Nov. 27, 1945. H. A. TALBERT ET AL 2,390,010

RAILWAY SIGNALING APPARATUS

Filed June 30, 1944 2 Sheets-Sheet 1

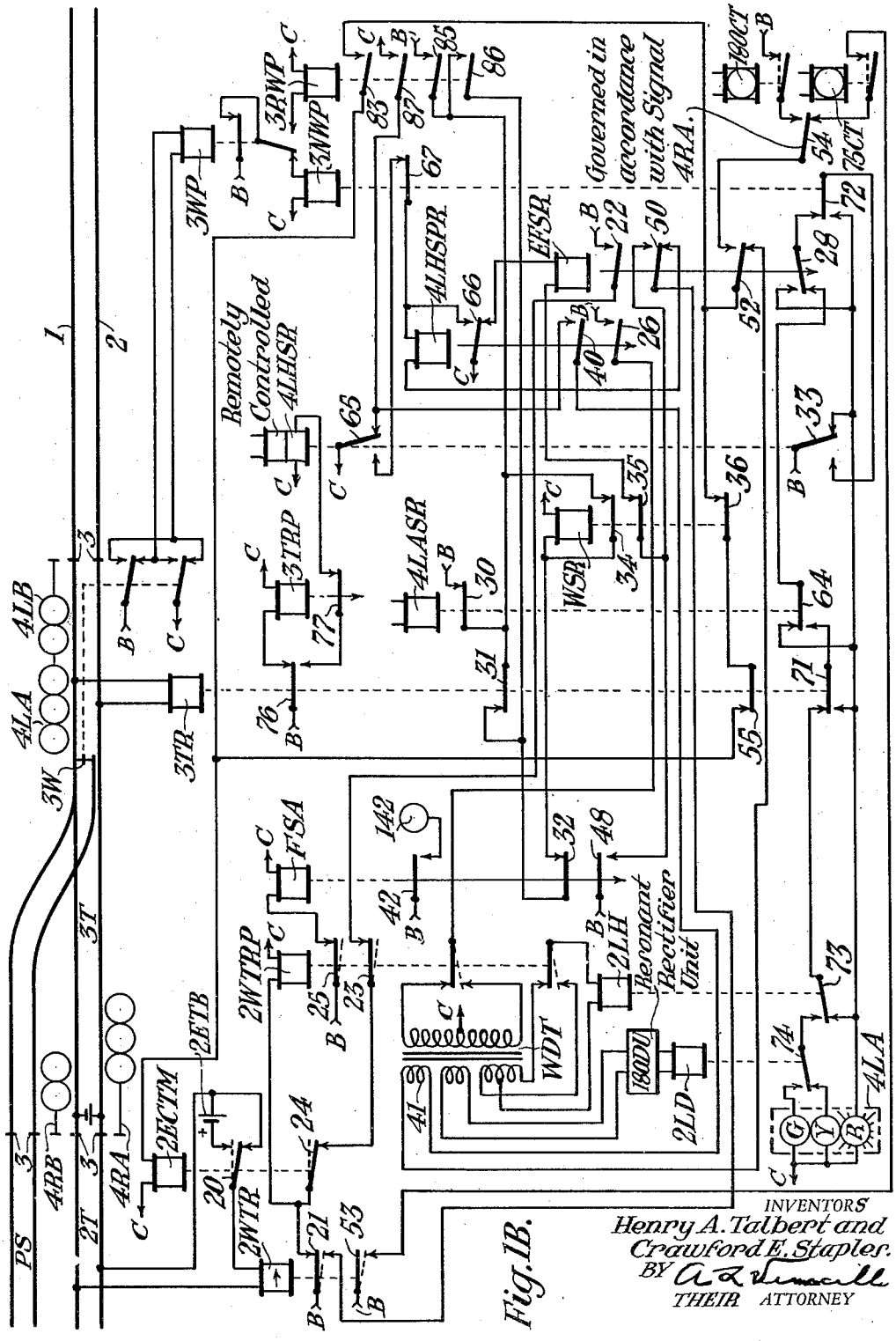


Fig. 1B.

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RAILWAY SIGNALING APPARATUS

Filed June 30, 1944 2 Sheets-Sheet 2

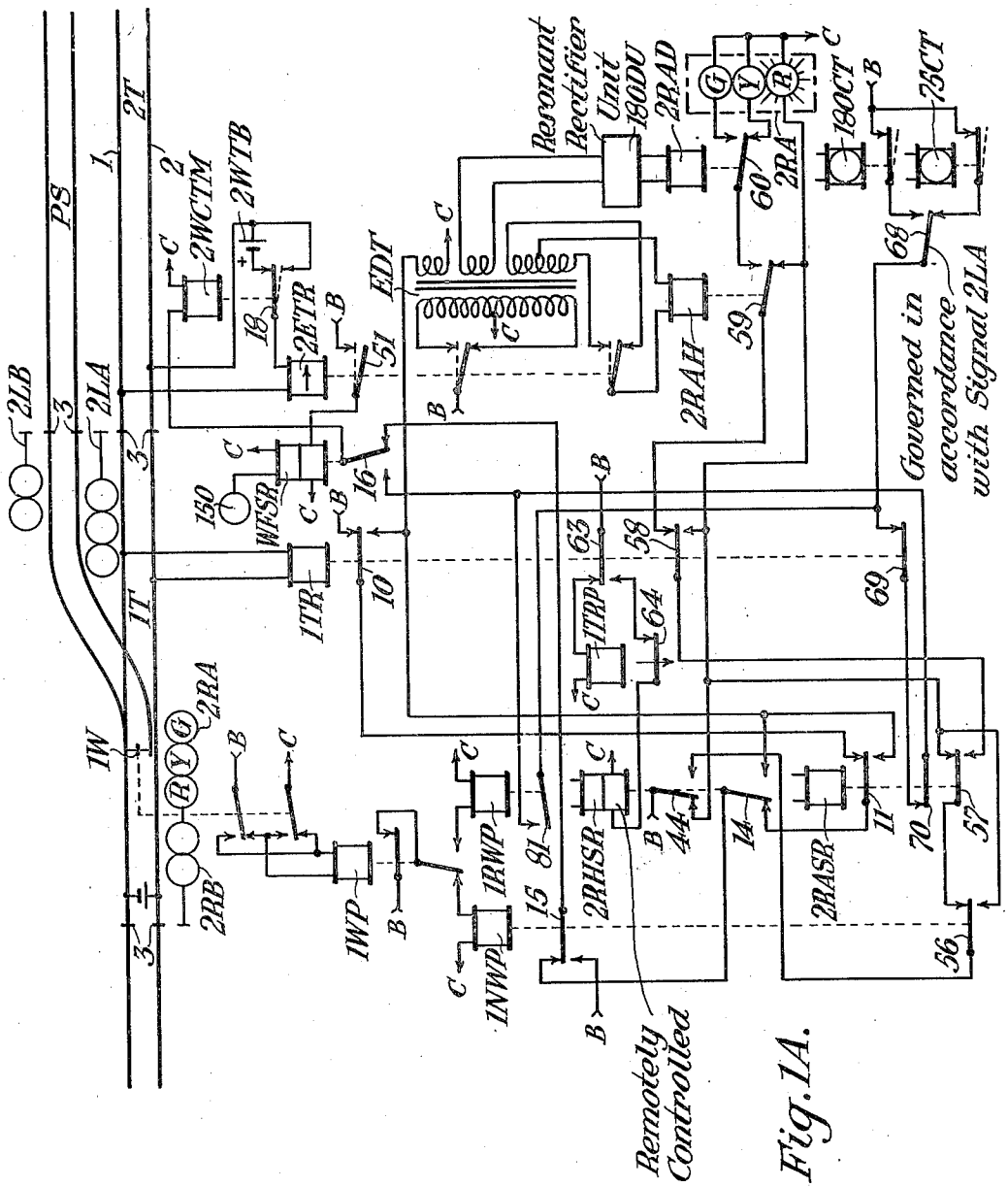


Fig. 1A.

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RAILWAY SIGNALING APPARATUS

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Application June 30, 1944, Serial No. 542,936

11 Claims. (Cl. 246—3)

Our invention relates to railway signaling apparatus for use on stretches of track through which traffic may move in either direction, but only in one direction at one time.

In Letters Patent of the United States No. 2,344,333 issued March 14, 1944 to James J. Van Horn, there is shown a signaling system for use on stretches of single track between two passing sidings. That system is arranged so that when the single track stretch is vacant and is not prepared for traffic in either direction, steady energy is supplied to the section at one end of the single track stretch and is cascaded or repeated through all of the other sections to the other end of the track stretch where it energizes traffic locking means to indicate that the single track stretch is not occupied.

When it is desired to condition the single track stretch to permit movement of a train therethrough, the supply of steady energy to the track stretch is cut off, while coded energy is supplied to the section at the exit end of the stretch with the result that coded energy is supplied to the remaining sections in the stretch and causes the wayside signals, including the signal at the entrance to the stretch, to display permissive indications.

The operation of the system shown in the Van Horn patent is such that coded energy is supplied to the rails of the track sections when and only when movement of a train through the track stretch is authorized, while steady energy is supplied to the rails of the track sections when trains are not permitted to enter the single track stretch.

