a* is energized to pick up relay 2RFK and light lamp 2RFE to show that the stretch has been prepared for eastbound traffic. The operator at the central office may now inform the train crew at the switch location that the push button 8PB should be pressed. When this is done, the circuit of relay 8NWP is opened and the relay releases so that its contact 62 interrupts the circuit of relay 7LCTP and cuts off transmission of coded energy past the switch from right to left. After release of relay 8NWP the relay 9RTR continues to be operated by coded energy supplied at the right-hand or east end of the stretch and during subsequent picked-up periods of the relay 9RTR energy is supplied over back contact 62 of relay 8NWP to the slow release relay 9RTFP and its contacts pick up with the result that during subsequent release periods of relay 9RTR energy is supplied to the code detecting relay 9RTBP and its contact 138 in the circuit of the winding of lock 8WL is closed.

After release of relay 8NWP and consequent cutting off of the supply of energy to relay 7LCTP, the supply of coded energy to the portion of the stretch at the left or west of the switch 8W is cut off and relays 2RHR and 6RTFPR at the left-hand end of the stretch become released. On release of relay 2RHR, relay 2RFSR is maintained picked up by energy supplied over its stick circuit so its contact 137 interrupts the circuit governed by contact 135 of relay 5RWLS for supplying energy over wire 147 to the relay 2RSPR and relay 2RSPR is not energized on release of contact 17 of relay 2RHR.

After release of relay 6RTFPR, the wire 149 leading from the left-hand terminal of the winding of transmitter relay 6RCTPR is connected to contact 117 of the code transmitter 75CT over a circuit which includes front contact 29 of relay 2RFSR, back contact 136 of relay 6RTFPR, reverse polar contact 140 of relay 5RWLS, wire 160, and back contact 116 of relay 2LAHR. Accordingly, the transmitter relay 6RCTPR now operates to cause coded energy to be supplied from battery 6LTB to the rails of section 6T. This energy is repeated into section 7T by the equipment at the intermediate signal location, Fig. 1B, so that the relay 7LTR is operated by coded energy. During the picked-up periods of relay 7LTR, energy is supplied over back contact 37 of relay 8NWP to the slow release relay 7LTFP, and during the released periods of contact 36 of relay 7LTR energy is supplied to the code detecting relay 7LTBP and its contact 141 in the circuit of the winding of switch lock 8WL is closed. The circuit of the winding of lock 8WL is now complete and its lock now releases the switch so that it may be moved. When the train under consideration enters the stretch, the track relay 8TR releases and its contacts 35 and 60 interrupt the circuits for supplying energy to the code detecting relays with the result that they release, but at this time the lock 8WL is energized by current supplied over back contact 35 of relay 8TR.

As explained above, it is assumed that the train will proceed eastbound so that the train advances into section 8T and holds relay 9RTR released. When section 8T is vacated, relay 8TR picks up and when the switch 8W is restored to its normal position and is locked in that position, the relay 8NWP again becomes energized.

After the switch has been reversed, one of the train crew phones the operator at the central of-

fice and he restores the switch lock lever 5WL, Fig. 2, to its normal position. A control code is now sent to field station 1—2 which causes the contacts of relay 5RWLS to be restored to their normal position.

On this movement of the contacts of relay 5RWLS its contact 140 interrupts the previously traced circuit for supplying coded energy to transmitter relay 6RCTPR and connects wire 149 extending to the left-hand terminal of the winding of this relay to terminal C of the source with the result that the contacts of the relay move to their right-hand or reverse position and remain in that position, thereby interrupting the circuit of battery 6LTB and connecting the relay 6RTR across the rails of section 6T.

When the supply of coded energy to the entrance end of the stretch is cut off, the supply of coded energy to the other portions of the stretch in the rear of the train is cut off and relay 7LTR, Fig. 1C, releases and remains released and no longer establishes the circuit for relay 9RCTP so that it releases and establishes the circuit of relay 9RTR.

