

March 21, 1944.

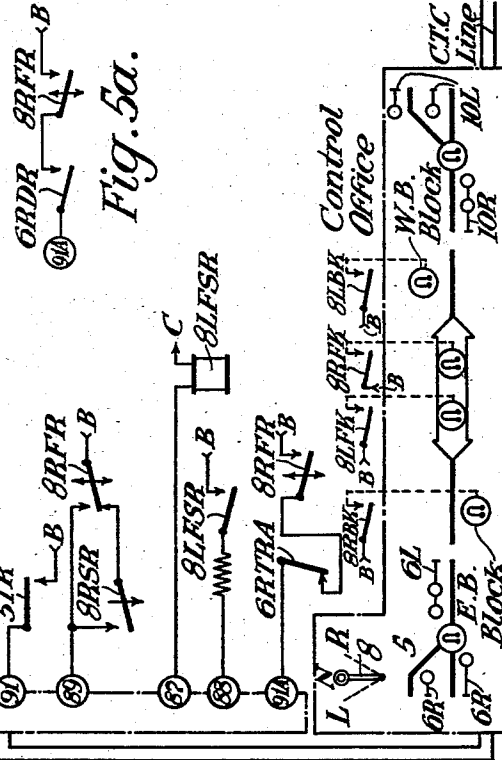
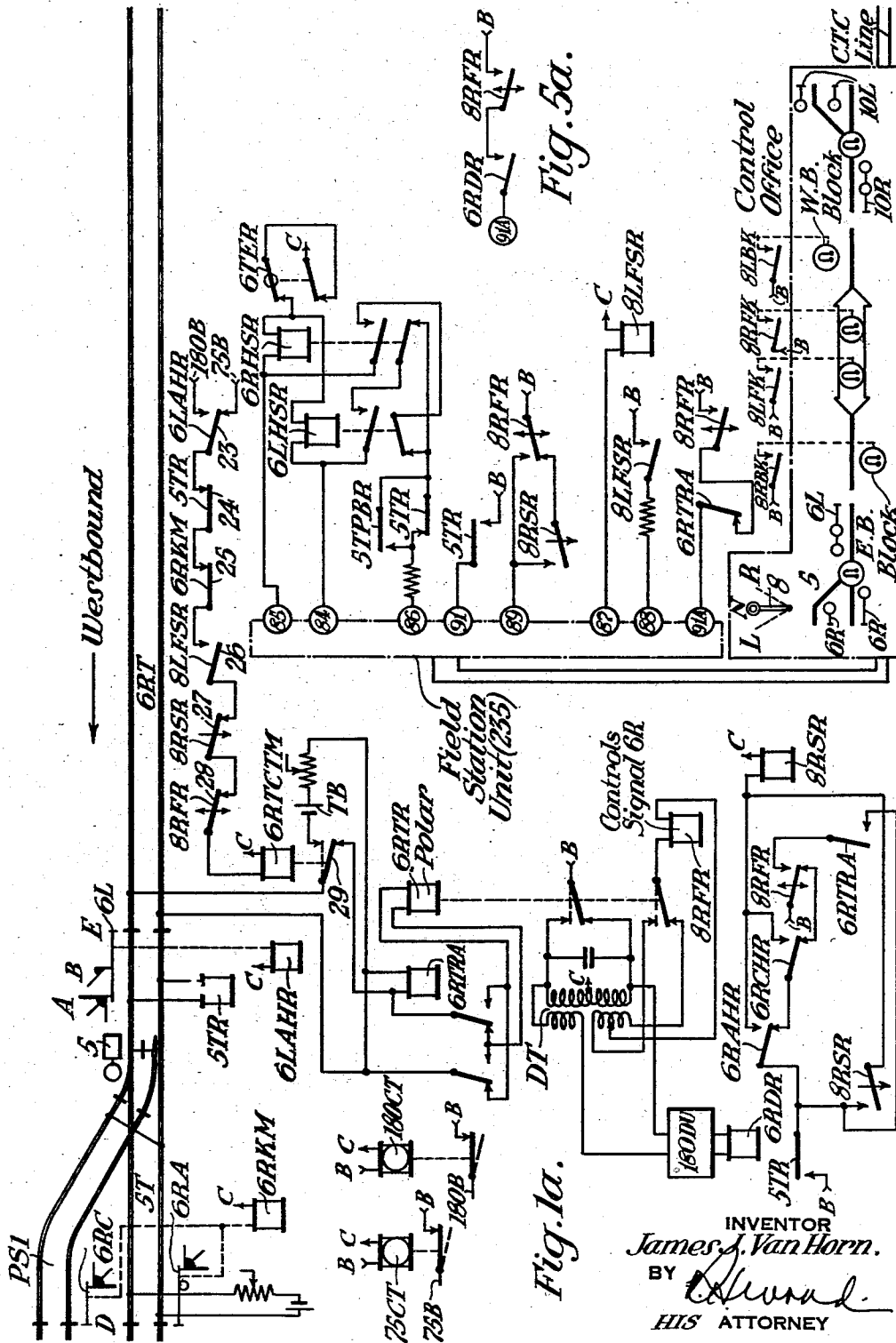
J. J. VAN HORN

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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 12, 1941

10 Sheets-Sheet 1



March 21, 1944.

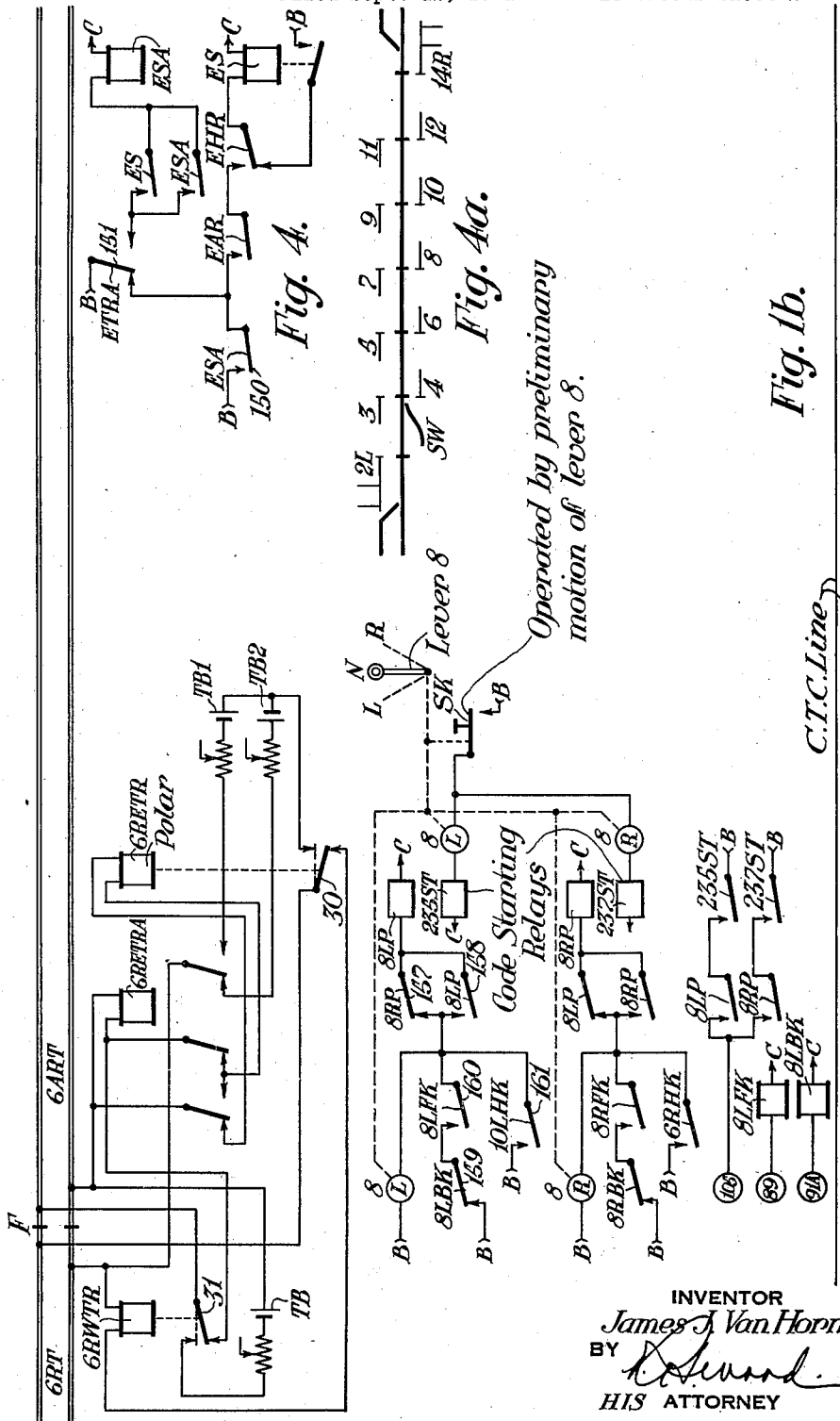
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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 12, 1941

10 Sheets-Sheet 2



March 21, 1944.

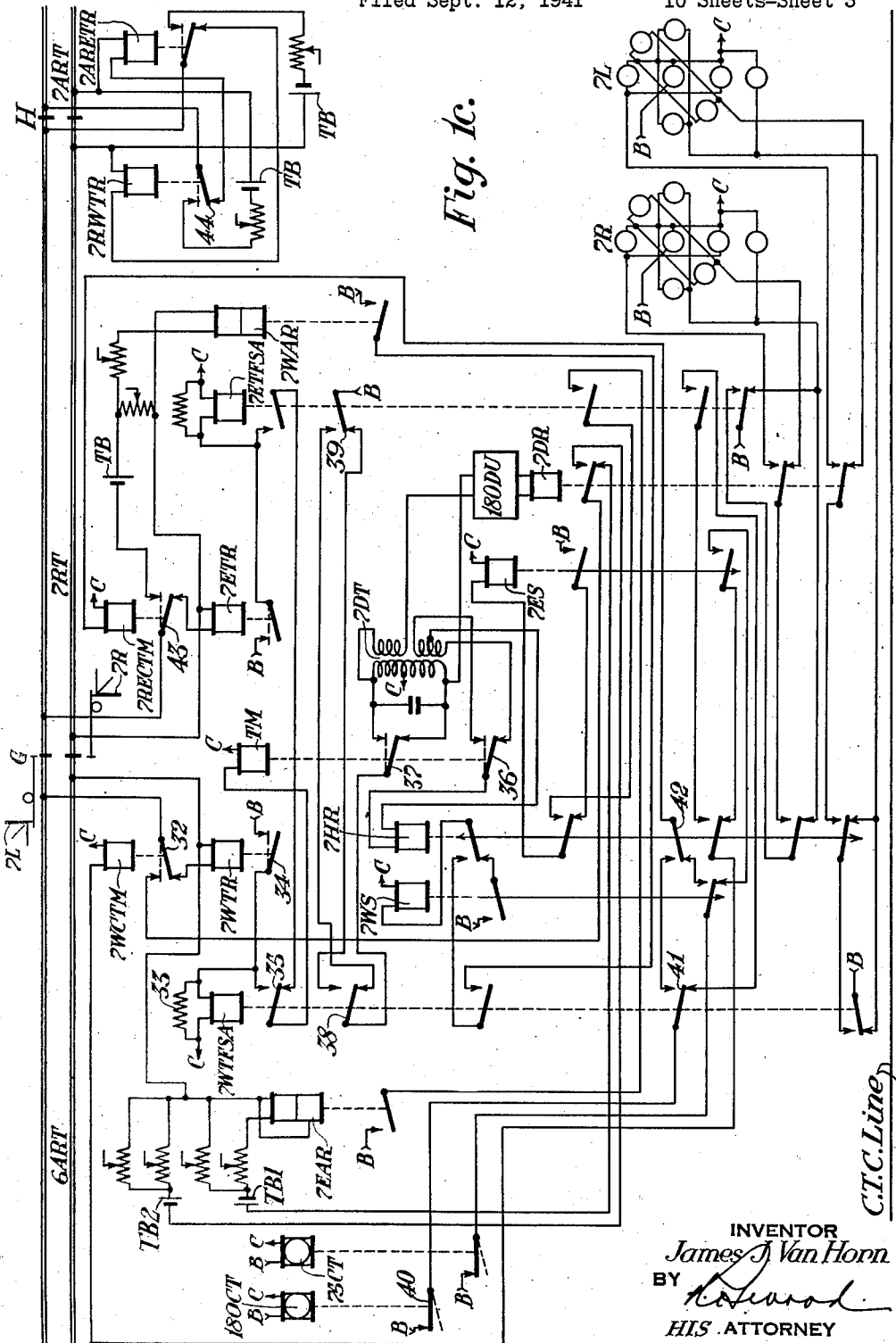
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RAILWAY TRAFFIC CONTROLLING APPARATUS