It is desired to permit signal maintainers or others to operate small motor cars in the track stretch to transport themselves and their equipment. As usually constructed, the wheels and axles of these cars are insulated so that these cars do not shunt the track circuits and therefore do not control the wayside signals so trains in the track stretch are not informed of the presence of the motor cars.

It is desired to provide means to inform operators of the motor cars of traffic conditions in the track stretch so that these cars can be removed from the track rails when movement of a train through the stretch is anticipated. In order to provide this information on the motor cars it has been proposed to equip the motor cars with indication lamps controlled by relays connected across the track rails so as to be operated by energy from the track circuits. When a car is traversing a stretch in which traffic movements are not authorized, the steady energy supplied to the track rails causes the relay on the car to steadily establish the circuit of the indication lamp on the car, but if the car is traversing a stretch in which traffic movements are authorized, the coded energy supplied to the track rails causes the relay on the car to intermittently establish the circuit of the indication lamp on the car and this flashing lamp is notice to the operator of the car to expect a train and to remove the car from the track.

In order for the indications on the motor cars to be complete it is necessary for the track circuits for the track sections in the portions of the main track beside passing sidings, and in the passing sidings if they are provided with track circuits, to be arranged to operate in substantially the same manner as the track circuits for the track sections in the single track stretch, that is, so that coded or steady energy is supplied to the section rails according as traffic is or is not authorized to move through the track section.

It is an object of our invention to provide improved track circuit apparatus for use in the track sections beside a passing siding, or in passing sidings equipped with track circuits, of a track stretch equipped with signaling apparatus of the type described.

A further object of the invention is to provide improved apparatus of the type described which is arranged so as to be controlled by the remote control apparatus governing traffic in the track stretch without exceeding the normal capacity of the remote control apparatus.

Other objects of the invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawings.

We shall describe one form of railway signaling apparatus embodying our invention and shall then point out the novel features thereof in claims.

In practicing our invention we provide a track section with two sets of coded track circuit apparatus, one for each direction of traffic. When the signals at both ends of this section are manually held at stop, steady energy is supplied to the section rails at one end of the section and picks up the track relay at the other end of the section to indicate that the section is not occupied.

When it is desired to prepare the section for traffic in one direction, the C. T. C. system or other remote control apparatus is operated to cut off the supply of steady energy to the section rails, thereby releasing the track relay at the other end of the section and causing the equipment at that end of the section to operate to supply coded energy to the section rails. This energy operates the track relay of the track circuit for the selected direction of traffic to clear the associated signal, while at this time the track circuit apparatus for the other direction of traffic is operated by feed-back energy and thus maintains the indication of the fact that the section is not

occupied. When a train enters the section, the supply of feed-back energy over the section rails is cut off, thereby causing the track circuit apparatus to operate to indicate that the section is occupied, while steady energy is supplied to the section rails behind the train, and when the section is vacated, this energy picks up the track relay at the exit end of the section to thereby cut off the supply of coded energy to the section rails and indicate that the section has been vacated.

When it is desired to prepare the section for traffic in the opposite direction, the C. T. C. or remote control system is operated to cut off the supply of steady energy to the section rails and to cause coded energy to be substituted therefor to thereby operate the track relay of the track circuit for the selected direction of traffic to clear the associated signal. On movement of a train through the section, the apparatus of the track circuit for the other direction of traffic is arranged to be operated by feed-back energy when the section is vacated and master code energy is again supplied over the section rails, while operation of this track circuit apparatus by feed-back energy cuts off the supply of coded energy to the section rails and causes steady energy to be supplied thereto.

In the drawings, Figs. 1A and 1B, when placed together with Fig. 1B at the right, form a diagram of a section of railway track equipped with track circuit apparatus embodying our invention.

Referring to the drawings there is shown therein a portion of a stretch of railway track through which traffic may move in either direction. The portion of the track stretch shown includes a passing siding PS, the left-hand or west end of which is connected with the main track by a switch 1W, and the right-hand or east end of which is connected with the main track by a switch 3W.

The track rails 1 and 2 of the main track are divided by insulated joints 3 into a plurality of track sections including a detector section 1T which includes the switch 1W, a detector section 3T which includes the switch 3W, and a section 2T which includes the portion of the main track beside the passing siding PS.

The single track portions of the track stretch at each side of the passing siding are likewise divided into track sections and these portions are equipped with signaling apparatus of the type shown in Letters Patent of the United States No. 2,344,333 to James J. Van Horn.

This invention is directed particularly to the track circuits for section 2T and to the means for controlling the signals 2RA and 4LA which govern traffic in section 2T, and is not concerned with the construction and operation of the signaling system for the single track portions except insofar as the apparatus of this invention is intended to operate in conjunction with the apparatus for the single track portions.

The detector sections 1T and 3T are each provided with a track circuit including a track relay TR which is energized by current supplied from a track battery over the section rails.

Each switch has associated therewith a polarized indication relay WP to which is supplied energy of normal or reverse polarity according as the switch occupies its normal or its reverse position, while each switch indication relay WP controls a normal switch indication relay NWP and a reverse switch indication relay RWP.

The track section 2T is provided with two sets of coded track circuit apparatus, one for each direction of traffic. As shown, there is a code following track relay 2ETR located at the west end of section 2T and operated by energy supplied from a battery 2ETB at the east end of the section, while a code following track relay 2WTR at the east end of section 2T is operated by energy supplied from a battery 2WTB at the west end of the section.

The relays 2ETR and 2 WTR are of the polar biased neutral type and their contacts pick up only when energy flows through their windings in the direction indicated by the arrows, while coding relays 2WCTM and 2ECTM control the supply of energy from the track batteries through the track relay windings to the track rails.

The signaling apparatus for section 2T is governed by remote control apparatus, such as a C. T. C. system, which controls relays 2RHSR and WFSR at the west end of section 2T and relay 4LHSR at the east end of section 2T.

The equipment at each end of section 2T includes a source of direct current, the positive and negative terminals of which are designated B and C, respectively.

The equipment is shown in its normal condition in which traffic in neither direction is authorized to enter section 2T. At this time, the contacts of relay 2RHSR occupy their left-hand or normal positions, while the contacts of relays WFSR and 4LHSR occupy their right-hand or reverse positions, and steady energy is supplied to relay 2WCTM over the circuit which includes front contact 10 of relay 1TR, front contact 11 of relay 2RASR, normal polar contact 14 of relay 2RHSR, front contact 15 of relay 1NWP, and reverse polar contact 16 of relay WFSR. Accordingly, contact 18 of relay 2WCTM is picked up and establishes the circuit for supplying steady energy from battery 2WTB through the winding of relay 2ETR to the rails of section 2T.

At this time, relay 2ETR is steadily released so relays 2RAH and 2RAD are released, while as the contacts of relay 2RHSR are in their left-hand or normal positions, energy is supplied to the red or stop lamp R of signal 2RA.

As hereinafter explained, relay 2ECTM is released at this time and its contact 20 establishes the circuit of relay 2WTR so that energy supplied from battery 2WTB to the rails of section 2T feeds to relay 2WTR and picks up its contacts. As relay 2WTR is picked up, energy is supplied over its front contact 21 to relay TWTRP which is a code following repeater of relay 2WTR. Accordingly, relay 2WTRP is picked up and its contact 23 permits energy to be supplied over the relay stick circuit including back contact 24 of relay 2ECTM and front contact 22 of relay EFSR, while contact 25 of relay 2WTRP establishes the circuit of slow release relay FSA and relay FSA is picked up.

At this time, relay 4LHSPR is released so that its contact 26 interrupts the circuit of the primary winding of decoding transformer WDT.

As relay 2WTRP is steadily energized, and as the circuit of the primary winding of transformer WDT is interrupted, the relays 2LH and 2LD are released.

As relay FSA is picked up, its contact 48 interrupts the pick-up circuit of relay EFSR, while contact 21 of relay 2WTR interrupts the stick circuit of relay EFSR so it is released and its contact 22 interrupts the stick circuit for relay 2WTRP.

As the contacts of relay 4LHSR are in their

right-hand position, contact 33 establishes the circuit of the red or stop lamp R of signal 4LA.

At this time, the relay WSR is energized by current supplied over its pick-up circuit which includes front contact 30 of relay 4LASR, front contact 31 of relay 3TR, and front contact 32 of relay FSA, while energy is also supplied to relay WSR over the stick circuit which includes its own front contact 34 and front contact 30 of relay 4LASR. As relay WSR is picked up, its contact 35 permits energy to be supplied to relay EFSR, and its contact 36 permits energy to be supplied to relay 2ECTM.

As relay 2WTR is steadily picked up, its contact 21 interrupts the circuit of relay 4LHSPR and its contacts are released so that contact 40 interrupts connection from one terminal of secondary winding 41 of transformer WDT to terminal C and thus prevents supply of energy from this winding to relay 2ECTM.