When the train under consideration passes out of the stretch, coded energy supplied at the right-hand or east end of the stretch feeds to relay 9RTR and operates it so that it causes relay 7LCTP to supply coded energy to the rails of section 7T. As a result the equipment at the intermediate signal location operates as previously described to cause coded energy to be supplied to the rails of section 6T and this energy operates relay 6RTR to cause relays 6RTFPR and 2RHR to become picked up.

When relay 2RHR picks up its contact 87 interrupts the stick circuit for relay 2RFSR, while contact 83 of relay 2RHR establishes the previously traced circuit for supplying energy to relay 2RRR and its contact 85 picks up to interrupt the circuit of relay 2RFSR and to establish the circuit of relay 2RRPR.

When relays 2RRR and 2RRPR are picked up they control the transmitter relay 6RCTPR to cause it to supply deenergizing current to the rails of section 6T, this current consisting of a long impulse of steady energy followed by a similar period of coded energy.

As a result of release of relay 2RFSR its contacts 90 and 91 open and cause relays 2RFK and 2RBK to release to thereby extinguish the lamps 2RFE and 2—4BKE.

The deenergizing current supplied to the rails of section 6T is cascaded to the right-hand or exit end of the stretch where it operates track relay 9LTR to cause release of the code sending relay 4LCSR and thereby restore the equipment to its normally deenergized condition on termination of the deenergizing current.

Although I have herein shown and described only a few forms of railway signaling system embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a normally deenergized coded track circuit signaling system, in combination, a stretch of railroad track having at each end a signal governing entrance of traffic into the stretch, code transmitting means for each end of said track stretch effective when rendered active to supply energy to the rails of said track stretch, a code following track relay for each end of said track stretch effectively connected across the track rails when the associated code transmitting means is not supplying energy to the rails, to detect whether or not energy is being supplied thereto from the opposite end of the stretch, a code sending relay at each end of said track stretch effective when operated to render the associated code transmitting means active to supply pulses of signal control energy to the rails of the stretch at a predetermined code rate, each code sending relay being of the slow pick-up type responsive to energization of the associated track relay only when such track relay is steadily energized for a period substantially longer than the longest pulse of signal control energy supplied to said track relay, a code detecting relay for each end of said track stretch, means for picking up each of said code detecting relays only in response to the reception of signal control energy as manifested by a plurality of movements of the contacts of the associated track relay between their two positions within a predetermined time interval and for thereafter maintaining the relay picked up as long as the track relay responds periodically to such signal control energy, a manually operable signal control relay at each end of the stretch effective when operated to cause the associated signal to clear upon picking up of the associated code detecting relay, and actuating means at each end of the stretch effective when the associated signal control relay is operated and the code detecting relay responsive to operation of the associated track relay is released for causing the associated code transmitting means to supply to the rails actuating code energy comprising pulses of energy each of which is of substantially greater duration than a pulse of signal control energy, the successive pulses of said actuating code energy being separated by periods of substantial duration so that when a track relay responds thereto it operates the associated code sending relay without picking up the associated code detecting relay and so that when a track relay responds to signal control energy it picks up the associated code detecting relay without operating the associated code sending relay.

2. In a normally deenergized coded track circuit signaling system, in combination, a stretch of railroad track having at each end a signal governing entrance of traffic into the stretch, code transmitting means for each end of said track stretch effective when rendered active to supply energy to the rails of said track stretch, a code following track relay for each end of said track stretch effectively connected across the track rails when the associated code transmitting means is not supplying energy to the rails, to detect whether or not energy is being supplied thereto from the opposite end of the stretch, a code sending relay at each end of said stretch effective when operated to render the associated code transmitting means active provided the associated track relay is released to supply pulses of signal control energy periodically to the rails of the stretch at a predetermined code rate, each code sending relay being of the slow pick-up type responsive to energization of the associated track relay only when such track relay is steadily energized for a period substantially longer than the longest pulse of signal control energy supplied to said track relay, each code sending relay having a slow acting repeater which is