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10 Sheets-Sheet 3



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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 12, 1941

10 Sheets-Sheet 4

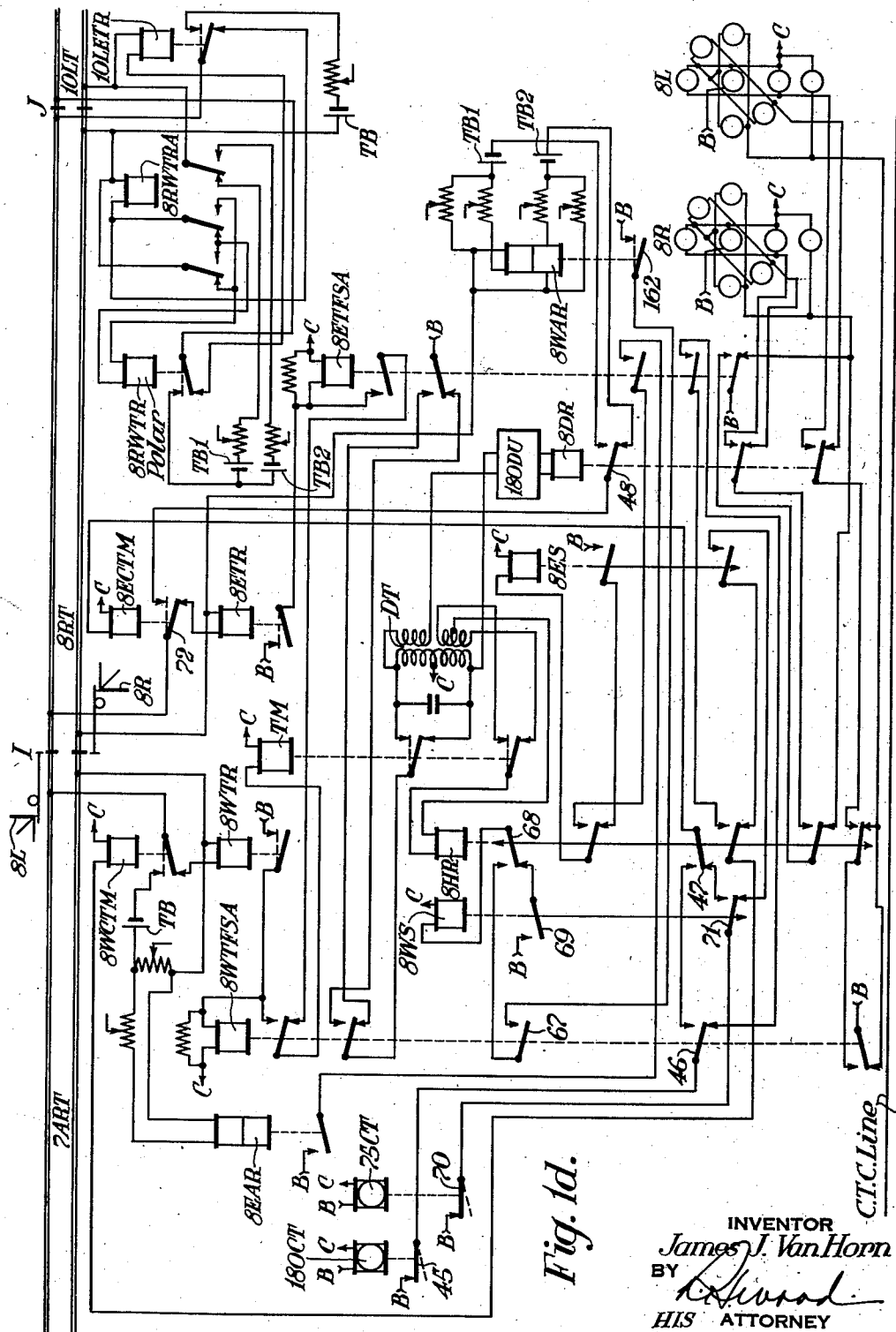


Fig. 1d.

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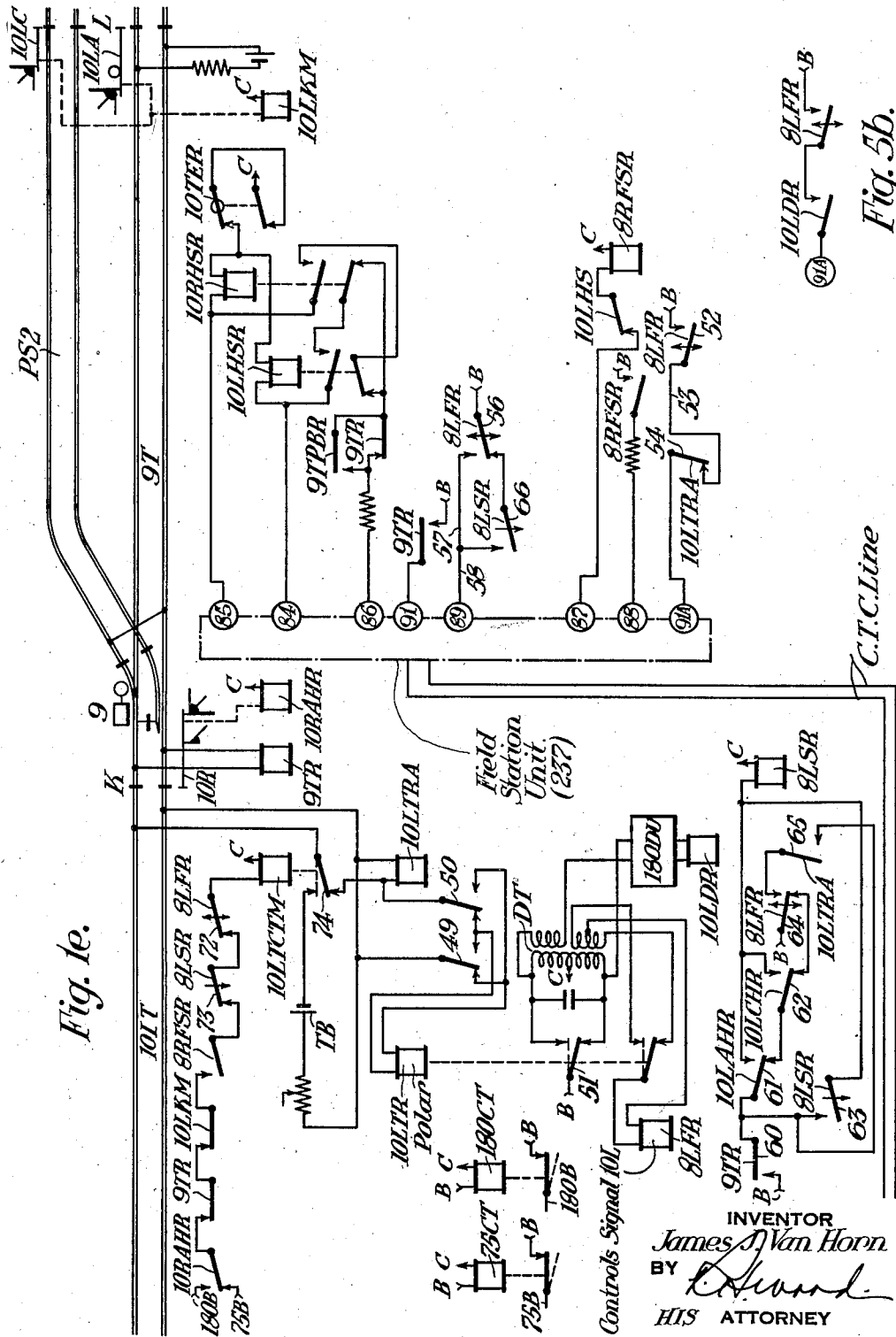
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RAILWAY TRAFFIC CONTROLLING APPARATUS

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March 21, 1944.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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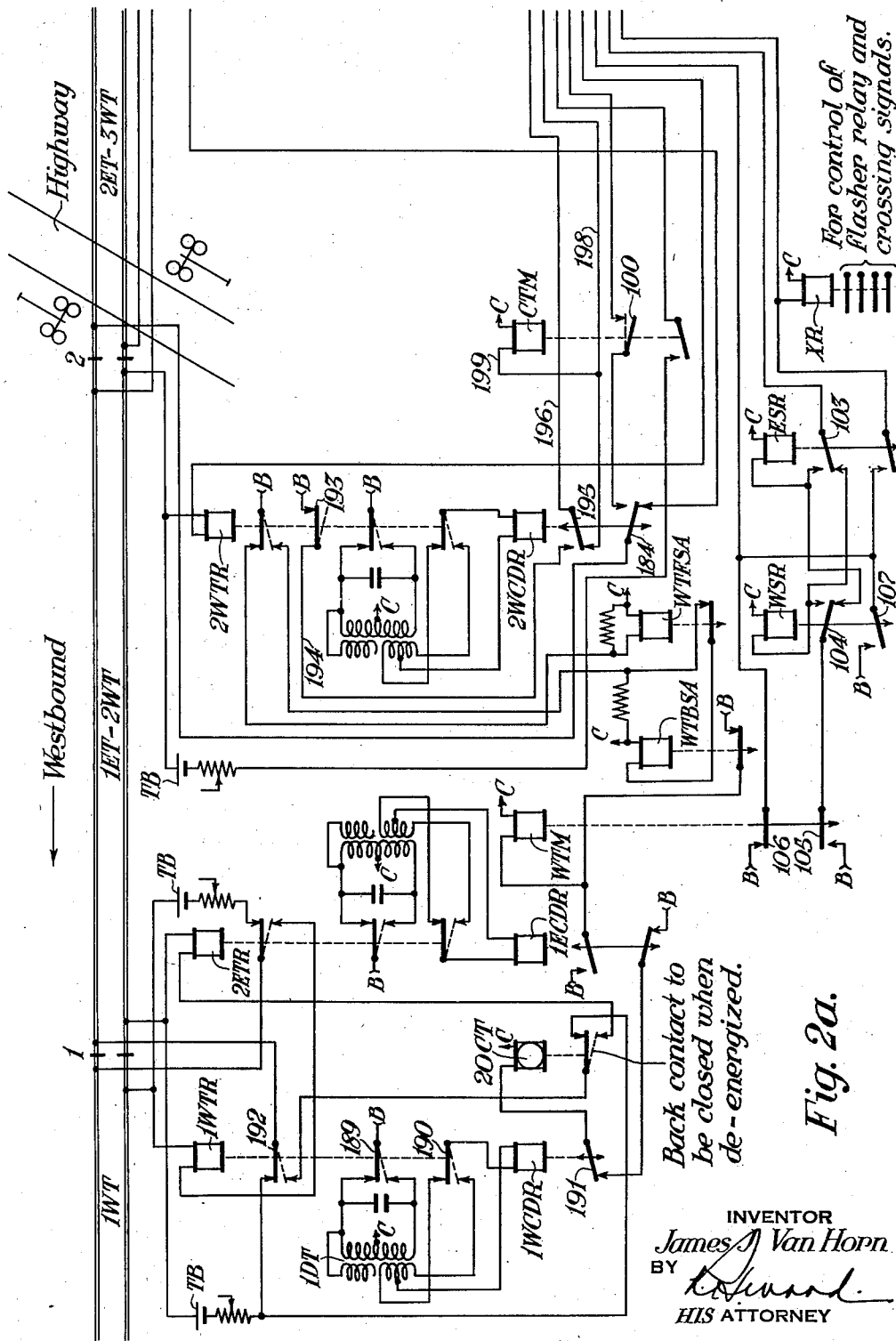