The approach locking stick relay 4LASR is provided to prevent movement of switch 3W or clearing of signals 4LA and 4LB except when conditions are proper. The details of the control of relay 4LASR are not a part of this invention and this relay may be governed in any manner well known in the art, and one way in which the relay may be governed is shown in Letters Patent of the United States No. 2,093,170 of Ronald A. McCann, or in Letters Patent of the United States No. 2,117,691 of Earl M. Allen et al. The relay 4LASR, when picked up, causes both of the signals governing movement of westbound traffic across switch 3W to display stop indications, and must be released before either of these signals can display a permissive indication.

Similarly, the relay 2RASR is provided to prevent movement of the switch 1W or clearing of the signals 2RA and 2RB governing movement of eastbound traffic across the switch 1W except when conditions are proper. The relay 2RASR when picked up causes both of the signals governing movement of westbound traffic across the switch 1W to display stop indications, and must be released before either of these signals can display a permissive indication.

As explained in the above identified patent to Allen et al. the circuits of the locking relays RASR and LASR are controlled by route relays so that the locking relays release when and only when the route sought to be established is complete.

The C. T. C. system employed for communication between the office and stations may be of the type shown in application for Letters Patent of the United States, Serial No. 496,907 of Arthur P. Jackel, filed July 31, 1943, for Remote control systems. The details of the construction and operation of the C. T. C. system are not a part of this invention except insofar as the apparatus of this invention is intended to operate in conjunction with the C. T. C. system.

For purposes of this application it is sufficient to state that the C. T. C. system provides means operable at the will of the operator to energize the relay 2RHSR with current of either polarity and to energize relay 4LHSR with current of either polarity, while the system also provides means under the control of the operator for supplying energy to the upper winding of relay WFSR to thereby move the contact of this relay to its left-hand or normal position. A terminal of the winding of relay WFSR is connected to a terminal 150 on the coding unit of the C. T. C. system at the field station, and this terminal is identified by the same reference numeral as is employed in the Jackel application referred to above to identify the corresponding terminal.

This system provides means for causing the C. T. C. system to operate to transmit to the office an indication of occupancy of section 2T. When relay FSA releases, its contact 42 establishes a connection from a source of current to terminal 142 of the station unit, this terminal being identified by the same reference numeral as is employed for the corresponding terminal in Fig. 2C of the above-mentioned Jackel application.

From the foregoing, it will be seen that when the signals governing entrance of trains into section 2T at both ends of the section are at stop steady energy is supplied to the section rails. Accordingly, if at this time a motor car equipped with indication means governed by energy in the track circuit is present in section 2T, the indication means will operate to indicate that trains are not authorized to enter this section.

Operation of equipment to authorize an eastbound train to enter section 2T

In order to prepare section 2T for eastbound traffic the operator manipulates the C. T. C. system to move the contacts of relay 2RHSR to their right-hand or reverse positions. On this movement of the contacts of relay 2RHSR contact 44 interrupts one circuit for supplying energy to the red lamp R of signal 2RA and establishes the circuit controlled by contacts of relays 1NWP and 2RASR for supplying energy to the lamps of signal 2RA.

On movement of the contacts of relay 2RHSR to their reverse positions the relay 2RASR releases to permit energy to be supplied to the lamps of signal 2RA over the circuits controlled by relays 1TR, 2RH and 2RD. The means by which relay 2RASR is controlled by relay 2RHSR is not a part of this invention, and the circuits of relay 2RASR may be arranged in any appropriate manner well known in the art, as for example as shown in the above-mentioned patents to Ronald A. McCann, and to Earl M. Allen et al.

In addition, on this movement of the contacts of relay 2RHSR its contact 14 interrupts the circuit traced above for supplying steady energy to relay 2WCTM and connects relay 2WCTM to a secondary winding of the decoding transformer EDT. Accordingly, contact 18 of relay 2WCTM releases and cuts off the supply of energy from battery 2WTB to the rails of section 2T so relay 2WTR releases and its contact 21 interrupts the pick-up circuit of relay 2WTRP. At this time the stick circuit of relay 2WTRP is interrupted by contact 22 of relay EFSR so relay 2WTRP releases when its pick-up circuit is interrupted.

On release of relay 2WTR its contact 21 establishes connection from terminal B over back contact 50 of relay EFSR, to one terminal of the winding of relay 4LHSPR. However, at this time, contact 65 of relay 4LHSR interrupts connection from the other terminal of the winding of relay 4LHSPR to terminal C so relay 4LHSPR remains released and its contact 66 maintains connection from terminal C to one terminal of the winding of relay EFSR.

On release of relay 2WTRP, its contact 25 interrupts the circuit of relay FSA and it releases so that energy is supplied to relay EFSR over its pick-up circuit which includes back contact 48 of relay FSA, front contact 35 of relay WSR, winding of relay EFSR, and back contact 66 of relay 4LHSPR. Accordingly, the contacts of re-

lay EFSR pick up and energy is supplied to the relay over its stick circuit which includes back contact 21 of relay 2WTR, front contact 50 of relay EFSR, front contact 35 of relay WSR, and back contact 66 of relay 4LHSPR, while contact 50 of relay EFSR interrupts the circuit of relay 4LHSPR to thereby insure that relay 4LHSPR remains released.

When relay EFSR picks up, its contact 52 establishes a circuit for supplying to the relay 2ECTM coded energy of 75 or 180 code frequency depending on the position of a contact 54 which is governed in accordance with the aspect displayed by signal 4RA so as to be released when signal 4RA displays its stop indication and to be picked up when signal 4RA displays either its caution or its clear indication. After picking up of relay EFSR, if contact 54 is released, energy is supplied to relay 2ECTM over the circuit which includes back contact 53 of relay 2WTR, a contact of code transmitter 75CT, contact 54, front contact 52 of relay EFSR, front contact 36 of relay WSR, and front contact 55 of relay 3TR, while if contact 54 is picked up, energy is supplied from terminal B over a contact of code transmitter 180CT, front contact 54, front contact 52 of relay EFSR, front contact 36 of relay WSR, and front contact 55 of relay 3TR to relay 2ECTM.

The coded energy supplied to relay 2ECTM operates it so that coded energy is supplied from battery 2ETB to the rails of section 2T and this energy feeds to relay 2ETR over back contact 18 of relay 2WCTM and operates relay 2ETR so that energy is supplied through the decoding transformer EDT to relay 2RH, and is also supplied to relay 2RD through the resonant rectifier unit 180DU if relay 2ETR is operated by energy of 180 code frequency.

During the picked-up periods of relay 2ETR, energy is supplied over its front contact 51 to the lower winding of relay WFSR, and this energy serves to maintain contact 16 of relay WFSR in its reverse position as shown.

At this time, therefore, energy is supplied over reverse polar contact 44 of relay 2RHSR, front contact 56 of relay 1NWP, back contact 57 of relay 2RASR, front contact 58 of relay 1TR, front contact 59 of relay 2RH, and contact 60 of relay 2RD to the green or the yellow lamp of signal 2RA depending on whether contact 60 of relay 2RD is picked up or released.

In addition, as a result of operation of relay 2ETR energy is supplied from a secondary winding of transformer EDT to relay 2WCTM. The relay 2WCTM is of a type the contact of which picks up only when energy of a selected polarity is supplied to the relay winding, while the various parts of the equipment are arranged so that energy of this polarity is supplied from transformer EDT to the relay 2WCTM on release of the contacts of relay 2ETR. The impulses of energy supplied from transformer EDT to relay 2WCTM pick up the contacts of relay 2WCTM momentarily and keep them picked up for a period somewhat shorter than the shortest "off" period in the coded energy supplied to relay 2ETR.

When contact 18 of relay 2WCTM picks up, an impulse of feed-back energy is supplied from battery 2WTB through the winding of relay 2ETR to the rails of section 2T and this energy feeds over back contact 20 of relay 2ECTM to relay 2WTR and picks up its contacts so that its contact 21 establishes the circuit of relay 2WTRP. When relay 2WTRP picks up, energy is supplied to the relay over its stick circuit which includes front contact 22 of relay EFSR, front contact 23 of relay 2WTRP, and back contact 24 of relay 2ECTM, and this energy serves to maintain the contacts of relay 2WTRP picked up throughout the entire released period of the contacts of relay 2ECTM.

When relay 2WTRP picks up, its contact 25 establishes the circuit of relay FSA and its contact 42 interrupts the circuit leading to terminal 142 of the C. T. C. field station unit and the C. T. C. equipment operates to indicate that section 2T is not occupied.

When relay 2WTR picks up, its contact 53 interrupts the circuit for supplying coded energy of 75 code frequency to relay 2ECTM. Mowever, the impulses of energy supplied to relay 2WTR when relay 2WCTM is operated by energy from the transformer EDT are of such limited duration that relay 2WTR releases and reestablishes the circuit for supplying energy to relay 2ECTM before closing of the contact of the code transmitter controlling the supply of energy of 75 code frequency to relay 2ECTM.

When relay 2WTR releases, its contact 21 interrupts the pick-up circuit of relay 2WTRP but this relay is held picked up by energy supplied over its stick circuit until relay 2ECTM picks up.