energized over contacts closed in its operated position and on movement of the contacts of the code sending relay to their normal position is restored to normal only after a substantial time interval, a code detecting relay for each end of said track stretch, means for picking up each of said code detecting relays only in response to the reception of signal control energy as manifested by a plurality of movements of the contacts of the associated track relay between their two positions within a predetermined time interval and for thereafter maintaining the relay picked up as long as the track relay responds periodically to such signal control energy, each code detecting relay being effective when picked up to cause the associated code sending relay to be restored to normal, a manually operable signal control relay at each end of the stretch effective when operated to cause the associated signal to clear in response to picking up of the associated code detecting relay, actuating means at each end of the stretch effective when the associated signal control relay is operated and the code detecting relay responsive to operation of the associated track relay is released for causing the associated code transmitting means to supply to the rails actuating code energy comprising pulses of energy each of which is of substantially greater duration than a pulse of signal control energy, the successive pulses of said actuating code energy being separated by periods of substantial duration so that when a track relay responds thereto it operates the associated code sending relay without picking up the associated code detecting relay and so that when a track relay responds to signal control energy it picks up the associated code detecting relay without operating the associated code sending relay, and restoring means at each end of the stretch effective when the associated signal control relay and the associated code sending relay repeater are not operated and the code detecting relay responsive to operation of the associated track relay is picked up for causing the associated code transmitting means to supply to the rails steady energy for a substantial time interval and to thereafter supply to the rails pulses of signal control energy for a time interval of predetermined duration such as to pick up the code detecting relay and thereby release the code sending relay at the opposite end of the stretch and to thereafter cause said code detecting relay to release before the associated code sending relay repeater is restored to normal.

3. In a normally deenergized coded track circuit signaling system, in combination, a stretch of railroad track having at each end a signal governing entrance of traffic into the stretch, code transmitting means for each end of said track stretch for supplying energy to the rails of said stretch, a code following track relay for each end of said stretch effectively connected across the track rails when the associated code transmitting means is not supplying energy to the rails, to detect whether or not energy is being supplied thereto from the opposite end of the stretch, a code detecting relay at each end of said stretch, means for picking up each of said code detecting relays only in response to a plurality of movements of the contacts of the associated track relay between their two positions within a predetermined time interval, a code sending relay at each end of said stretch effective when operated to cause the associated code transmitting means to supply to the rails coded signal control energy which when supplied to a track relay causes the contacts thereof to move between their two positions a plurality of times within said predetermined time interval, means effective only when a code detecting relay is released for supplying energy to the associated code sending relay in response to energization of the associated track relay, each code sending relay being of the slow pick-up type arranged to operate only when the associated track relay is supplied with energy for a period substantially longer than the longest pulse of signal control energy supplied to said track relay, each of said code sending relays being arranged to be restored to normal when the associated code detecting relay is energized, a manually controlled signal control relay at each end of the stretch effective when operated to cause the associated signal to clear upon picking up of the associated code detecting relay, actuating means at each end of the stretch effective when the associated signal control relay is operated and the code detecting relay responsive to operation of the associated track relay is released for causing the associated code transmitting means to supply to the rails actuating code energy comprising pulses of energy each of which is of substantially greater duration than a pulse of signal control energy, the successive pulses of said actuating code energy being separated by periods substantially longer than the intervals between successive pulses of signal control energy, and restoring means at each end of the stretch effective when the associated signal control relay is not operated and the code detecting relay responsive to operation of the associated track relay is picked up for causing the associated code transmitting means to supply to the rails steady energy for a first predetermined time interval and to thereafter supply to the rails coded signal control energy for a second predetermined time interval.