Fig. 2a.

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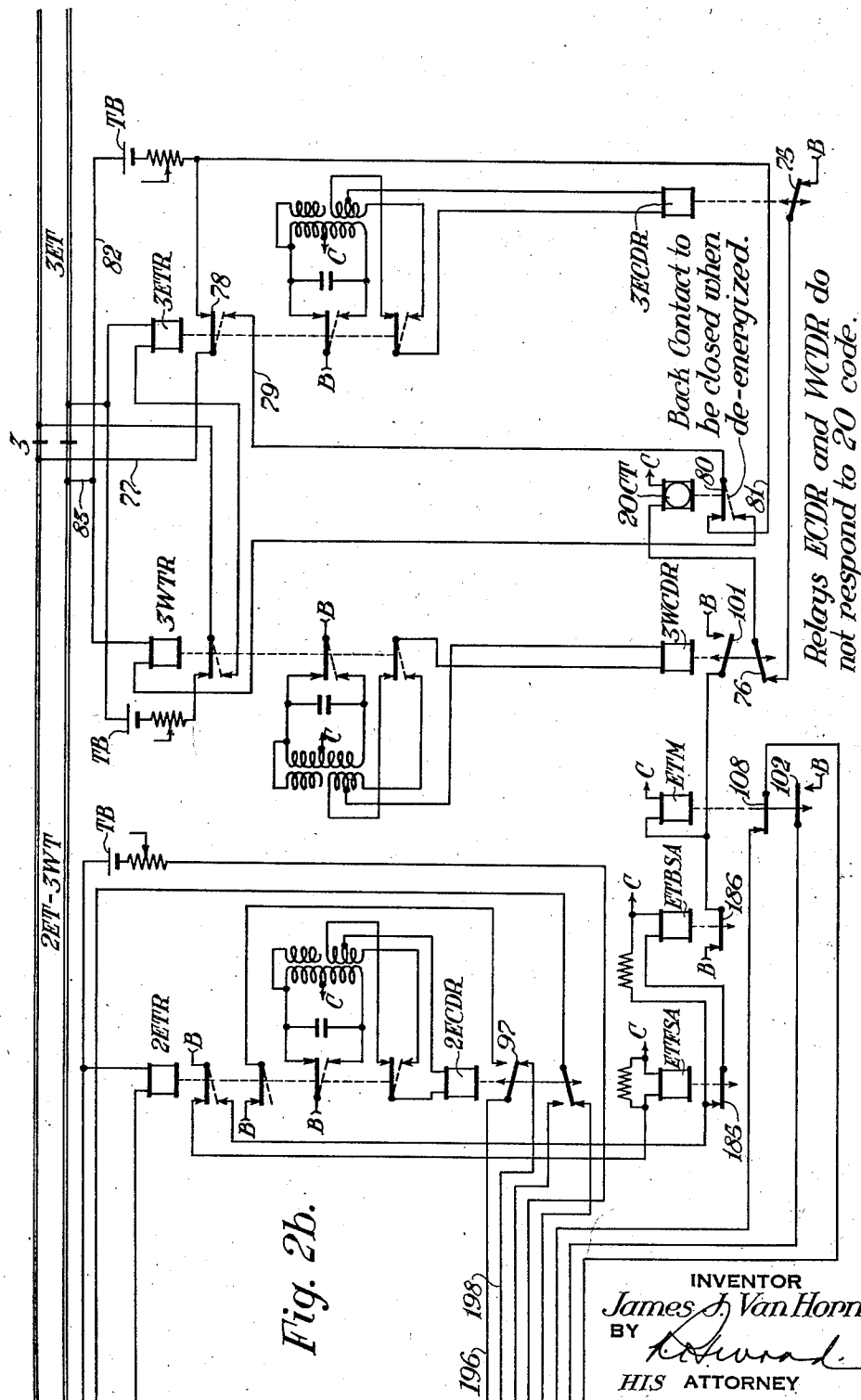
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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 12, 1941

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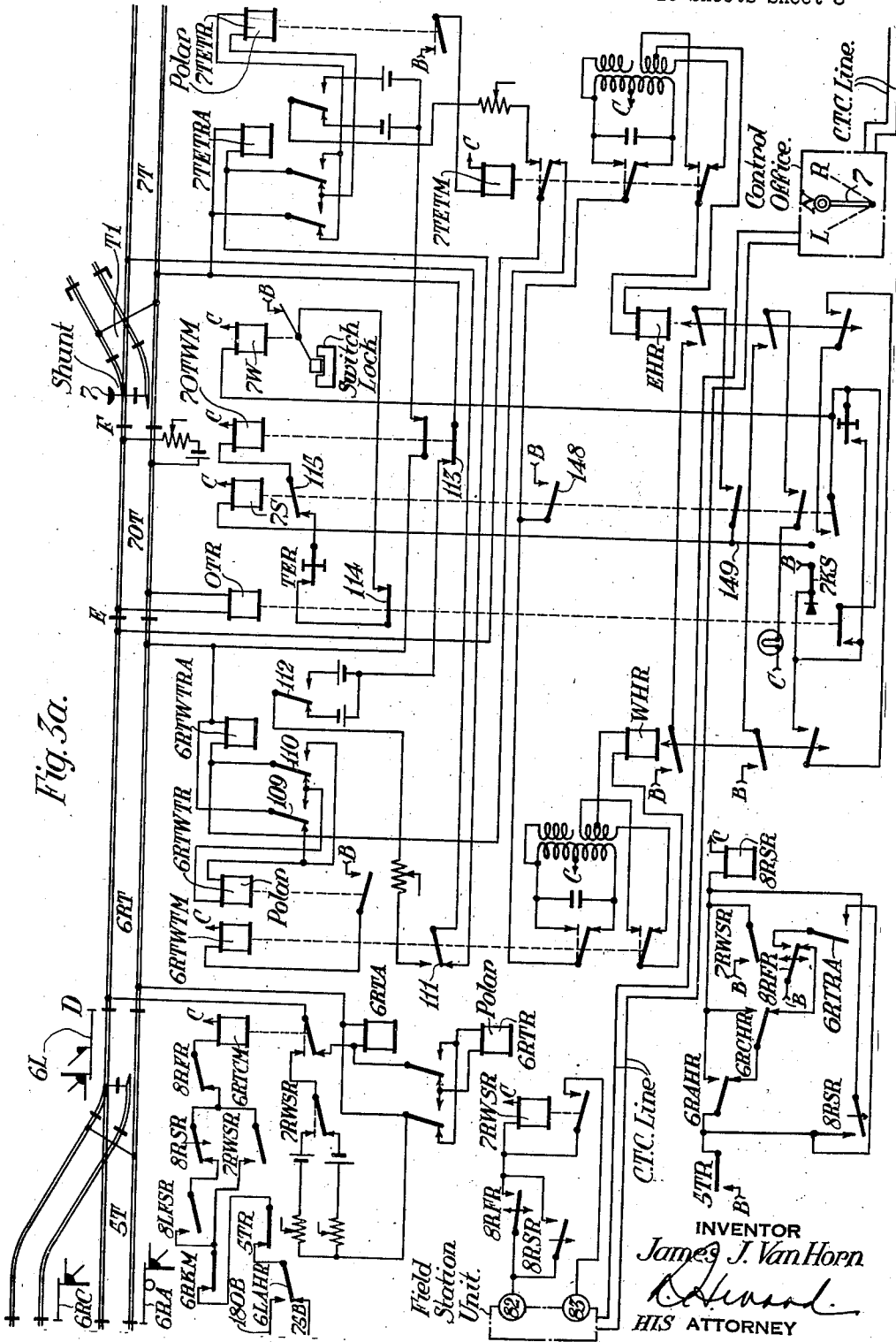
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RAILWAY TRAFFIC CONTROLLING APPARATUS