If at this time energy of 180 code frequency is being supplied to relay 2ECTM, the circuit for supplying energy to relay 2ECTM is established as soon as the contact of code transmitter 180CT closes regardless of whether or not the contacts of relay 2WTR have released. Under these conditions, when relay 2ECTM picks up, its contact 24 interrupts the stick circuit for relay 2WTRP, while its contact 20 interrupts the circuit connecting relay 2WTR across the section rails and establishes the circuit for supplying energy from battery 2ETB through the relay 2WTR to the section rails. The energy supplied from battery 2ETB through the winding of relay 2WTR causes the relay contacts to release, if they are not already released, so that contact 21 interrupts the pick-up circuit for relay 2WTRP and its contacts release.

At this time, therefore, relay 2ECTM is operated by coded energy and causes impulses of master code to be supplied to the rails of section 2T, while relay 2WCTM operates as a feed-back impulse relay to supply an impulse of feed-back energy to the section rails during each "off" period in the master code. The impulses of feed-back energy pick up the relay 2WTR momentarily so that relay 2WTRP is picked up and remains picked up until relay 2ECTM picks up to supply another impulse of master code to the section rails, whereupon relay 2WTRP releases.

As relay FSA is picked up, its contact 48 interrupts the pick-up circuit of relay EFSR but relay EFSR is maintained picked up by energy supplied over its stick circuit during the released periods of contact 21 of relay 2WTR.

As relay 4LHSPR is released, its contact 26 interrupts the circuit of the primary winding of transformer WDT so energy is not supplied through transformer WDT to relays 2LD and 2LH and they remain released.

When an eastbound train accepts signal 2RA and enters section 1T, the track relay 1TR releases and its contact 58 interrupts the circuit controlled by relays 2RH and 2RD for supplying energy to the lamps of signal 2RA and establishes a circuit for supplying energy to the red lamp R of the signal.

In addition, on release of relay 1TR, its contact

63 interrupts the circuit of slow releasing relay 1TRP and establishes a circuit including front contact 64 of relay 1TRP for supplying to the lower winding of relay 2RHSR energy effective to move the contacts of relay 2RHSR to their left-hand or normal positions so that contact 44 establishes the circuit of the red lamp R of signal 2RA, while contact 14 establishes a circuit including back contact 11 of relay 2RASR for supplying energy from transformer EDT to relay 2WCTM.

When relay 1TR releases and the contacts of relay 2RHSR move to their left-hand or normal positions, a pick-up circuit, not shown, is established for relay 2RASR and its contacts pick up.

On release of relay 1TR, its contact 10 interrupts the circuit for supplying steady energy to relay 2WCTM and establishes a circuit for connecting relay 2WCTM to a secondary winding of transformer EDT after relay 2RASR picks up and the contacts of relay 2RHSR move to their normal positions. This circuit is traced from a terminal of the transformer secondary winding over back contact 10 of relay 1TR, front contact 11 of relay 2RASR, normal polar contact 14 of relay 2RHSR, front contact 15 of relay 1NWP, and reverse polar contact 16 of relay WFSR to the relay 2WCTM, and insures that relay 2WCTM will continue to operate to supply impulses of feed-back energy to the rails of section 2T until the train advances into section 2T.

When the train advances into section 2T, the track relay 2ETR is shunted and relays 2RH and 2RD release, while relay 2WCTM ceases to supply impulses of feed-back energy to the rails of section 2T so relay 2WTR remains released and does not establish the circuit of relay 2WTRP. Accordingly, relay 2WTRP remains released and does not establish the circuit of relay FSA and it releases so that its contact 42 establishes the circuit for supplying energy to terminal 142 of the C. T. C. system station unit to thereby cause the C. T. C. system to transmit to the office an indication of the fact that section 2T is occupied.

At this time relay EFSR is maintained picked up by energy supplied over its stick circuit which includes its own front contact 50 and back contact 21 of relay 2WTR, as well as by energy supplied over back contact 48 of relay FSA.

On release of relay FSA, its contact 32 interrupts the pick-up circuit for relay WSR, but relay WSR is maintained picked up by energy supplied over its stick circuit.

If, at this time, signal 4RA is displaying a permissive indication, the train may advance into the single track stretch, and when it enters section 3T, track relay 3TR releases and its contact 55 interrupts the circuit for supplying coded energy to relay 2ECTM, while contact 31 of relay 3TR additionally interrupts the pick-up circuit of relay WSR.

On release of relay 3TR, means not shown, causes the signal 4RA to display its stop indication and contact 54 causes coded energy subsequently supplied to relay 2ECTM to be of 75 code frequency, while signal 4RA continues to display its stop indication as long as the adjacent section in advance of section 3T is occupied.

When the train vacates section 1T, track relay 1TR picks up and steady energy is supplied to relay 2WCTM over front contact 10 of relay 1TR, front contact 11 of relay 2RASR, normal polar contact 14 of relay 2RHSR, front contact 15 of relay 1NWP, and reverse polar contact 16 of relay WFSR. Accordingly, contact 13 of relay 2WCTM is picked up so that steady energy is supplied from battery 2WTB to the rails of section 2T. When the train vacates section 2T, this steady energy feeds to relay 2WTR and picks up its contacts so that contact 53 interrupts the circuit for supplying coded energy of 75 code frequency to relay 2ECTM, while contact 21 interrupts the stick circuit of relay EFSR and establishes the circuit of relay 2WTRP so that relay 2WTRP picks up and its contact 25 establishes the circuit of relay FSA and it picks up with the result that contact 48 interrupts the pick-up circuit of relay EFSR. Accordingly, relay 2ECTM remains released and maintains the circuit of relay 2WTR, while relay EFSR releases so that its contact 50 additionally interrupts the relay stick circuit, while contact 52 of relay EFSR interrupts the circuit for supplying coded energy to the relay 2ECTM.

On the supply of energy to relay 2WTRP and resultant picking up of relay FSA, its contact 42 interrupts the supply of energy to terminal 142 of the C. T. C. system station unit and thus causes the C. T. C. system to transmit to the office an indication of the fact that section 2T has been vacated.

If, while section 2T is occupied, the operator wishes to permit another eastbound train to enter section 2T as soon as it is vacated by the first train, the C. T. C. system is operated to move the contact 14 of relay 2RHSR to its reverse position to thereby cut off the supply of steady energy to relay 2WCTM and it remains released so that steady energy is not supplied to the rails of section 2T.

Accordingly, when the first train vacates section 2T, the equipment at the east end of the section supplies coded energy to the section rails and this energy operates track relay 2ETR to clear signal 2RA while relay 2WCTM functions as an impulse relay to supply feed-back energy to the section rails and cause the equipment at the exit end of the section to indicate that the section has been vacated.

If, after signal 2RA has been cleared but before a train has entered section 2T, it is desired to put the signal to stop, the C. T. C. system is operated to move the contacts of relay 2RHSR to their left-hand positions so that contact 44 of relay 2RHSR establishes the circuit of the red or stop lamp R of signal 2RA. As a result of this movement of the contacts of relay 2RHSR, a circuit, not shown, is established to pick up relay 2RASR after a predetermined time interval, such as four minutes. When relay 2RASR picks up, steady energy is supplied to relay 2WCTM and it is picked up to interrupt the circuit of relay 2ETR and to cause steady energy to be supplied to the rails of section 2T. This energy keeps relay 2WTR picked up so that relay EFSR releases and its contact 52 cuts off the supply of coded energy to the relay 2ECTM and thus to the rails of section 2T.

Operation of equipment to authorize a westbound train to enter section 2T

In order to prepare section 2T for westbound traffic, the operator manipulates the C. T. C. system to cause the station apparatus at the right-hand end of section 2T to supply energy to relay 4LHSR to move its contacts to their left-hand or normal position, while the station apparatus at the left-hand end of section 2T is caused to establish connection from terminal B of the source of current to terminal 150 of the station unit and thus cause to be supplied to relay WFSR

energy effective to move its contact 16 to its left-hand or normal position.

On this movement of the contact 16 of relay WFSR, the supply of steady energy to relay 2WCTM is cut off and coded energy is supplied thereto over the circuit which includes a contact of a code transmitter 180CT or 75CT, depending on the position of contact 68 which is governed in accordance with the indication displayed by signal 2LA, front contact 69 of relay 1TR, front contact 70 of relay 2RASR, and normal polar contact 16 of relay WFSR. Accordingly, relay 2WCTM operates to supply coded energy from battery 2WTB to the rails of section 2T.

On movement of contact 65 of relay 4LHSR to its left-hand or normal position, connection is established from terminal C over front contact 67 of relay 3NWP to the right-hand terminal of the winding of relay 4LHSPR, so that as soon as the contacts of relay 2WTR release, energy is supplied to relay 4LHSPR over the circuit including back contact 21 of relay 2WTR, back contact 50 of relay EFSR, winding of relay 4LHSPR, front contact 67 of relay 3NWP, and normal polar contact 65 of relay 4LHSR. The energy supplied to relay 4LHSPR picks up its contacts so that contact 66 interrupts connection from terminal C to the right-hand terminal of the winding of relay EFSR to thereby insure that relay EFSR remains released, while contact 66 establishes connection from terminal C to the right-hand terminal of the winding of relay 4LHSPR to thereby keep the relay energized after contact 65 of relay 4LHSR is moved to its right-hand or reverse position.