4. In a normally deenergized coded track circuit signaling system, in combination, a stretch of railroad track having at each end a signal governing entrance of traffic into the stretch, code transmitting means at each end of said stretch effective when rendered active to supply code pulses across the track rails of said stretch, a code sending relay at each end of said stretch effective when operated to cause the associated code transmitting means to supply to the rails signal control energy comprising energy pulses of a predetermined duration separated by off intervals of the same duration, actuating impulse generating means at each end of said stretch effective when rendered active to cause the associated code transmitting means to supply to the rails actuating code energy comprising pulses of energy of substantially greater duration than the pulses of signal control energy, a code following track relay at each end of said stretch effectively connected across the track rails when the associated code transmitting means is not supplying energy to the rails, to detect whether or not energy is being supplied thereto from the opposite end of the stretch, a code detecting relay at each end of said stretch, means for picking up each of said code detecting relays when and only when the associated track relay is operated by a plurality of successive pulses of said signal control energy, means for operating each of said code sending relays when and only when the associated track relay is energized by a pulse of substantially greater duration than a pulse of said signal control energy, each

of said code sending relays being restored to normal when the associated code detecting relay is energized, a manually operable signal control relay at each end of said stretch, signal clearing means at each end of said stretch for causing the associated signal to clear when the associated signal control relay is operated and the associated code detecting relay is picked up, actuating means at each end of said stretch for rendering the associated actuating impulse generating means active when the associated signal control relay is operated and the code detecting relay responsive to operation of the associated track relay is released, and restoring means at each end of said stretch effective when the associated signal control relay is not operated and the code detecting relay responsive to operation of the associated track relay is picked up to cause the associated code transmitting means to supply to the rails steady energy for a substantial time interval and to thereafter supply to the rails coded signal control energy for a time interval sufficient to pick up a code detecting relay and thereby release the associated code sending relay.

5. In a normally deenergized coded track circuit signaling system, in combination, a stretch of railroad track having at each end a signal governing entrance of traffic into the stretch, code transmitting means at each end of said stretch effective when rendered active to supply code pulses across the track rails of said stretch, a code sending relay at each end of said stretch effective when operated to cause the associated code transmitting means to supply to the rails signal control energy comprising energy pulses of a predetermined duration separated by off intervals of the same duration, actuating impulse generating means at each end of said stretch effective when rendered active to cause the associated code transmitting means to supply to the rails actuating code energy comprising pulses of energy of substantially greater duration than the pulses of signal control energy, a code following track relay at each end of said stretch effectively connected across the track rails when the associated code transmitting means is not supplying energy to the rails, to detect whether or not energy is being supplied thereto from the opposite end of the stretch, a code detecting relay at each end of said stretch, means for picking up each of said code detecting relays when and only when the associated track relay is operated by a plurality of successive pulses of signal control energy, means for operating each of said code sending relays when and only when the associated track relay is energized by a pulse of substantially greater duration than a pulse of said signal control energy, a repeater relay for each code sending relay, means for operating each repeater relay when the code sending relay is operated and for restoring such relay to normal only on expiration of a substantial time interval subsequent to restoration of the code sending relay, means for restoring each code sending relay to normal when the associated code detecting relay is energized, a manually operable signal control relay at each end of said stretch, signal clearing means at each end of said stretch for causing the associated signal to clear when the associated signal control relay is operated and the associated code detecting relay is picked up, actuating means at each end of said stretch for rendering the associated actuating impulse generating means active when the associated signal control relay is operated and the code detecting relay responsive to operation of the associated track relay is released, and restoring means at each end of said stretch effective when the associated signal control relay is not operated, the code detecting relay responsive to operation of the associated track relay is picked up and the associated code sending relay repeater is not operated to cause the associated code transmitting means to supply to the rails steady energy for a substantial time interval and to thereafter supply to the rails coded signal control energy for a time interval sufficient to pick up a code detecting relay but to maintain it picked up only for a period shorter than the time required to restore a code sending relay repeater to normal.