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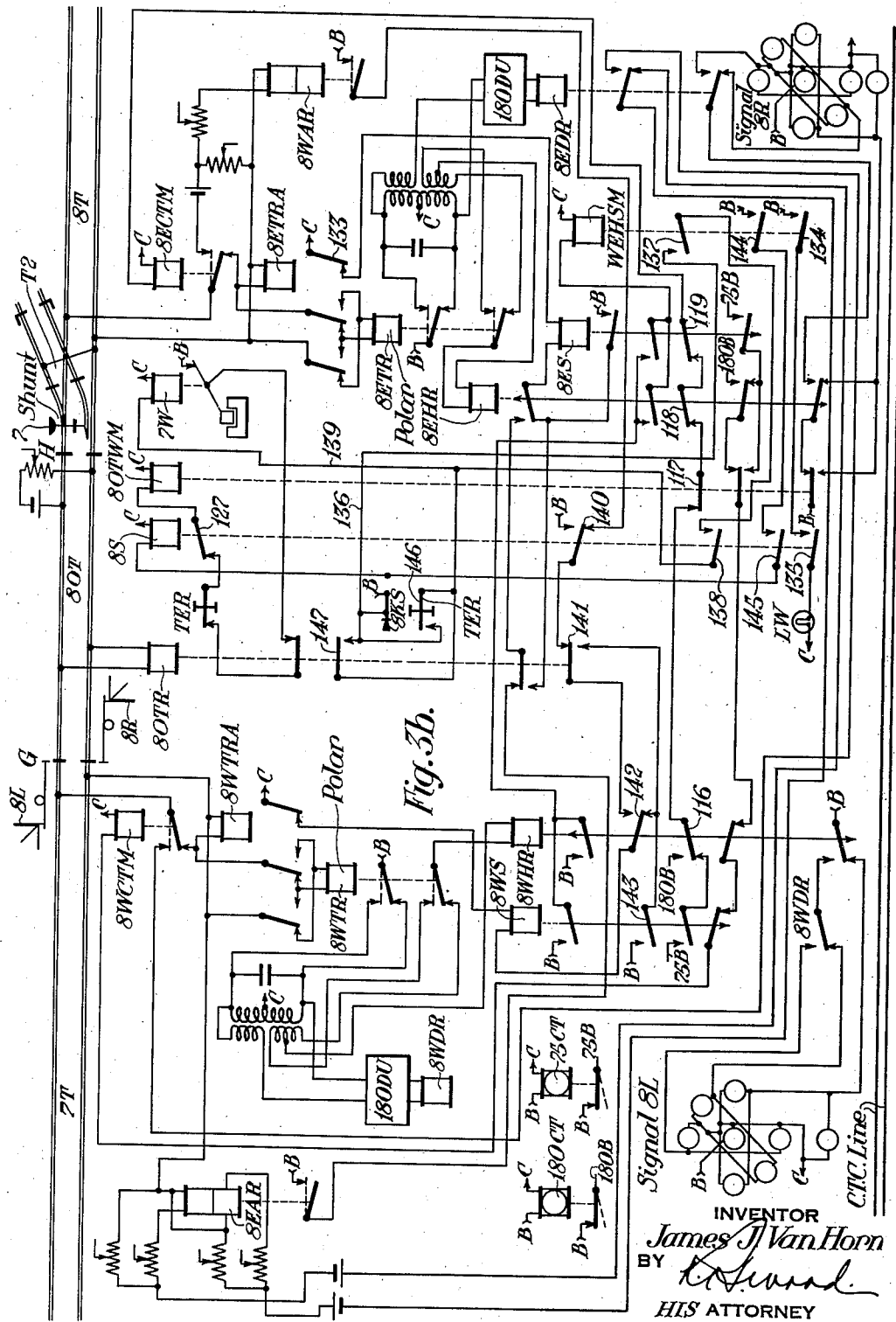
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RAILWAY TRAFFIC CONTROLLING APPARATUS

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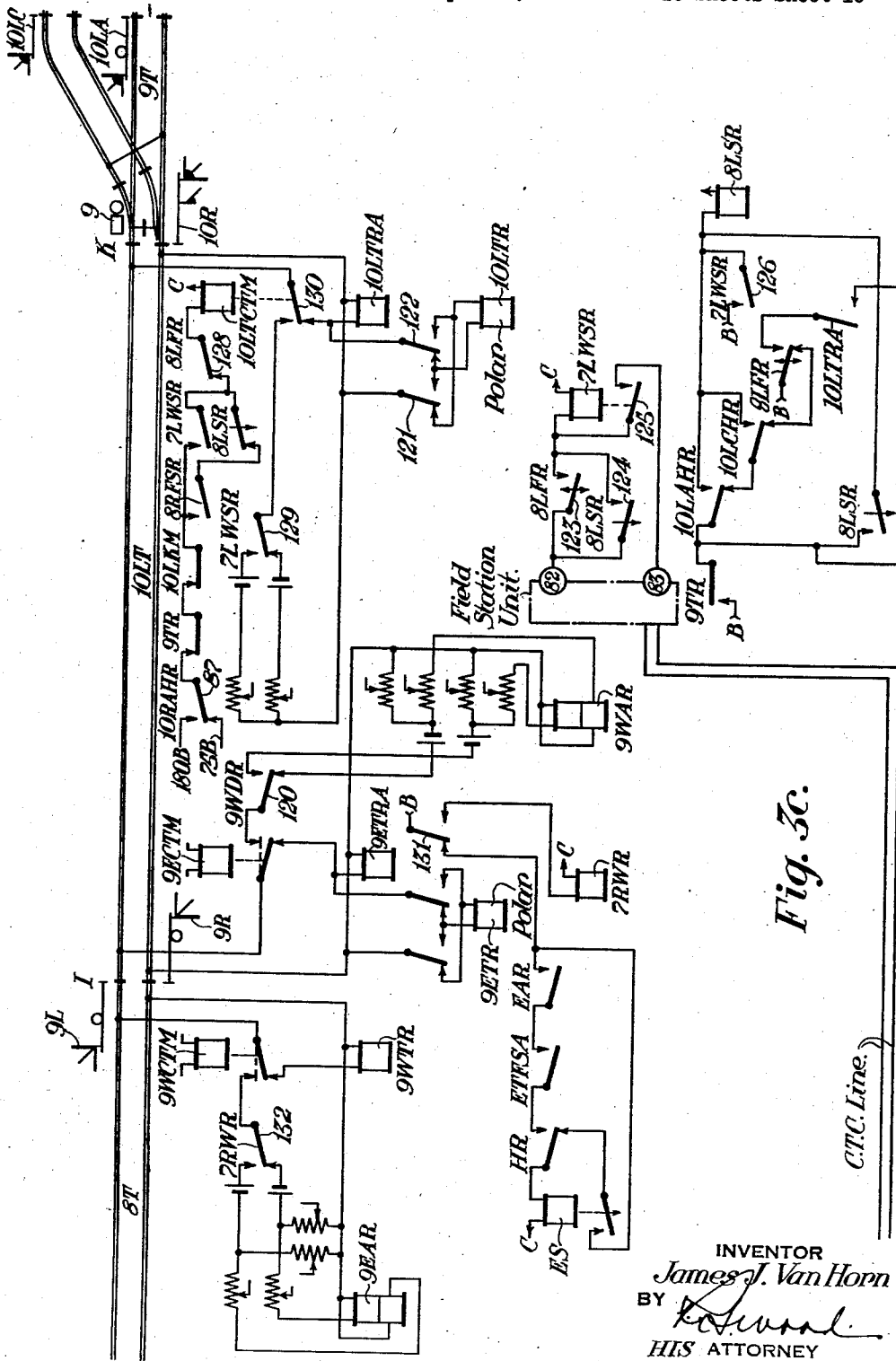


Fig. 3c.

CTC Line

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2,344,573

RAILWAY TRAFFIC CONTROLLING
APPARATUS

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Application September 12, 1941, Serial No. 410,504

31 Claims. (Cl. 246—3)

My invention relates to railway traffic controlling apparatus and is directed more particularly to the control of traffic in a single track two-direction system wherein centralized traffic control or other suitable manual control is used for establishing the traffic direction. A distinguishing feature of my system is that it employs normally deenergized track circuits and dispenses with all control line wires except the coded C. T. C. line circuit, if C. T. C. control is used.

One object of my invention is to provide a normally deenergized track circuit system of signaling for traffic moving in either direction on a single track, without employing the usual control line wires. Another object of my invention is to establish the desired traffic direction merely by moving a traffic lever at the control office, the checking and safety features of the system being brought into play automatically as a result of such movement. A further object of my invention is to provide certain inter-controls on the C. T. C. machine, if used, to prevent interference with the established traffic direction when the entrance signal is at proceed or the section is occupied by a train. A still further object of my invention is to provide for the proper control of highway crossing signals and electric switch locks in a normally deenergized, non-line-wire system of the character herein disclosed. An additional object of my invention is to use but one set of code responsive apparatus for controlling both signals at intermediate locations. A further object of my invention is to provide a block indication for certain track circuits by polarizing the code effective therein. Other objects, purposes, and characteristic features of my invention will be apparent from the description which follows.

I accomplish the foregoing objects by: applying a rail current code at the new exit end of the stretch and cascading this code progressively over the track circuit sections to the new entrance end to thereby check unoccupancy of the stretch and obtain proper restrictive indications of the opposing signals as well as permissive indications of the signals for the new direction; using properly controlled stick repeater relays of the traffic lever to prevent interference with the established traffic direction and to permit following moves; using the code checking relay (FSA) for directional control when the stretch is unoccupied and using the eastbound stick relay (ES) and the westbound stick relay (WS) for this directional control when the stretch is occupied; using the approach lighting relay (AR) for the control of

the directional stick relays (ES and WS); employing an additional rail current of a "slow" code for highway crossing control purposes in conjunction with the normally deenergized track circuits of my invention; and employing polarized coded track circuits for switch lock control without line wires, and feeding coded energy from both ends of the section toward the electric switch lock to indicate that the track sections on each side of the lock are unoccupied and that, if occupied, the train is moving away from the lock.

The present invention is an improvement on the invention disclosed in the United States patent application Serial No. 403,502, filed on July 22, 1941, by Ralph R. Kemmerer, for Railway traffic controlling apparatus.

I shall describe several forms of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Figs. 1a to 1e taken together, with Fig. 1a at the left, are a diagrammatic view showing one embodiment of my invention as applied to a stretch of single track railway extending between the passing sidings at the two ends of the stretch. Figs. 2a and 2b taken together, with Fig. 2a at the left, are a diagrammatic view showing my invention applied to a highway crossing location within a stretch of single track such as shown in Fig. 1. Figs. 3a, 3b, and 3c taken together, with Fig. 3a at the left, are a diagrammatic view showing my invention applied to the control of electric switch locks associated with the single track stretch. Fig. 4 shows a modified form of a portion of the apparatus of Fig. 3, also embodying my invention. Fig. 4a is an explanatory track diagram for Fig. 4. Figs. 5a and 5b are modified forms of certain portions of the apparatus shown in Figs. 1a and 1e, respectively, and also embodying my invention. Similar reference characters refer to similar parts in each of the several views.

Referring first to Figs. 1a to 1e, inclusive, the stretch of track between the passing sidings PS1 and PS2 is divided by the usual insulated rail joints at locations E, F, G, H, I, J, and K, to form a number of track circuit sections. Each of these track sections is identified by the reference character T with a distinguishing prefix which also identifies the apparatus associated with that section or location. The signals which govern traffic movements through the single track stretch are the head-block signals 6R and 10L at the respective ends of the stretch and the intermediate signals 7 and 8 at locations G and I. The cut section locations F, H, and J could likewise be

provided with signals, if desired, by adding similar apparatus to that shown at the intermediate signal locations.

Each section of the single track stretch is, in reality, provided with two track circuits, one eastbound and one westbound, each of which includes a code following track relay TR at one end and a source of direct current track circuit energy, conveniently shown as a battery, at the other end. This current is properly coded under the influence of traffic conditions, or as initiated by the operator at the central control location shown diagrammatically as the control office in Fig. 1a. Depending upon the direction of traffic movement, only one or the other track circuit is effective at any one time as will become clear hereinafter. The control relays involved in an eastbound move generally carry the prefix E or R (for right-hand) and those which control westbound moves include the prefix W or L (for left-hand) in order to make the disclosure more readily understandable.

For simplicity, I make use of but two codes, these comprising direct current periodically interrupted at the rate of 75 times per minute for "approach" and 180 times per minute for "clear" signal indications. The coding is accomplished by means of suitable code transmitters 75CT and 180CT which are well known. It is understood that for cab signaling purposes, alternating current coded over the contacts of these code transmitters could be superimposed on the direct current track circuits but I have not shown this added complication since it does not involve my invention. Certain of the track circuits are polarized and employ polarized track relays as a means for providing an indication by means of a block light on the track model as to the location of a train within the single track stretch. This feature will be described more fully hereinafter. Directional stick relays are used for permitting following moves to be made without any further action being required on the part of the operator.