During code following operation of the relay 2WTR, the supply of energy to relay 4LHSPR is interrupted during the picked-up periods of contact 21 of relay 2WTR, but the relay 4LHSPR is slow enough in releasing to remain picked up in the periods during which the supply of energy to the relay winding is interrupted.

When relay 4LHSPR picks up, its contact 26 establishes the circuit for supplying energy to the primary winding of transformer WDT so that on coding operation of relay 2WTRP energy is supplied through the transformer to relay 2LH and also to relay 2LD if relay 2WTRP is operated at the 180 code rate.

In addition, on picking up of relay 4LHSPR, its contact 40 establishes connection from one terminal of secondary winding 41 of transformer WDT to the reverse polar contact 65 of relay 4LHSR so that, when contact 65 of relay 4LHSR is returned to its reverse position, energy may be supplied from secondary winding 41 of transformer WDT to relay 2ECTM.

At this time, relay EFSR is released and its contact 22 interrupts the stick circuit for relay 2WTRP so that relay 2WTRP operates as a direct repeater of relay 2WTR.

On movement of the contacts of relay 4LHSR to their left-hand or normal position, contact 33 interrupts the circuit of the red lamp R of signal 4LA and estabishes the circuit controlled by relays 3NWP, EFSR, 4LASR, 2LH and 2LD for supplying energy to the lamps of signal 4LA, while on this movement of the contacts of relay 4LHSR the relay 4LASR releases. The means for controlling relay 4LASR is not a part of this invention and this relay may be controlled as explained in the above-identified patents to McCann and to Allen et al.

On release of relay 4LASR, its contact 30 interrupts the circuit of relay WSR and it releases with the result that its contact 34 additionally interrupts the relay stick circuit, while its contact 35 additionally interrupts the circuit of relay EFSR to insure that it remains released.

On release of relay 4LASR, energy is supplied over normal polar contact 33 of relay 4LHSR, front contact 72 of relay 3NWP, back contact 23 of relay EFSR, back contact 64 of relay 4LASR, front contact 71 of relay 3TR, front contact 73 of relay 2LH, and contact 74 of relay 2LD to the yellow or the green lamp of signal 4LA.

As a result of code following operation of relay 2WTRP energy is induced in the secondary winding 41 of transformer WDT. However, relay WSR is released and its contact 36 interrupts the circuit for supplying energy from winding 41 of transformer WDT to relay 2ECTM, while this circuit is additionally interrupted by contact 65 of relay 4LHSR so relay 2ECTM remains released and does not operate to supply impulses of feedback energy to the rails of section 2T. Accordingly, relay 2ETR remains released and its contact 51 does not establish the circuit of the lower winding of relay WFSR and its contact 16 remains in its normal position to maintain the circuit for supplying coded energy to relay 2WCTM.

If a westbound train now accepts the permissive indication displayed by signal 4LA and advances into section 3T, track relay 3TR will release so that its contact 71 interrupts the circuits controlled by relays 2LD and 2LH for supplying energy to the lamps of signal 4LA and establishes a circuit for supplying energy to the red lamp R of this signal.

Also, on release of relay 3TR, its contact 76 interrupts the circuit of slow releasing relay 3TRP and establishes a circuit including front contact 77 of relay 3TRP for supplying to relay 4LHSR energy effective to move the relay contacts to their right-hand or reverse position. On release of relay 3TR and movement of the contacts of relay 4LHSR to their reverse position, the relay 4LASR is picked up by a circuit, not shown, while relay 4LASR remains picked up after relay 3TR picks up.

On movement of the contacts of relay 4LHSR to their right-hand or reverse position, contact 65 interrupts connection from terminal C to a terminal of the winding of relay 4LHSPR, but contact 66 of relay 4LHSPR maintains connection from terminal C to the relay winding so the relay contacts remain picked up.

On movement of contact 65 of relay 4LHSR to its right-hand or reverse position, connection is established from terminal C over front contact 40 of relay 4LHSPR to one terminal of the winding 41 of transformer WDT, but at this time the supply of energy from the transformer to relay 2ECTM is prevented because of release of contact 36 of relay WSR or contact 55 of relay 3TR, while as soon as the train enters section 2T the relay 2WTR ceases to follow code and impulses of energy are no longer induced in secondary winding 41 of transformer WDT and energy therefore is not supplied from this winding to relay 2ECTM. Accordingly, at this time, relay 2ECTM remains released and maintains the circuit of relay 2WTR and does not cause energy to be supplied from battery 2ETB to the rails of section 2T.

In addition, on movement of the contacts of relay 4LHSR to their right-hand or reverse position, contact 33 establishes the circuit of the red lamp R of signal 4LA.

When the train advances into section 2T, the

track relay 2WTR ceases to follow code so relay 2WTRP remains released and relay FSA releases and its contact 42 establishes the circuit leading to terminal 142 of the C. T. C. system station unit and this system transmits to the office an indication of the fact that section 2T is occupied. In addition, on release of relay FSA, its contact 32 interrupts the pick-up circuit of relay WSR so that relay WSR remains released after section 3T is vacated and relay 3TR picks up.

When relay 2WTRP ceases to follow code, energy ceases to be supplied through transformer WDT to relays 2LH and 2LD and they release.

If signal 2LA has been cleared, the train may advance into the single track portion at the left of section 2T. When the train enters section 1T, track relay 1TR releases and its contact 69 interrupts the circuit traced above for supplying coded energy to relay 2WCTM so coded energy ceases to be supplied to the rails of section 2T. At this time, signal 2LA is caused to display its stop indication so contact 68 establishes the circuit for supplying energy of 75 code frequency to relay 2WCTM after section 1T is vacated and relay 1TR picks up.

When the train vacates sections 2T and 1T, the relay 2WCTM is operated by energy of 75 code frequency and causes coded energy to be supplied to the rails of section 2T. This energy picks up relay 2WTR so that it establishes the circuit of relay 2WTRP and it picks up and its contact 25 establishes the circuit of relay FSA. Accordingly, relay FSA picks up so that its contact 42 interrupts the circuit leading to terminal 142 of the C. T. C. system station unit and the C. T. C. system operates to transmit to the office an indication of the fact that section 2T has been vacated.

When relay FSA picks up, energy is supplied to relay WSR over its pick-up circuit which includes front contact 39 of relay 4LASR, front contact 31 of relay 3TR, and front contact 32 of relay FSA, so the relay WSR picks up and its contact 34 establishes a stick circuit to maintain the relay picked up as long as relay 4LASR is picked up.

When relay 2WTR picks up, its contact 21 interrupts the circuit of relay 4LHSPR but this relay is slow in releasing so that its contacts remain picked up during the picked-up periods of relay 2WTR while relay 2WTR is operated by coded energy. Accordingly, front contact 66 of relay 4LHSPR remains closed so that energy is supplied to the relay winding during the released periods of contact 21 of relay 2WTR, while contact 40 of relay 4LHSPR maintains connection from a terminal of the winding 41 of transformer WDT over reverse polar contact 65 of relay 4LHSR to terminal C, and contact 26 of relay 4LHSPR maintains the circuit of the primary winding of transformer WDT.

During the first "off" interval in the coded energy supplied from battery 2WTB to the rails of section 2T, relays 2WTR and 2WTRP release and there is induced in the secondary winding 41 of transformer WDT an impulse of energy of the polarity effective to pick up the contacts of relay 2ECTM momentarily. This energy is supplied to relay 2ECTM over the circuit which is traced from terminal C over reverse polar contact 65 of relay 4LHSR, front contact 40 of relay 4LHSPR, winding 41 of transformer WDT, back contact 52 of relay EFSR, front contact 36 of relay WSR, front contact 55 of relay 3TR, and winding of relay 2ECTM to terminal C.

When relay 2ECTM picks up, an impulse of feedback energy is supplied from battery 2ETB to the rails of section 2T and this energy feeds over back contact 18 of relay 2WCTM to relay 2ETR and picks up its contacts so that contact 51 establishes the circuit for supplying energy to the lower winding of relay WFSR. This energy moves the contact 16 of relay WFSR from its normal to its reverse position to thereby cut off the supply of coded energy to relay 2WCTM and to establish the circuit for supplying steady energy thereto. This circuit includes front contact 19 of relay 1TR, front contact 11 of relay 2RASR, normal polar contact 14 of relay 2RHSR, front contact 15 of relay 1NWP, and reverse polar contact 16 of relay WFSR.

Accordingly, relay 2WCTM is steadily picked up and causes steady energy to be supplied from battery 2WTB to the rails of section 2T. This energy feeds over back contact 20 of relay 2ECTM to relay 2WTR and keeps it picked up so that relay 2WTRP is steadily picked up to maintain the circuit of relay FSA, while as relay 2WTR is steadily picked up, its contact 21 interrupts the circuit of the relay 4LHSPR.

As relay 2WTRP is steadily picked up, energy is not supplied from transformer WDT to relay 2ECTM and it remains released and connects relay 2WTR across the rails of section 2T.

After a short time interval, relay 4LHSPR releases and its contact 26 interrupts the circuit of the primary winding of transformer WDT, and there is induced in secondary winding 41 an impulse of energy of the polarity effective to pick up the contacts of relay 2ECTM. However, on release of relay 4LHSPR, its contact 40 interrupts the circuit for supplying energy from transformer winding 41 to the relay 2ECTM so relay 2ECTM remains released and maintains the circuit of relay 2WTR.