6. In combination, a stretch of single track railway over which traffic may move in either direction, a signal at each end of said track stretch, a communication system connecting the ends of said stretch with a control office, a system of reversible circuits extending the length of said stretch for controlling said signals in accordance with traffic conditions in said track stretch, actuating means at the ends of said track stretch manually governed from said office through said communication system to at times condition said system of reversible circuits to prepare said stretch for traffic in one direction and thereby permit clearing of the signal at one end of said track stretch and to at other times condition said system of reversible circuits to prepare said stretch for traffic in the other direction and thereby permit clearing of the signal at the other end of said stretch, signal clearing means at each end of said stretch manually controlled from said office and effective only when said system of reversible circuits has prepared the stretch for traffic in the corresponding direction for clearing the signal at that end of said stretch, an indication control relay at each end of said stretch, means at each end of said stretch governed by said system of reversible circuits for operating the associated indication control relay when said system of reversible circuits shows that the stretch has been prepared for traffic in the direction for which the indication control relay is at the entrance end of the stretch, restoring means at each end of said stretch for causing the associated indication control relay to be restored to normal when and only when said system of reversible circuits is governed to discontinue preparation of the stretch for traffic in the direction in which the indication control relay is at the entrance end of the stretch, occupancy indication means at said office governed through said communication system to indicate whether or not said stretch is occupied, and means at each end of said stretch governed by said system of reversible circuits but effective only when the associated indication control relay is operated for governing the energization of said occupancy indication means in accordance with the condition of occupancy of said stretch.

7. In occupancy indication means for indicating occupancy of a stretch of railroad track equipped with a system of reversible circuits governed by traffic conditions in the stretch and controlled from a central office through a communication system including field stations at the ends of said stretch, said system of reversible circuits being controllable so as to at times prepare said stretch for traffic in one direction and thereby permit clearing of a signal at the corresponding entrance end of the stretch and to at other times prepare said stretch for traffic in the other di-

rection and thereby permit clearing of a signal at the corresponding entrance end of the stretch, said occupancy indication means comprising in combination, indication means at said office governed in accordance with the condition of energization of indication terminals at the field stations at the ends of said stretch to indicate whether or not said stretch is occupied, an indication control relay at each end of said stretch, means at each end of said stretch governed by said system of reversible circuits for operating the associated indication control relay when said system of reversible circuits shows that the stretch has been prepared for traffic in the direction for which the indication control relay is at the entrance end of the stretch, restoring means at each end of said stretch for causing the associated indication control relay to be restored to normal when and only when said system of reversible circuits is governed to discontinue preparation of the stretch for traffic in the direction in which the indication control relay is at the entrance end of the stretch, and means at each end of said stretch governed by said system of reversible circuits but effective only when the associated indication control relay is operated for governing energization of the indication terminal at the associated field station in accordance with the condition of occupancy of said stretch.

8. In occupancy indication means for indicating occupancy of a stretch of single track between passing sidings, said track stretch being equipped with coded track circuit apparatus including at each end of the stretch code transmitting means for supplying coded energy to the rails of the stretch and code responsive means energized in response to coded energy supplied over the rails of the stretch when and only when said stretch is unoccupied, said code transmitting means being governed from a central office through a communication system having a field station at each end of the stretch to at times cause coded energy to be transmitted throughout the stretch in one direction or the other, in combination, indication means at said office governed in accordance with the condition of energization of indication terminals at the field stations at the ends of said stretch, to indicate whether or not the stretch is occupied, an indication control relay at each end of said stretch, means for operating each indication control relay when the associated code responsive means is energized, restoring means at each end of said stretch, means controlled by each restoring means when operated for restoring the associated indication control relay to normal and to concurrently cause the code transmitting means at the opposite end of the stretch to cease to supply coded energy to the stretch, and means at each end of said stretch governed by the associated code responsive means but effective only when the associated indication control relay is operated for governing energization of the indication terminal at the associated field station in accordance with the condition of occupancy of said stretch.

CRAWFORD E. STAPLES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,353,421	Staples	July 11, 1944
2,401,201	Thompson	May 28, 1946
2,411,375	Jackel	Nov. 19, 1946