The relays 8LF SR (Fig. 1a) and 8RFSR (Fig. 1e) adjacent the two ends of the stretch are manually controlled traffic direction selecting relays which govern the direction of traffic movement through the stretch. The communication system by means of which the operator at the C. T. C. machine or control office may govern these relays may be of any suitable type, but preferably it is of the selective or code type in which communication is established intermittently by means of impulse codes transmitted over a single pair of line wires to the desired control location or field station. The details of such a communication system do not enter actively into the present invention and it is deemed sufficient for an understanding of the present invention to point out that the traffic direction from right to left or westbound is established by moving the lever 3 in the control office (Fig. 1a) to the left-hand or L position so as to energize the traffic relay 8LF SR at the field station at the left-hand end of the stretch (location E), and that the traffic direction from left to right or eastbound is established by moving the lever 3 to the right-hand or R position so as to energize the traffic relay 8RFSR at the other end of the stretch (location K). It is understood that the communication system is also used to provide an indication of traffic and apparatus conditions within the stretch, as well as to prevent reversal of the established traffic direction except under proper conditions as will be pointed out hereinafter. It may also be used to

govern the traffic leaving the single track stretch at either end by controlling the signals and switches at such ends. One form of communication system suitable for use in my system is that shown in Letters Patent of the United States No. 2,229,249, granted to L. V. Lewis on January 21, 1941, for Remote control system, and the general designation of the relays comprising the C. T. C. portion of my system corresponds with that used in this patent. In order further to simplify the disclosure, I have used the same reference numbers as in the Lewis patent to designate corresponding terminals or wires of the field station code units at the two ends of the stretch, these wires serving to transmit analogous control or indication functions.

I shall now describe the operation of the apparatus of my invention in detail, first assuming that all of the track apparatus (except the code transmitters) is deenergized, and that the operator moves the traffic lever 3 to its left-hand or L position, thereby energizing the traffic relay 8LF SR. The movement of lever 3 causes a control code to be transmitted from the control office, over the C. T. C. line, to the field station at location E, thus causing relay 8LF SR to become energized. This relay sets up the traffic direction from right to left, or westbound. The energization of relay 8LF SR completes a circuit which energizes the code repeating relay 6RTCTM on code to thereby transmit a corresponding code to the track section 6RT. If the home relay 6LAHR for signal 6LA is deenergized, so that back contact 23 is closed, as shown, 75 code will be transmitted to condition signal 7L at location G to display an approach indication. If, however, signal 6LA is at approach or clear, then relay 6LAHR will be energized so that 180 code will be supplied over contact 23, now closed in its up position. As shown, signal 6LA is at stop so that the coding circuit for relay 6RTCTM may be traced from the code transmitter wire 75B which is one terminal of the 75 code source, back contact 23 of relay 6LAHR, front contacts 24, 25, and 26 of relays 5TR, 6RKM, and 8LF SR (now up), back contacts 27 and 28 of relays 8RSR and 8RFR, and the winding of relay 6RTCTM, to the other terminal C of the source. Contact 24 of relay 5TR checks that an eastbound move has not been started past signal 6R, and contact 25 of relay 6RKM checks that the opposing signals 6RA and 6RC are at stop. Since relays 6LAHR and 6RKM are well known, the specific control circuits for these relays are not shown in detail, it being sufficient to associate these relays with their respective signals. Back contacts 27 and 28 of relays 8RSR and 8RFR, respectively, check that traffic has not been established for an eastbound move, as will be apparent hereinafter. Accordingly, with the apparatus in the condition illustrated, 75 code is being supplied to the section 6RT from the track battery TB over the front point of coding contact 29 of relay 6RTCTM.

The 75 code is received at location F by the westbound code following track relay 6RWTR, over the back point of contact 30 of the eastbound track relay 6RETR, and is relayed into the cut section 6ART over the coding contact 31 of relay 6RWTR. This contact supplies a current impulse from the track battery TB over an obvious circuit each time that its front point closes. The 75 code is received by relay 7WTR at location G, over the back point of contact 32 of relay 7WCTM which results in the energization of relay 7WTFSA which is slow acting by virtue of

the resistor snub 33 and therefore retains its picked up position while relay 7WTR is coding. The energization of relay 7WTFSA closes an obvious circuit over its front contact 35 and front contact 34 of relay 7WTR for the code repeater relay TM which follows the code and controls one set of decoding apparatus common to both sections 6ART and 1RT. Relay TM itself is also common to both these sections and when traffic is eastbound, this relay is picked up over front contacts of the corresponding eastbound relays 7ETR and 7ETFS and the back point of contact 35 of relay 7WTFSA.

Relay TM will follow the code supplied by the 7WTR relay (which in this case is 75 code) and in so doing will energize the slow pick-up, slow release relay 7HR from the decoding transformer 7DT over the rectifying contact 36 of relay TM in the usual and well-known manner. The transformer 7DT is energized over the coding contact 37 of relay TM and this circuit also includes the front point of contact 38 of relay 7WTFSA and the back point of contact 39 of relay 7ETFS. Should relay TM be following the 180 code instead of 75, then the decoding relay 7DR which responds selectively to 180 code only, because of the presence of the resonant decoding unit 180DU, will be energized in addition to relay 7HR. Since relays 7WTFSA and 7HR are both energized, a 180 code circuit is completed for the code following relay 7RECTM over the coding contact 40 of code transmitter 180CT and front points of contacts 41 and 42 of relays 7WTFSA and 7HR, respectively, whereupon relay 7RECTM will supply 180 code from battery TB over the front point of its coding contact 43 to the section 1RT. The operation of the westbound approach relay 7WAR will be explained hereinafter.

At the cut section location H, the 180 code will be received by relay 7RWTR and re-transmitted or cascaded into section 7ART over the front point of coding contact 44 of this relay. This code will be received at signal location I in the same manner as described for the signal location G so that this description need not be repeated. With relays 8WTFSA and 8HR both energized, relay 8ECTM will be energized on 180 code over the front points of contacts 45, 46, and 47, as at location G, and will repeat this code into section 8RT. From this section, the code will be repeated into section 10LT by polar relay 8RWTR (which is connected in parallel with the polarized track relay 8RWTRA), as previously explained. Relays 10LTRA and 10LTR at location K will receive the 180 code and will make it possible for the operator to clear the headblock signal 10L so as to permit a westbound train to enter the single track stretch.

Referring again to location I, it will be noted that the code supplied to section 8RT is polarized and is of one polarity when the 180 code decoding relay 8DR is energized so that the front point of contact 48 is closed, but is of the other polarity when relay 8DR is deenergized and the back point of contact 48 is closed. Contact 48 selects either battery TB1 or TB2 as the supply battery for the track code and since these batteries are oppositely poled, polarized track circuit operation is obtained. The reason for polarizing the block I-K is to provide a proper block indication on the track model, which feature will be described more fully hereinafter. For the present, it will be sufficient to state that the code following biased polar track relay 10LTR at location K is

energized in parallel with the non-biased polarized code following relay 10LTRA and is checked over the polar contacts 49 and 50 of the latter relay to insure that the latter has responded properly to the polarized track circuit code. The track relays of my system such as 6RWTR, 7WTR, 7RWTR, etc., are preferably of the biased polar type which means that these relays will respond only to current of the proper polarity. Current of the other polarity will merely hold these relays more strongly in their released position. The non-biased polarized track relays such as 8RWTRA and 10LTRA respond selectively to current of either polarity and remain in the position to which they were last operated.

Returning again to location K, the coding action of relay 10LTR will energize the decoding transformer DT at 180 code over the coding contact 51 so that both relays 10LDR and 8LFR will become energized. Relay 8LFR is the usual code detecting relay which remains energized on impulses of either 75 or 180 code. With relay 8LFR energized and polarized relay 10LTRA occupying its normal position as shown, a circuit will be completed to terminal 91A of the field station unit over front contact 52 of relay 8LFR, wire 53, and the normal polar contact 54 of relay 10LTRA, so as to provide the operator with an unoccupied westbound block indication on the track model. The energization of relay 8LFR also closes a circuit to terminal 89 of the field station unit over the front point of its contact 56 and wires 57 and 58 to provide an indication at the control office that traffic is established for a westbound move. Signal 10LA or 10LC may now be cleared by the operator in the usual and well-known manner through the code equipment, to permit a train to enter the single track stretch and proceed toward the signal 6L at the other end. If cab signaling is used, then after the train passes signal 10LA or 10LC, a code applying relay would be energized in the usual manner to provide the track section 9T (and other successive sections) with code. This code supply circuit is of conventional form and so has not been illustrated.

If the single track stretch should include but one intermediate signal location (G) then the westbound block indication can be provided, as shown in Fig. 5b (Sh.5), over a front contact of relay 8LFR and a front contact of the 180 code detecting relay 10LDR. The eastbound block indication under this condition will similarly be provided, as shown in Fig. 5a (Sh. 1), over a front contact of relay 8RFR and the 180 code detecting relay 6RDR. In this arrangement, it is unnecessary to polarize the code in order to obtain a continuous block indication.

Having described the manner in which the apparatus is conditioned for a traffic movement in the westbound direction over the stretch, I shall next trace the progress of a westbound train as it moves over the various sections.

As the train enters section 9T, relay 9TR will release and a circuit will be completed for the directional stick relay 8LSR over the back contact 60 of relay 9TR and the front point of contact 61 of relay 10LAHR which is the home relay for signal 10LA. If the train enters from the siding PS2, then the circuit for relay 8LSR will include the back point of contact 61 and the front point of contact 62 of the corresponding home relay 10LCHR for signal 10LC. Once relay 8LSR picks up, it closes a stick circuit for itself over back contact 60 of relay 9TR and its own

front contact 63. When the train enters section 10LT, the code detecting relay 8LFR will release, closing an auxiliary stick circuit for relay 8LSR over back contact 64 of relay 8LFR, back points of contacts 62 and 61 of relays 10LCHR and 10LAHR, and front contact 63 of relay 8LSR. This stick circuit does not include the back contact 60 of relay 9TR so that when the train fully clears section 9T and relay 9TR picks up, the directional stick feature provided by relay 8LSR will continue to be maintained. Furthermore, when the train fully clears sections 10LT and 8RT so that relay 8LFR picks up on 75 code, an additional stick circuit for relay 8LSR will become effective in order that this relay may remain energized during the whole time that the stretch is occupied. Consequently, the westbound traffic directional arrow on the track model will remain lighted. This additional stick circuit for relay 8LSR includes the front point of contact 64 of relay 8LFR, reverse polar contact 65 of relay 10LTRA, and front contact 63 of relay 8LSR. Reverse polar contact 65 will close before relay 8LFR picks up and will remain closed thereafter until the stretch is cleared, whereupon relay 8DR at location I will become energized and will restore normal polarity code to block I—K. Relay 10LTRA will then again become energized in the normal direction.

Referring for the moment to the field station unit at location K, it will be seen that the control circuit to terminal 89 for the westbound traffic direction indication can also be established over the back point of contact 56 of relay 8LFR and the front point of contact 66 of relay 8LSR. The traffic direction indication is accordingly maintained to provide the operator with this information during the whole time that the stretch is occupied. Moreover, this indication will persist even after the stretch becomes unoccupied, until such time as the operator places lever 8 in the normal or N position and sends out a code to release relay 8LFSR and so to deenergize the track circuits.