On release of relay 4LHSPR, its contact 66 additionally interrupts the circuit of the relay winding.

From the foregoing it will be seen that when section 2T is conditioned for westbound traffic, the supply of steady energy to the section rails is cut off and coded energy is supplied to the section rails at the west or exit end of the section. This energy operates the equipment at the east or entrance end of the section to control signal 4LA and to keep relay FSA picked up and cause the C. T. C. system to indicate that section 2T is not occupied.

Since coded energy is supplied to the rails of section 2T when the section is prepared for westbound traffic, the equipment on a motor car present in the track section when the section is prepared for westbound traffic will operate to indicate that trains are authorized to enter the section.

When a westbound train enters the section, relay FSA releases and causes the C. T. C. system to report that the section is occupied, while coded energy continues to be supplied to the west end of the section. Entrance of a westbound train into section 3T conditions the equipment at the east end of section 2T to operate to supply feedback energy to the section rails when section 2T is vacated and master code energy is again supplied over the section rails. The feed-back energy supplied to the rails of section 2T causes the equipment at the west end of the section to cut off the supply of coded energy to the section rails and to supply steady energy thereto and thus restore the equipment to its normal inactive condition.

If, while section 2T is occupied, the operator wishes to authorize another westbound train to enter the section as soon as it is vacated by the first train, the C. T. C. system is operated to move the contacts of relay 4LHSR to their left-hand or normal positions. On this movement of the contacts of relay 4LHSR, the relay 4LASR releases and its contact 30 interrupts the circuit of relay WSR so that relay WSR remains released if the first train vacates section 2T before the second train enters the section. As relay WSR is released, its contact 36 interrupts the circuit for supplying energy from winding 41 of transformer WDT to relay 2ECTM. Furthermore, when contact 65 of relay 4LHSR is in its left-hand position, it interrupts connection from terminal C over front contact 40 of relay 4LHSPR to a terminal of secondary winding 41 of transformer WDT and therefore additionally prevents supply of energy from this winding to relay 2ECTM. Accordingly, when the first train vacates section 2T and relay 2WTR is operated by coded energy supplied over the section rails, energy is not supplied from winding 41 of transformer WDT to relay 2ECTM and it does not operate to supply impulses of feed-back energy from battery 2ETB to the rails of section 2T and relay 2ETR remains released and its contact 51 does not establish the circuit of the lower winding of relay WFSR. As a result, contact 16 of relay WFSR remains in its left-hand position to maintain the circuit for supplying coded energy to relay 2WCTM so coded energy continues to be supplied to the rails of section 2T and operates the equipment at the east end of the section to clear signal 4LA and authorize the second westbound train to enter section 2T.

Operation of equipment for section 2T when a switch is reversed

The equipment for section 2T is arranged to operate in an appropriate manner when a switch at either end of the section is reversed.

When switch 1W is reversed to connect the passing siding with the single track portion at the left of section 1T, the relay 1NWP releases and relay 1RWP is picked up. On release of relay 1NWP, its contact 15 establishes a circuit independent of relay 2RHSR for supplying steady energy to relay 2WCTM. This permits the relay 2RHSR to be employed at these times to cause signal 2RB to be controlled by traffic conditions in the passing siding, and on movement of the contacts of relay 2RHSR to their reverse positions, steady energy continues to be supplied to relay 2WCTM.

On release of relay 1NWP, its contact 56 interrupts the circuit controlled by relays 2RASR, 1TR, 2RH and 2RD for supplying energy to the lamps of signal 2RA, and establishes a circuit for supplying energy to the red lamp R of this signal to thereby maintain the display of the stop indication by signal 2RA as long as the switch 1W is reversed.

The equipment operates to permit section 2T to be prepared for westbound traffic while switch 1W is reversed. As stated above, when switch 1W is reversed, relay 1NWP is released and relay 1RWP is picked up. When relay 1NWP is released, steady energy is supplied over its back contact 15 and reverse polar contact 16 of relay WFSR to relay 2WCTM so that steady energy is supplied from battery 2WTB to the rails of section 2T.

If it is desired to prepare section 2T for westbound traffic, the C. T. C. equipment is operated to supply energy to relays WFSR and 4LHSR to move their contacts to their left-hand or normal positions. On this movement of the contact 16 of relay WFSR, the supply of steady energy to relay 2WCTM is cut off, while energy of 75 code frequency is supplied thereto over the circuit which includes a contact of code transmitter 75CT, back contact 68, front contact 81 of relay 1RWP, and normal polar contact 16 of relay WFSR. Accordingly, the relay 2WCTM operates to cause energy of 75 code frequency to be supplied to the rails of section 2T, while the equipment at the right-hand or east end of the section operates as explained above so that signal 4LA displays its yellow or caution indication.

The circuit for supplying coded energy to relay 2WCTM at this time is independent of the track relay 1TR so that the supply of coded energy to the relay 2WCTM, and thus to the rails of section 2T, is not affected by occupancy of section 1T by a train moving between the passing siding and the main track.

Similarly, the circuit for supplying coded energy to relay 2WCTM at this time is independent of the relay 2RASR so that coded energy continues to be supplied to relay 2WCTM if relay 2RASR is released to clear signal 2RB and authorize an eastbound train to move from the main track to the passing siding.

If a westbound train accepts the permissive indication displayed by signal 4LA and enters section 2T, the supply of coded energy over the section rails is cut off so the signal 4LA displays its stop indication, while the equipment at the east end of section 2T is conditioned to supply feedback energy to the section rails when the section is vacated.

If, after section 2T is occupied, the switch 1W is restored to its normal position, the relay 1RWP releases and its contacts 81 interrupts the circuit traced above for supplying coded energy to the relay 2WCTM. However, before the switch 1W can be moved, the relays 2RASR and 1TR must be picked up, and on release of relay 1RWP coded energy is supplied to relay 2WCTM over the circuit including front contact 69 of relay 1TR and front contact 70 of relay 2RASR.

When signal 2LA is cleared and the train in section 2T vacates the section, the equipment for section 2T operates as explained above to cause steady energy to be supplied to relay 2WCTM and thus cause steady energy to be supplied to the rails of section 2T.

The equipment for section 2T is also arranged to operate in an appropriate manner when switch 3W is reversed. When switch 3W is reversed, relay 3NWP is released and relay 3RWP is picked up. When relay 3NWP is released, its contact 72 interrupts the circuit over which energy may be supplied to the yellow and green lamps of signal 4LA and establishes a circuit over which energy is supplied to the red lamp R of signal 4LA after movement of contact 33 of relay 4LHSR to its normal position.

When relay 3WRP is picked up, its contacts 85 and 86 establish circuits for energizing relay WSR, while contact 83 establishes a circuit for supplying energy to relay 2ECTM and contact 87 establishes connection from terminal C to the front contact 40 of relay 4LHSPR.

The relay WSR is normally energized by current supplied over its stick circuit which includes its own front contact 34 and front contact 30 of relay 4LASR, and as relay 4LASR must be

picked up before switch 3W can be moved, the relay WSR will normally be picked up when the switch 3W is moved to its reverse position. After movement of the switch 3W to its reverse position, energy may be supplied to relay WSR over the circuit including front contact 85 of relay 3RWP and front contact 34 of relay WSR, while energy may also be supplied to relay WSR over front contact 85 of relay 3RWP, front contact 86 of relay 3RWP, front contact 31 of relay 3TR, and front contact 34 of relay WSR. Accordingly, if, while switch 3W is reversed, relay 4LASR is released to clear signal 4RB, or if section 3T is occupied by a train moving between the passing siding and the main track, the relay WSR is maintained energized by current supplied over the circuits established on picking up of relay 3RWP and front contact 35 of relay WSR is closed to permit energy to be supplied to relay EFSR.

If, while switch 3W is reversed, it is desired to condition section 2T for eastbound traffic, the C. T. C. system is operated to move the contacts of relay 2RHSR to their right-hand or reverse position so that contact 14 of relay 2RHSR interrupts the supply of steady energy to the relay 2WCTM and connects relay 2WCTM to a secondary winding of transformer EDT. As explained above, this results in release of relays 2WTR and 2WTRP and picking up of relay EFSR so that energy of 75 code frequency is supplied to relay 2ECTM over the circuit which includes back contact 53 of relay 2WTR, a contact of code transmitter 75CT, contact 54, front contact 52 of relay EFSR, front contact 36 of relay WSR, and front contact 55 of relay 3TR. At this time, contact 83 of relay 3RWP is closed and establishes a connection shunting contact 55 of relay 3TR and contact 36 of relay WSR in the circuit of relay 2ECTM. This insures that the supply of coded energy to relay 2ECTM will be maintained if relay 3TR is released due to occupancy of section 3T by a train moving between the passing siding PS and the single track stretch at the right of section 3T.

On the supply of coded energy to relay 2ECTM it operates to cause coded energy to be supplied from battery 2ETB to the rails of section 2T and thus cause the equipment at the left-hand end of section 2T to establish the circuit of the yellow lamp Y of signal 2RA, while relay 2WCTM operates to cause impulses of feed-back energy to be supplied to the rails of section 2T. This feed-back energy operates relay 2WTR so that relay 2WTRP causes energy to be supplied to relay FSA.