If approach lighted signals are used, the westbound stick relay 8WS at location I may be picked up over front contact 162 of the approach relay 8WAR and front contacts 67 and 68 of relays 8WTFSA and 8HR, respectively, when the train approaches the signal 8L. If normally lighted signals are used, then the stick relay 8WS will be picked up over the front contacts 67 and 68 of relays 8WTFSA and 8HR only, as soon as code is supplied to section 7ART prior to occupancy of the single track stretch. When once picked up, relay 8WS is retained energized during occupancy, over a stick circuit which includes its own front contact 69 and the back point of contact 68 of relay 8HR. This stick circuit does not become operative, however, until the train passes signal 8L and shunts the track section 7ART so as to release relay 8HR. With relay 8WS energized, relay 8ECTM will respond to 75 code over a circuit which includes the 75 code contact 70, front point of contact 71 of relay 8WS, and back point of contact 47 of relay 8HR. Relay 8ECTM will transmit 75 code of reverse polarity over the front point of its contact 72 to the section I—K and the receipt of this code at location K will permit signal 10LA or 10LC to provide an indication for a following move through the stretch.

When the train clears signal 7L, 75 code will be fed to section 7RT in the same manner as just described for location I, whereupon relay

8HR at location I will pick up and in so doing will open the stick circuit of relay 8WS at the back point of contact 68 of relay 8HR. If the 8WAR contact is used in the pick-up circuit of relay 8WS, the latter relay will now be deenergized. If relay 8WAR is not used, relay 8WS will remain energized as its pick-up circuit remains effective over front contacts 67 and 68 of relays 8WTFSA and 8HR, respectively. The energization of relay 8HR will cause 180 code to be supplied to section I—K, as previously described. Relay 8WS must be sufficiently slow in releasing to bridge the release period of relay 8HR for a high speed, light weight engine movement past signal 8L and possible differences in the release periods of relays 8WTFSA and 8HR.

It will be noted that relay 8WTFSA provides the directional control when the track section ahead of signal 8L is unoccupied, and that relay 8WS retains the directional control when this section is occupied. With this arrangement, one TM relay, one decoding transformer DT, one DR relay (8DR), and one HR relay (8HR) are sufficient for the control of the two signals 8L and 8R. If the stretch contains but one set of intermediate signals between the two passing sidings, then it becomes unnecessary to polarize the track circuit code for proper block indication because the 180 code decoding relay 10LDR will then indicate the unoccupied condition of the block when the track circuits are energized and traffic is established for the westward direction.

I shall now explain how traffic is set up for a move in the eastbound direction. Since relay 10LTCTM at location K is controlled over the back contacts 72 and 73 of relays 8LFR and 8LSR, respectively, it is not possible to energize this relay while traffic is established for a westbound move because one or the other of these relays will be energized, depending upon whether the stretch is unoccupied or occupied. Consequently, if the operator desires to reverse the traffic direction to eastbound, the section must be unoccupied, and he may first send out a code (with lever 8 in the N position) to deenergize relay 8LFSR at the field station location E. When the clear block indication light on the track model disappears, as it will when relay 8LFR is deenergized due to the removal of track circuit energy from the stretch, relay 8RFSR at the field station location K may be energized by moving lever 8 to its R position, so that relay 10LTCTM may thereupon respond to code and thus apply energy to the track circuit 10LT over the front point of its contact 74. The code will then be cascaded from right to left to the other end of the stretch in the manner previously described and will permit clearing of the eastbound headblock signal 6R. Accordingly, the energization of relay 8RFSR enables an eastbound move to be established in a similar manner to that involving the energization of relay 8LFSR for a westbound move, as described in detail above. It is not essential that the operator place lever 8 in the N position and await extinguishment of the block light before moving the lever to the R position. The traffic change may be effected at any time by moving lever 8 from the L to the R position provided that the stretch is unoccupied at such time. Extinguishment of the block light may occur during this process and not necessarily prior to the lever reversal.

Referring for the moment to the code starting relays 235ST and 237ST (shown in Fig. 1b) which control the transmission of code for energizing

the westbound and eastbound traffic direction control relays 8LFSR and 8RFSR at field stations 235 and 237, respectively, it will be noted that energization of terminal 105 which is essential for code transmission, as will be apparent from the Lewis patent referred to hereinbefore, will not occur unless the lever 8 occupies the corresponding position and the corresponding lever repeater relay 8LP or 8RP is energized. The pick-up circuit for each lever repeater relay is checked over a back contact of the other lever repeater relay. Movement of lever 8 to the L position will pick up relay 8LP over the back contact 157 of lever repeater relay 8RP. Once relay 8LP picks up, a stick circuit will be completed therefor over its front contact 158. This stick circuit can be maintained either over the L contact of the lever, or over an auxiliary circuit which includes the back contact 159 of the block (unoccupied or occupied) indicator relay 8LBK and the front contact 160 of the traffic direction indicator relay 8LFFK. A still further stick circuit for relay 8LP will be closed over the front contact 161 of the signal indication relay 10LHK which indicates that signal 10L displays a proceed aspect. Accordingly, no reversal of the traffic direction can take place while the stretch is occupied or while the entrance signal is cleared. The indication circuits controlled by relays 8LFFK (terminal 89) and 8LBK (terminal 91A) are well known and will be obvious from the Lewis patent in which the corresponding terminals are numbered 89 and 91.

The form of traffic lever 8 which I prefer to use is one which has associated therewith a starting key SK which is closed during the preliminary motion of the lever, thus applying energy more quickly to the starting relay to avoid certain operating difficulties. Use of this type of lever makes it more easy to deenergize the signals by moving the lever to its N position, since the preliminary movement of the lever (before contact L or contact R opens) makes it possible to transmit the deenergizing code to the respective signal. However, this type of lever is not essential in the operation of my system, and an ordinary traffic lever may be used.

Referring next to Figs. 2a and 2b which show a highway crossing application of the apparatus embodying my invention, it will be seen that the single track stretch 1-3 is intersected by a highway at location 2. It will be understood that this highway crossing stretch is located at some point in the single track between the passing sidings PS1 and PS2 of Fig. 1 but has been shown as a separate portion of the complete system to simplify the disclosure.

Since the track circuits are normally deenergized, it becomes necessary to employ a different form of energy for clearing out the highway crossing control apparatus than the energy which is normally used for track circuit operation. Accordingly, I make use of current impulses of a code substantially slower than the signaling code, such for example as a code in which the current is interrupted at the rate of 20 times per minute.

Assuming now that the traffic lever 8 of Fig. 1 is in its neutral or N position so that neither traffic direction is established, the code transmitter 20CT at location 3 which supplies the 20 code will be energized over the back contacts 75 and 76 of the code detecting relays 3ECDR and 3WCDR, respectively, and will apply 20 code to the track circuit 2ET-3WT. This supply circuit may be traced from the upper rail at location 3, wire 77,

back point of contact 78 of relay 3ETR, wire 79, front point of contact 80 of coder 20CT, wire 81, battery TB, and wires 82 and 83, to the lower rail. This code will be received at location 2 and will operate the code following relay 2ETR over a circuit which can be readily traced and which includes the back point of contact 184 of relay 2WCDR. Operation of relay 2ETR causes pick-up of the ETFSA (eastbound front contact slow acting repeater) relay followed by pick-up of the ETBSA (eastbound back contact slow acting repeater) relay after front contact 185 of relay ETFSA closes. These repeater relays bridge the operation of relay 2ETR on 20 code and the closure of front contact 186 of relay ETBSA thus provides a check that relay 2ETR is following code and completes the energizing circuit for relay ETM.

At location 1, 20 code is similarly applied to the track circuit 1ET-2WT so that relay 2WTR follows 20 code and causes relays WTFSA, WTBSA, and WTM to become energized in the same manner as just described. With relays WTM and ETM both energized, the highway crossing control relay XR will be energized over the front contacts 106 and 108 of these relays so that the highway crossing signals will remain inactive.

It should be pointed out that since relays ETFSA and ETBSA are sufficiently slow acting to remain picked up on 20 code, they will also remain picked up on 75 and 180 code. However, the ECDR and WCDR relays are so designed as to pick up and to remain picked up on 75 and 180 code, but to release on 20 code.

Assuming next that traffic is established for a westbound move, coded energy of either 75 or 180 code will be applied to relay 1WTR (depending on traffic conditions in advance) which will cause energization of relay 1WCDR from the decoding transformer 1DT in well-known manner by virtue of the operation of the coding contact 189 and rectifying contact 190 of relay 1WTR. Energization of relay 1WCDR opens the circuit for coder 20CT at back contact 191, thus removing 20 code from the track circuit 1ET-2WT which controls the crossing.

Code operation of relay 1WTR at 75 or 180 code causes this code to be repeated over front contact 192 into the track circuit 1ET-2WT so as to cause operation of the code following relay 2WTR at the crossing at 75 or 180 code instead of 20 code. Relay 2WCDR will now become energized and will close a circuit for operating the coding relay CTM which relays the code from section 1-2 into section 2-3. The circuit for operating relay CTM includes front contact 193 of relay 2WTR, wire 194, front point of contact 195 of relay 2WCDR, wire 196, back point of contact 197 of relay 2ECDR, and wires 198 and 199, to relay CTM. The code feed circuit for section 2-3 includes the front point of contact 184 of relay 2WCDR and the coding contact 100 of relay CTM.

It is obvious that instead of using relay CTM, the code could be repeated over a contact of the track relay itself. However, it is advantageous from the standpoint of sensitivity to employ as few contacts on the track relay as possible. Therefore, I prefer to use the CTM repeater. Moreover, one CTM relay suffices for repeating the code in either direction, as will be obvious from the symmetrical arrangement of the apparatus at location 2. It will be noted that coded track circuit energy of 75 or 180 code may be applied to the location 2 end of section 2-3 at

the same time that coded track circuit energy of 20 code is applied to the location 3 end of the section. The energization of relay 2WCDR will open the control circuit of relay 2ETR, thus deenergizing this relay. Relays ETFSA and ETBSA will, however, retain their front contacts closed (due to their slow release characteristic) to bridge the open period of 20 code. During the first open period of 20 code in section 2—3, the 75 or 180 code will operate relays 3WTR and 3WCDR at location 3. The pick-up of relay 3WCDR opens the circuit for coder 20CT at its back contact 76, thus removing 20 code from section 2—3. The circuit for relay 3WTR will remain effective over the back point of contact 80 of coder 20CT since this coder is so designed as to close this contact, when deenergized.

The energization of relay 2WCDR at the crossing causes the release of relays 2ETR, ETFSA and ETBSA also at the crossing, but since relay 3WCDR is now energized, relay ETM is continued energized by the circuit over front contact 101 of relay 3WCDR so that the highway crossing signals remain inoperative. The receipt of 75 or 180 code by relay 2WTR at the crossing will continue to maintain relays WTFSA and WTBSA energized (these were previously energized on 20 code) so that relay WTM will also remain energized.

When a westbound train enters the section from the right and passes location 3, relay 3WTR will release because of the train shunt, followed by the release of relays 3WCDR and ETM, in turn. The opening of front contact 108 of relay ETM deenergizes relay XR which thereby initiates operation of the highway crossing signals. Relay WSR will be energized at this time over the back points of contacts 102 and 103 of relays ETM and ESR and will prepare a stick circuit for itself at front contact 104. This stick circuit will become effective with the closing of back contact 105 as soon as relay WTM is released due to the occupancy by the train of track section 1—2 which results in the shunting of relay 2WTR. The energization of relay WSR will close a path around front contact 106 of relay WTM at its front contact 107 so as to prepare a pick-up circuit for relay XR which will be effective as soon as the train vacates section 2—3 and front contact 108 of relay ETM closes. The pick-up of relay XR will cause the highway crossing signals to cease operating, in the usual manner.