If an eastbound train now accepts the permissive indication displayed by signal 2RA and enters section 2T, the supply of coded energy over the section rails is cut off and signal 2RA is caused to display its stop indication, while the equipment at the entrance to section 2T causes steady energy to be supplied to relay 2WCTM so that steady energy is supplied to the rails of section 2T.

When section 2T is occupied, the supply of feed-back energy over the section rails is cut off and relay FSA releases to cause the C. T. C. system to indicate that the section is occupied. In addition, when section 2T is occupied, relay 2WTR is released so its contact 21 establishes the stick circuit for relay EFSR which includes its own front contact 59 and front contact 35 of relay WSR and relay EFSR remains picked up to maintain the supply of coded energy to relay 2ECTM.

The switch 3W must be restored to its normal position before the eastbound train in section 2T can vacate the section, and when the switch 3W is moved to its normal position the relay 3RWP releases and relay 3NWP picks up. As relay 4LASR must be picked up before the switch 3W can be moved, contact 30 of relay 4LASR establishes the stick circuit for relay WSR and it remains picked up after release of relay 3RWP.

If signal 4RA is now cleared and the train in section 2T vacates the section, the steady energy supplied to the rails of section 2T at the west end of the section feeds to relay 2WTR and picks up its contacts to prevent supply of energy to relay 2ECTM, and to interrupt the stick circuit for relay EFSR and it thereupon releases. When relay 2WTR picks up, it establishes the circuit of relay 2WTRP and it picks up relay FSA so that contact 42 interrupts the circuit leading to terminal 142 and the C. T. C. system indicates that section 2T has been vacated.

The equipment at the east end of section 2T is arranged to insure proper operation of the track circuit apparatus for section 2T if the switch 3W is reversed at a time when section 2T is occupied by a westbound train. When section 2T is conditioned for westbound traffic, the contact 16 of relay WFSR occupies its left-hand position in which it establishes the circuit for supplying coded energy to relay 2WCTM, while the contacts of relay 4LHSR are moved to their left-hand position to permit signal 4LA to display a permissive indication and to pick up relay 4LHSPR.

On movement of a westbound train through section 3T, the contacts of relay 4LHSR are returned to their right-hand or reverse positions by energy supplied over the circuit controlled by relays 3TR and 3TRP so that contact 65 establishes connection from terminal C over front contact 40 of relay 4LHSPR to one terminal of the secondary winding 41 of transformer WDT. At this time, relay 4LHSPR is maintained picked up by energy supplied over its stick circuit which includes its own front contact 66.

If the switch 3W is now reversed, the relay 3NWP releases and relay 3RWP picks up. If it is desired to permit a second or following westbound train to enter the passing siding, the C. T. C. equipment may be manipulated to move the contacts of relay 4LHSR to their left-hand or normal positions to cause signal 4LB to display a permissive indication.

After the switch 3W has been reversed and relay 4LHSR has been operated to clear signal 4LB, but before the second train enters section 3T, the train in section 2T may vacate the section.

As explained above, when a westbound train vacates section 2T, the relay 2WCTM is operated by coded energy supplied over normal polar contact 16 of relay WFSR, and coded energy is supplied to the rails of section 2T. This energy operates relay 2WTR so that relay 2WTRP operates and causes impulses of energy to be induced in the secondary windings of transformer WDT.

At this time, energy is supplied from secondary winding 41 of transformer WDT to relay 2ECTM over the circuit which is traced from terminal C over front contact 87 of relay 3RWP, front contact 40 of relay 4LHSPR, winding 41, back contact 52 of relay EFSR, front contact 83 of relay 3RWP, and winding of relay 2ECTM to terminal C. Accordingly, relay 2ECTM operates to supply an impulse of feed-back energy to the rails of section 2T during an "off" period in the

master code supplied to the section rails and this feed-back energy picks up the contacts of relay 2ETR so that energy is supplied over front contact 51 to relay WFSR to move the contact 16 of relay WFSR to its right-hand position and cut off the supply of coded energy to relay 2WCTM and to establish the circuit for supplying steady energy to relay 2WCTM and thus cause the equipment for section 2T to assume its normal inactive condition.

It will be seen, therefore, that when the switch 3W is reversed the relay 3RWP establishes a circuit for supplying energy from the winding 41 of transformer WDT to relay 2ECTM so that as soon as a westbound train vacates section 2T, the equipment for the section assumes its normal inactive condition even though at the time the section is vacated the relay 4LHSR has been operated to clear signal 4LB and therefore interrupts the circuit which it controls for supplying energy from winding 41 to relay 2ECTM.

It will be seen that the track circuit apparatus for section 2T is arranged to be controlled by a C. T. C. system, and that the section is prepared for eastbound traffic as a result of movement of the contacts of relay 2RHSR to clear the signal 2RA governing entrance of eastbound trains into the section so no control functions in addition to those normally employed are required of the C. T. C. system to prepare section 2T for eastbound traffic.

The equipment for section 2T is conditioned for westbound traffic as a result of movement of the contacts of relay 4LHSR to clear the signal 4LA governing entrance of westbound trains into section 2T together with movement of the contact of relay WFSR. The control of relay WFSR requires a control step in the C. T. C. system field station unit at the left-hand end of section 2T. However, as usually constructed, the C. T. C. system station units have a control step not assigned to other functions so a control step is available for the control of relay WFSR and a standard C. T. C. system may be employed.

If desired, the passing siding may be provided with track circuit apparatus similar to that provided for section 2T to thereby provide means for controlling signals 2RB and 4LB in accordance with traffic conditions in the passing siding and to also cause the C. T. C. system to indicate whether or not the passing siding is occupied. In addition, the track circuit apparatus in the passing siding will operate as explained in connection with section 2T to cause equipment on motor cars in the passing siding to indicate whether or not trains are authorized to enter the passing siding.

The track circuit apparatus for the passing siding is preferably arranged the reverse of that for section 2T, so that the equipment at the left-hand end section 2T is at the right-hand end of the passing siding and the equipment at the right-hand end of section 2T is at the left-hand end of the passing siding. This arrangement of the track circuit apparatus for the main track and for the passing siding makes it possible to employ the spare control step in the C. T. C. system field station unit at one end of the passing siding to control the track circuit apparatus for the main track, and to employ the spare control step in the field station unit at the other end of the passing siding to control the track circuit apparatus for the passing siding.

Furthermore, this arrangement of the track circuit apparatus for the passing siding and for the main track causes the C. T. C. system field station unit at one end of the passing siding to transmit indications of occupancy of the main track while the C. T. C. system field station unit at the other end of the passing siding to transmit indications of occupancy of the passing siding.

Although we have herein illustrated and described one form of railway signaling apparatus embodying our 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 our invention.

Having thus described our invention, what we claim is:

1. In combination, a section of railway track, a first signal governing entrance of traffic into the section at the first end thereof, a second signal governing entrance of traffic into the section at the second end thereof, a first code following relay at the first end of the section operated by energy supplied over the section rails, a second code following relay at the second end of the section operated by energy supplied over the section rails, a first and a second control relay at the first end of the section, a third control relay at the second end of the section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said section, means at the second end of said section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to supply master code energy to the section rails, means responsive to code following operation of said first code following relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication and to cause impulses of feed-back energy to be supplied to the section rails in the intervals between impulses of master code, means at the first end of said section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code following operation of said second code following relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, and means responsive to energization of said second code following relay by steady energy, by master code energy, or by feed-back energy for indicating occupancy of said track section.

2. In combination, a section of railway track, a first signal governing entrance of traffic into the section at the first end thereof, a second signal governing entrance of traffic into the section at the second end thereof, a first code following relay at the first end of the section operated by energy supplied over the section rails, a second code following relay at the second end of the section operated by energy supplied over the section rails, a first and a second control relay at the first end of the section, a third control relay at the second end of the section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end

of said section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said section, means at the second end of said section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause coded energy to be supplied to the section rails, means responsive to code following operation of said first code following relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication, means at the first end of said section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code following operation of said second code following relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means responsive to code following operation of said second code following relay provided the contacts of said third control relay are in their first position to cause impulses of feed-back energy to be supplied to the section rails in the intervals between the impulses of master code supplied to the section rails at the first end of the section, and means responsive to energization of said first code following relay for moving the contacts of said second control relay from their second to their first position.

3. In combination, a section of railway track, a first relay at the first end of said section operated by energy supplied over the section rails, a second relay at the second end of the section operated by energy supplied over the section rails, means for at times supplying steady energy to the section rails at the first end thereof, means comprising a circuit including a back contact of said second relay for supplying master code energy to the section rails at the second end thereof, means responsive to code following operation of said first relay for supplying to the section rails during the "off" periods in the master code impulses of feed-back energy which maintain the contacts of said second relay picked up only for periods shorter than the "off" periods in said master code, a signal at the first end of said section, means responsive to code following operation of said first relay for controlling said signal, and indication means responsive to energization of said second relay by steady or coded energy.