During the time that section 1—2 is occupied, even though section 2—3 has been vacated, relay 2WCDR will remain deenergized so that track circuit energy of 75 or 180 code cannot be supplied to section 2—3. However, energy of 20 code will be applied to section 2—3, as previously described, whereby relays 2ETR, ETFSA, ETBSA, and finally ETM will be energized, thus cutting out the operation of the highway crossing signals through pick-up of relay XR, as indicated above.

When the westbound train vacates section 1—2 and passes beyond the next signal of the single track stretch, 75 code will be fed to the track circuit in the rear of the signal and by a cascading action, this 75 code will be repeated into all of the track circuit sections between that signal and the next signal in the rear thereof. The presence of 75 code in section 2—3 will remove the supply of 20 code to this section in the manner previously described.

It will be apparent that the highway crossing apparatus which I have provided is such that it will operate properly to provide protection even though it should prove impossible to set up the traffic direction by means of the 75 or 180 track circuit code and a train enters the block under train order authority. The presence of 20 code for highway crossing control under this condition makes it possible to provide proper and safe operation notwithstanding unforeseen failure of the ordinary track circuit code or its associated apparatus.

Referring next to Figs. 3a, 3b, and 3c, these taken together in that order show a single track stretch similar to that shown in Figs. 1a—1e, but having two intermediate sidings or turnouts T1 and T2 at locations F and H, respectively. The system shown in these figures makes application of the apparatus embodying my invention to the control of electric switch locks which are associated with the track switches for these turnouts.

In order to permit a train to leave a siding at an electrically locked switch, for example, the siding T2 at location H when the stretch is unoccupied, traffic would have to be established in one direction or the other by a movement of lever 8 as described in connection with Figures 1a—1e. I shall assume that traffic is established in the westbound direction, as described in detail in connection with Fig. 1. The operation of traffic lever 8 to the L position as described in detail in connection with the apparatus of Fig. 1 results in the energization of relay 8LFSR which applies coded energy to the track circuit 6RT in the rear of signal 6L. Since the switch lock control relay 1RWTR at location D is deenergized at this time, the polarity of this code is positive so as to operate the polarized relay 6RTWTRA at the cut section location E to its normal position in which the polar contacts 109 and 110 are closed to the left. This causes the biased polar relay 6RTWTR to pick up. The code received by relay 6RTWTR will be repeated by relay 6RTWTM (which itself is a repeater of relay 6RTWTR) over a circuit which includes the front point of contact 111 of relay 6RTWTM, polar contact 112 of relay 6RTWTRA closed to the left, and front contact 113 of relay 1OTWM, into the section 7T. This circuit is the same as previously described (for Fig. 1) in connection with cut sections involving polarized TRA relays for the control of the block indication except for the addition of the contact of the OTWM relay. This relay repeats the deenergized position of the electric switch lock 7W, the unoccupied condition of the short releasing track section 7OT (by means of the front contact 114 of relay OTR), the contact of the usual time element release TER, and the back contact 115 of the stick relay 7S. The function of this portion of the apparatus will be described hereinafter.

The application of code of positive polarity to the section 7T will be detected at signal location G by relays 8WTRA and 8WTR, in the manner previously described, and this code will be decoded in the usual manner to energize relay 8WHR alone, if signal 6L is at stop (75 code to the rear); or to energize both relays 8WHR and 8WDR if signal 6L indicates approach or clear (180 code to the rear of the signal). The energization of relay 8WHR will cause 180 code to be supplied to relay 8ECTM at location H over a circuit which includes the 180 code terminal 180B, front point of contact 116 of relay 8WHR, front

contact 117 of relay 8OTWM, and back contacts 118 and 119 of relays 8EHR and 8ES, to relay 8ECTM. The operation of relay 8ECTM on 180 code will repeat this code into section 8T and thence into section 10LT to operate relays 10LTRA and 10LTR at signal 10R. The control circuits for the coding relays 9ECTM and 9WCTM are not shown for simplicity, but it will be understood that these control circuits are similar to those shown and described for the coding relay 8ECTM. The decoding relays HR and 9WDR at location I are also not shown (except by their contacts), for simplicity, since these relays and their control circuits are identical with the corresponding apparatus at locations G and H.

With relay 9WDR at location I energized (front point of contact 120 closed) the code fed to the track circuit 10LT will be of positive polarity so as to close the normal or left-hand contacts 121 and 122 of relay 10LTRA, thereby providing the proper block indication on the track model. When relay 10LTRA is energized on this code, relay 8LFR of Fig. 1e will be energized and will transmit an indication to illuminate the traffic direction arrow on the track model for a westbound move. A clear block indication will also be established on the track model because of the normal polarity energization of relay 10LTRA. The operator may now position lever 7 at the control office to the left-hand or L position and send out a code to energize terminal 82 of the field station unit so as to energize relay 7LWSR at location K which will be picked up over the front contact 123 of relay 8LFR. If a westbound train is in the section, relay 8LSR will be energized so that relay 7LWSR could be picked up over front contact 124 of that relay. After pick-up, relay 7LWSR closes a stick circuit from terminal 83 of the field station unit over its own front contact 125. The energization of relay 7LWSR picks up relay 8LSR over front contact 126 to thereby retain control of the traffic direction indication at the control office.

After the code has been sent to the end of the single track stretch to energize relay 7LWSR at location K, the operator may instruct the trainman to operate the knife switch 8KS associated with the electric switch lock 7W at location H for the purpose of completing a circuit for relay 8S. This relay will pick up and thereby open its back contact 127 which is included in the circuit for relay 8OTWM, thus deenergizing this relay and thereby opening front contact 117 in the circuit of relay 8ECTM. The release of relay 8ECTM will cut off the code from section 8T and also from section 10LT, up to signal 10R.

The resulting deenergization of code detecting relay 8LFR will complete the circuit for relay 10LTCTM at its back contact 128 so that, with relay 7LWSR at location K energized, code of negative polarity will be applied to the track at location K, over the front point of contact 129 of relay 7LWSR and the front point of contact 130 of relay 10LTCTM. This code will be either 75 or 180 depending upon the position of signal 10R (position of contact 87 of relay 10RAHR).

The negative polarity code will be detected at signal 9R, location I, and will cause relay 9ETRA to close its polar contacts in the reverse or right-hand position, whereby relay 7RWR will become energized over contact 131 in its right-hand position. Relay 7RWR will now close its front contact 132 and in so doing will cause negative polarity code to be applied to the track section 8T.

This code will be detected by relay 8ETRA at location H.

The negative polarity code received by relay 9ETR at location I will be decoded in the same manner as described for the other intermediate signal location. Also, the control of the code supply into the adjoining track circuit 8T by the operation of relay 9WCTM will be clear from the previous description presented in connection with the apparatus of Fig. 1.

With relay 9ETRA energized on code of negative polarity, relay 8ETRA will also be energized to its reverse position so that its normal polar contact 133 will be open. Accordingly, the east-bound directional stick relay 8ES will then be deenergized. This arrangement prevents improper operation of the stick relays such as might otherwise cause a locked-up condition in which both relays WS and ES at adjoining locations would be picked up when a train enters the main track at an electric switch lock. This condition might result from the fact that coded energy is applied to both ends of the section at the same time so that no particular direction of traffic is then established. It is to prevent the possibility of such a locked-up condition that I employ code of reverse polarity supplied to the track circuit at one end of the section when an electric switch lock is involved.

The negative polarity code received by relay 8ETR will be decoded in the usual manner to energize relay 8EHR which causes energization of relay WEHSM. Closing of the front contact 134 of relay WEHSM completes a circuit over front contact 135 of relay 8S to illuminate the indication lamp LW at the electric switch lock at location H. When this indication is received, the trainman will restore the knife switch 8KS to its normal or closed position so as to complete a circuit for energizing the switch lock 7W. This circuit may be traced from the knife switch 8KS, wire 136, front contacts 137 and 138 of relays WEHSM and 8S, respectively, and wire 139, to the switch lock 7W. Relay WEHSM becomes energized when either of the relays 8WS or 8WHR is energized at the same time that either relay 8EHR or 8ES is energized, as will be obvious from the drawings.

When the switch is unlocked the switch may be reversed and the train may enter the main track and proceed westward toward signal 6L. If relay 8WTRA at location G receives coded energy of normal polarity, the following stick relay 8WS may be energized over a circuit which includes the front points of contacts 140, 141, and 142 of relays 8S, 8OTR, and 8WHR. Relay 8WS will remain energized upon the occupancy of track circuit 8OT, over a circuit which includes its own front contact 143, the back point of contact 141 of relay 8OTR, now released, and the front point of contact 142 of relay 8WHR. When relay 8WHR releases following the movement of the train out of track circuit 8OT into section 7T, the back point of contact 142 of relay 8WHR will be substituted for the back point of contact 141 of relay 8OTR in the stick circuit for relay 8WS.

It will be noted that relay 8S becomes energized following the opening of the knife switch 8KS and that when the indication light is received, the knife switch is restored to its closed position. In order to retain relay 8S energized until the unlock has been accepted, a stick circuit has been provided for relay 8S which includes the front contacts 144 and 145 of relays WEHSM and 8S.

Accordingly, relay 8S will remain energized until the switch is opened and relay 8WTR is shunted so as to deenergize relays 8WHR and WEHSM.

If, for some reason, coded energy cannot be received over the track circuits 7T and 8T to the switch lock location, it will then be necessary to operate the time element release TER which is provided to take care of this contingency. Operation of the time release will release the electric switch lock with the circuit including the knife switch 8KS in its normal position, by closing a circuit to the switch lock over the time release contact 146 which is designed to close a predetermined time following the operation of the time release, in the well-known manner.

Should a westbound train wish to enter the turnout T2, it would not be possible for relays 8ETRA and 8ETR to receive coded energy if any portion of the train remained on the track circuit 8T of the main track. It is therefore necessary to make use of the short releasing track circuit 8OT immediately ahead of the switch so that when this track circuit is occupied, the switch lock may be energized directly over the circuit which includes the closed knife switch 8KS, and the back contact 147 of relay 8OTR.

From the foregoing description, it will be seen that coded energy is fed from each end of the single track stretch toward the electric switch lock location and when this energy is detected at the switch lock, this indicates that the single track stretch is unoccupied or that, if occupied, the train is moving away from the switch lock location toward one or the other end of the section and has cleared the adjacent intermediate signal.

The control of the electric switch lock at the cut section location F is similar to that described for the electric switch lock at location H. In the cut section arrangement, as in the signal arrangement just described, separate EHR and WHR relays with their individual decoding transformers are required to secure an unlock for the electric switch lock. The decoding circuits in this instance are normally deenergized and become energized when relay 7S picks up and closes its front contact 148 following the operation of the knife switch 7KS to the right so as to energize wire 149.