4. In combination, a stretch of railway track divided into a plurality of track sections including an intermediate section having at the first end thereof a first section and having at the second end thereof a second section, a first track relay at the first end of the intermediate section operated by energy supplied over the section rails, a second track relay at the second end of the intermediate section operated by energy supplied over the section rails, a first signal governing entrance of traffic into said intermediate section at the first end thereof, a second signal governing entrance of traffic into said intermediate section at the second end thereof, a first and a second control relay at the first end of said intermediate section, a third control relay at the second end of said intermediate section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said intermediate section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said intermediate section, means at the second end of said intermediate section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause coded energy to be supplied to the rails of said intermediate section, means responsive to code following operation of said first track relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication, means at the first end of said section effective when the contacts of said second control relay are in their second position to supply coded energy to the rails of said intermediate section, means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means operative on movement of a train through said first section to cause the contacts of said first control relay to occupy their first position, means operative on movement of a train through said second section to cause the contacts of said third control relay to occupy their first position, and means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their first position to cause the contacts of said second control relay to occupy their first position.

5. In combination, a stretch of railway track divided into a plurality of track sections including an intermediate section having at the first end thereof a first section and having at the second end thereof a second section, a first track relay at the first end of the intermediate section operated by energy supplied over the section rails, a second track relay at the second end of the intermediate section operated by energy supplied over the section rails, a first signal governing entrance of traffic into said intermediate section at the first end thereof, a second signal governing entrance of traffic into said intermediate section at the second end thereof, a first and a second control relay at the first end of said intermediate section, a third control relay at the second end of said intermediate section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said intermediate section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said intermediate section, means at the second end of said intermediate section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause master code energy to be supplied to the rails of said intermediate section, means responsive to code following operation of said first track relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication and to cause impulses of feed-back energy to be supplied to intermediate section rails in the intervals between impulses of master code supplied to the section rails at the second end thereof, means at the first end of said intermediate section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code follow-

ing operation of said second track relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means responsive to energization of said second track relay by steady energy, by master code energy, or by feed-back energy for indicating occupancy of said intermediate section, means operative on movement of a train through said first section to cause the contacts of said first control relay to occupy their first position, means operative on movement of a train through said second section to cause the contacts of said third control relay to occupy their first position, and means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their first position to cause the contacts of said second control relay to occupy their first position.

6. In combination, a stretch of railway track divided into a plurality of track sections including an intermediate section having at the first end thereof a first section and having at the second end thereof a second section, a first track relay at the first end of the intermediate section operated by energy supplied over the section rails, a second track relay at the second end of the intermediate section operated by energy supplied over the section rails, a first signal governing entrance of traffic into said intermediate section at the first end thereof, a second signal governing entrance of traffic into said intermediate section at the second end thereof, a first and a second control relay at the first end of said intermediate section, a third control relay at the second end of said intermediate section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said intermediate section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said intermediate section, means at the second end of said intermediate section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause master code energy to be supplied to the rails of said intermediate section, means responsive to code following operation of said first track relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication and to cause impulses of feed-back energy to be supplied to the intermediate section rails in the intervals between impulses of master code supplied to the section rails at the second end thereof, means responsive to energization of said first track relay for causing the contacts of said second control relay to occupy their first position, means at the first end of said intermediate section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means responsive to energization of said second track relay by steady energy, by master code energy, or by feed-back energy for indicating occupancy of said intermediate section, means operative on movement of a train through said first section to cause the contacts of said first control relay to occupy their first position, means operative on movement of a train through said second section to cause the contacts of said third control relay to occupy their first position, and means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their first position to cause impulses of feed-back energy to be supplied to the intermediate section rails in the intervals between the impulses of master code supplied to the section rails at the first end thereof.

7. In combination, a stretch of railway track divided into a plurality of track sections including an intermediate section having at the first end thereof a first section and having at the second end thereof a second section, a first track relay at the first end of the intermediate section operated by energy supplied over the section rails, a second track relay at the second end of the intermediate section operated by energy supplied over the section rails, a first signal governing entrance of traffic into said intermediate section at the first end thereof, a second signal governing entrance of traffic into said intermediate section at the second end thereof, a first and a second control relay at the first end of said intermediate section, a third control relay at the second end of said intermediate section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said intermediate section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said intermediate section, means at the second end of said intermediate section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause master code energy to be supplied to the rails of said intermediate section, means responsive to code following operation of said first track relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication and to cause impulses of feed-back energy to be supplied to the intermediate section rails in the intervals between impulses of master code supplied to the section rails at the second end thereof, means responsive to energization of said first track relay for causing the contacts of said second control relay to occupy their first position, means at the first end of said intermediate section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means responsive to energization of said second track relay by steady energy, by master code energy, or by feed-back energy for indicating occupancy of said intermediate section, means operative on movement of a train through said first section to cause the contacts of said first control relay to occupy their first position, means operative on movement of a train through said second section to cause the contacts of said third control relay to occupy their first position, and means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their first position and said second section is not occupied to cause impulses of feed-back

energy to be supplied to the intermediate section rails in the intervals between the impulses of master code supplied to the section rails at the first end thereof.

8. In combination, a stretch of railway track divided into a plurality of track sections including an intermediate section having at the first end thereof a first section and having at the second end thereof a second section, a first track relay at the first end of the intermediate section operated by energy supplied over the section rails, a second track relay at the second end of the intermediate section operated by energy supplied over the section rails, a first signal governing entrance of traffic into said intermediate section at the first end thereof, a second signal governing entrance of traffic into said intermediate section at the second end thereof, a first and a second control relay at the first end of said intermediate section, a third control relay at the second end of said intermediate section, each of said control relays having contacts which normally occupy a first position and which may be caused to occupy a second position, means at the first end of said intermediate section effective when the contacts of said first and second control relays are in their first position to supply steady energy to the rails of said intermediate section, means at the second end of said intermediate section effective on cutting off of the supply of steady energy over the section rails provided the contacts of said third control relay are in their first position to cause master code energy to be supplied to the rails of said intermediate section, means responsive to code following operation of said first track relay provided the contacts of said first control relay are in their second position to cause said first signal to provide a permissive indication, means responsive to code following operation of said first track relay for causing impulses of feed-back energy to be supplied to the rails of said intermediate section in the intervals between impulses of master code supplied to the section rails at the second end thereof provided the contacts of said first control relay are in their second position or are in their first position and said first section is occupied, means responsive to energization of said first track relay for causing the contacts of said second control relay to occupy their first position, means at the first end of said intermediate section effective when the contacts of said second control relay are in their second position to supply master code energy to the section rails, means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their second position to cause said second signal to provide a permissive indication, means responsive to energization of said second track relay by steady energy, by master code energy, or by feed-back energy for indicating occupancy of said intermediate section, means operative on movement of a train through said first section to cause the contacts of said first control relay to occupy their first position, means operative on movement of a train through said second section to cause the contacts of said third control relay to occupy their first position, and means responsive to code following operation of said second track relay provided the contacts of said third control relay are in their first position to cause impulses of feed-back energy to be supplied to the intermediate section rails in the intervals between the impulses of master code supplied to the section rails at the first end thereof.

9. In combination, a section of railway track, a first track relay at the first end of said section operated by energy supplied over the section rails, a second track relay at the second end of said section operated by energy supplied over the section rails, a coding relay controlling the supply of energy to the section rails at the second end of the section, means for at times supplying energy to the section rails at the first end of the section, a circuit governed by a contact of said second track relay for supplying energy of a first code frequency to said coding relay, and a circuit independent of said second track relay contact for supplying energy of a second code frequency to said coding relay.

10. In combination, a section of railway track, a first track relay at the first end of said section operated by energy supplied over the section rails, a second track relay at the second end of said section operated by energy supplied over the section rails, said second track relay having contacts biased to a first position and movable therefrom to a second position when energy is supplied to the relay winding over the section rails from the first end of the section, a coding relay effective when operated by coded energy to cause coded energy to be supplied to the section rails at the second end thereof, a circuit for supplying coded energy of a first code frequency to said coding relay, said circuit being interrupted when the contacts of said second track relay are in their second position, a circuit independent of the contacts of said second track relay for supplying energy of a second code frequency to said coding relay, and means for at times supplying energy to the section rails at the first end thereof.

11. In combination, a section of railway track, a first track relay at the first end of said section operated by energy supplied over the section rails, a second track relay at the second end of said section operated by energy supplied over the section rails, said second track relay having contacts biased to a first position and movable therefrom to a second position when energy is supplied to the relay winding over the section rails from the first end of the section, a coding relay effective when operated by coded energy to cause to be supplied to the section rails at the second end thereof impulses of master code energy which are separated by intervals during which energy is not supplied to the section rails, a circuit for supplying coded energy of a first code frequency to said coding relay, said circuit being interrupted when the contacts of said second track relay are in their second position, a circuit independent of the contacts of said second track relay for supplying energy of a second code frequency to said coding relay, and means for at times supplying steady energy to the section rails at the first end thereof and for at other times supplying to the section rails at the first end thereof in the intervals between impulses of master code energy impulses of feed-back energy effective to maintain the contacts of said second track relay in their second position only for periods shorter than the intervals between impulses of master code energy of said first code frequency.

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