It will be observed that two relays 7RWSR and 7LWSR have been provided one at each end of the stretch for the control of the electric switch locks. The relay to be selected and energized when a switch is to be unlocked will be the one located at the entrance end of the stretch for the particular direction of traffic, as established by the position of traffic lever 8. The circuits in the C. T. C. machine at the control office will accordingly be so arranged that the code will automatically be sent to the proper one of these two relays in accordance with the position of lever 7 which, as here shown, corresponds with the position of the traffic lever 8 of Fig. 1. That is to say, if the traffic lever 8 occupies its L position (for westbound traffic) then with the switch lever 7 also in the L position, a code is sent out to the field station unit at location K for energizing terminal 82 and relay 7LWSR, but code is not sent out to the field station unit at location D at the other end of the stretch. The latter unit will receive code and relay 7RWSR will become energized only after both levers 8 and 7 occupy their R position (for eastbound traffic). It is not necessary, however, that the coding circuits on the control machine at

the office should be so selected that the control code for these relays is transmitted to the entrance end of the block only, for if codes were sent to both ends of the stretch, the relay at the entrance end of the block would be the only one to pick up because it is only at that end of the block that the code detecting relay (8LFR or 8RFR) would then be energized. In the system embodying my invention, it is unnecessary for the operator to establish an additional control from the C. T. C. machine to the switch lock when a train occupying the main track wishes to enter an electrically locked switch, as the switch will be unlocked automatically by virtue of the occupancy of the releasing track section OT.

The switch lock control apparatus shown in Fig. 3 is adequate if not more than two pairs of intermediate signals are located within the single track stretch (two pairs are shown in Fig. 3). For a greater number of intermediate signals, the modified circuit arrangement shown in Fig. 4 of Sh. 2 may be used for the control of the ES relay. This figure shows the control arrangement for the eastbound stick relay (ES), but it will be understood that a similar control would be used for the westbound stick relay (WS). In the arrangement shown in Fig. 4, the first train through the block will energize relay ES. Relay ES will remain energized through its stick circuit until the block is vacated when coded track circuit energy of negative polarity will be received to energize relay EHR. Before relay ES opens its front contacts, a circuit is complete through reverse polar contact 151 (closed to right) of relay ETRA to energize relay ESA which will be retained in its energized position by the same circuit just traced except through a front contact of relay ESA instead of relay ES. Relay ESA will remain energized until the train clears the block, so that following trains will cause relay ES to be energized over the front contact 150 of relay ESA rather than the normal polar contact 151 of relay ETRA which will remain in its reverse position until the train clears the block. Of course, with the arrangement of Fig. 4, if the block is occupied by an eastbound train and a second train enters at the switch lock SW shown in the track diagram of Fig. 4a, the ES relay at signal 4 location may be energized even though this second train proceeds in the westbound direction after entering the main track at the switch lock. The lever circuits shown in Fig. 1b will, however, retain coded energy in the block for an eastbound move until such time as both trains clear the block so that no difficulty would be experienced through improper operation of the following stick relays.

From the foregoing description it will be apparent that I have provided a signaling system for a stretch of single track, two-direction railway which combines C. T. C. control with coded wayside signaling in a novel manner such that no control line wires (except those involved in highway crossing control) apart from the C. T. C. code line are required. Since the system is of the normally deenergized type, it lends itself readily to primary battery operation in territory where the ordinary commercial power sources are not available. Operation of a traffic lever at a central control location establishes the permitted direction by applying code at the exit end of the stretch, which code when cascaded to the entrance end checks unoccupancy of the stretch and permits clearing of the entrance sig-

nal. Passage of the train approach-energizes the signals as these are approached, for the purpose of conserving the energy of the power supply source. The approach relays are included in the control for the following directional stick relays so as to provide proper directional control since the use of the advance track circuit for this purpose, as in the usual case, is not possible because of the normally deenergized condition of the track circuits of the system. Deenergization of these track circuits brings on the normal condition of the system and cannot, therefore, be used for the directional control function. Polarized track circuit code is used to detect the occupied condition of the stretch and to indicate this condition by means of traffic lights on the track model in the C. T. C. control office. Where the stretch includes but one intermediate signal location, the 180 code decoding relay may be used to provide the block indication. Traffic direction is retained during occupancy by intercontrols on the C. T. C. machine which prevent the operator from reversing the traffic direction once the stretch is occupied until the train passes completely out of the stretch. The apparatus embodying my invention also provides for proper control of highway crossing apparatus through the use of an additional code such as 20 code for detection purposes. Moreover, the apparatus embodying my invention lends itself readily to the control of electric switch locks without any line wires other than those required for the C. T. C. line circuit.

Although I have herein shown and described only a few forms of railway traffic controlling apparatus 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 combination with a stretch of single track over which traffic may move in either direction, said stretch being divided into a plurality of track circuit sections, a traffic direction control relay, manually controlled means at a control office for operating said traffic direction relay, means effective when said traffic direction relay is operated for cascading current impulses of a track circuit code from the exit end of said stretch for a given traffic direction over said sections to the entrance end for establishing said traffic direction, an entrance signal, code responsive means operated in response to the code received at the entrance end, means controlled from said office and effective when said code responsive means is operated for clearing said entrance signal, and means at said control office effective when said entrance signal is cleared for preventing a reversal of the established traffic direction.

2. In combination with a stretch of single track over which traffic may move in either direction, manually controlled means at a control office, direction selecting means in the trackway responsive to operation of said manually controlled means for establishing traffic in a given direction over said stretch, means adjacent the exit end of said stretch for said given direction and controlled by said direction selecting means for transmitting coded rail current impulses from said exit end to the entrance end, an entrance signal, control means operated in response to the receipt of said rail current impulses at said

entrance end, means controlled from said office and effective when said control means is operated for clearing said entrance signal, and means at said control office effective when said signal is cleared for preventing the reversal of said given traffic direction.

3. In combination with a stretch of single track over which traffic may move in either direction, a manually controlled selector at a control office having a first and a second position, traffic direction control means in the trackway selectively responsive to operation of said selector to said first or said second position for establishing traffic in one or the other direction respectively over said stretch, means adjacent one end of said stretch governed by said traffic direction control means and effective when the selector is in its first position for transmitting coded rail current impulses from said one end to the other end of said stretch, means adjacent said other end also governed by said traffic direction control means and effective when said selector occupies said second position for transmitting coded rail current impulses from said other end to said one end of the stretch, an entrance signal at each end of the stretch, control means at each end operated in response to the receipt of said coded current at the associated end of the stretch, means at each end controlled from said office and effective when the associated control means is operated for clearing the entrance signal at that end, and means at the control office effective when either signal is cleared for preventing a reversal of the established traffic direction.

4. In combination with a stretch of single track over which traffic may move in either direction, a normally deenergized traffic direction relay adjacent the exit end of said stretch for a given traffic direction, manually controlled means at a control office for energizing said traffic direction relay, means effective when said traffic direction relay is energized for transmitting coded rail current impulses from said exit end to the entrance end of said stretch for establishing traffic in a given direction, means effective when said coded rail current is received at said entrance end for permitting traffic to enter said stretch, and means effective during occupancy of said stretch for maintaining said traffic direction relay energized to thereby retain the established traffic direction.

5. In combination with a stretch of single track over which traffic may move in either direction, a normally deenergized westbound traffic direction control relay adjacent one end of said stretch, a normally deenergized eastbound traffic direction control relay adjacent the other end of said stretch, manually controlled means for selectively energizing said westbound or said eastbound direction control relay, a first and a second normally deenergized code detecting relay adjacent said one and said other end of said stretch respectively, means including a front contact of said westbound direction control relay and a back contact of said first code detecting relay for transmitting coded rail current impulses from said one end to said other end of the stretch to thereby energize said second code detecting relay and establish traffic in the westbound direction over said stretch, and means including a front contact of said eastbound direction control relay and a back contact of said second code detecting relay for transmitting coded rail current impulses from said other end to said one end of the stretch to thereby energize said first code detecting relay and establish traffic in the eastbound

direction over said stretch, whereby when either code detecting relay is energized its associated back back contact is open so as to prevent code transmission from that end and so prevent a reversal of the established traffic direction.

6. In combination with a stretch of single track over which traffic may move in either direction, a normally deenergized traffic direction control relay adjacent one end of said stretch, manually controlled means for energizing said direction control relay, a normally deenergized code detecting relay adjacent the other end of said stretch, means effective when said direction control relay is energized for transmitting coded rail current impulses from said one end to said other end of the stretch to thereby energize said code detecting relay and establish traffic in a given direction over said stretch, and means effective when said code detecting relay is energized for preventing a reversal of said given traffic direction.

7. In combination with a stretch of single track over which traffic may move in either direction, a normally deenergized traffic direction control relay adjacent one end of said stretch, manually controlled means for energizing said direction control relay, means effective when said direction control relay is energized for transmitting coded rail current impulses from said one end to said other end of the stretch to thereby establish traffic in a given direction over said stretch, a normally deenergized stick relay adjacent said other end of the stretch, means effective when a train enters said stretch at said other end for energizing said stick relay, and means effective when said stick relay is energized for preventing a reversal of said given traffic direction.

8. In combination with a stretch of single track over which traffic may move in either direction, a normally deenergized traffic direction control relay adjacent one end of said stretch, manually controlled means for energizing said direction control relay, a normally deenergized code detecting relay adjacent the other end of said stretch, an entrance signal adjacent said other end, means effective when said direction control relay is energized for transmitting coded rail current impulses from said one end to said other end of the stretch to thereby energize said code detecting relay so as to establish traffic in a given direction over said stretch and permit clearing of said entrance signal, a normally deenergized stick relay adjacent said other end of the stretch, means effective when a train accepts said entrance signal and enters the stretch at said other end for energizing said stick relay, and means effective when said stick relay is energized for preventing a reversal of said given traffic direction.

9. In combination with a stretch of single track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, means including a code following track relay for said first section for cascading coded rail current impulses over said stretch from said first to said second section for establishing traffic in a given direction, a slow acting repeater relay energized over a front contact of said code following track relay, a directional stick relay, a code repeater relay energized over a front contact of said slow acting repeater relay, a pick-up cir-

cuit for said directional stick relay including a front contact of said slow acting repeater relay, and traffic controlling apparatus common to both said sections controlled by said code repeater relay.

10. In combination with a stretch of single track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, means including a code following track relay for said first section for cascading coded rail current impulses over said stretch from said first to said second section for establishing traffic in a given direction so as to permit a train to enter said stretch and approach said intermediate signal, a slow acting repeater relay which remains energized when said track relay is following code, a directional stick relay, a code repeater relay controlled over a front contact of said slow acting repeater relay, an approach relay for said second section which becomes energized when the train approaches within a predetermined distance of said intermediate signal, a pick-up circuit for said directional stick relay including a front contact of said approach relay and a front contact of said slow acting repeater relay, and traffic controlling apparatus common to both said sections controlled by said code repeater relay.

11. In combination with a stretch of single track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit also within said stretch on the other side of said intermediate signal location, a westbound code following track relay for said first section, an eastbound code following track relay for said second section, means for supplying coded rail current impulses to said first section when the traffic direction is westbound to operate said westbound track relay, means for supplying coded rail current impulses to said second section when the traffic direction is eastbound to operate said eastbound track relay, a westbound and an eastbound slow acting repeater relay for said westbound and said eastbound track relay respectively, a westbound directional stick relay having a pick-up circuit including a front contact of said westbound repeater relay, an eastbound directional stick relay having a pick-up circuit which includes a front contact of said eastbound repeater relay, a code repeater relay having a first energizing circuit which includes a front contact of said westbound repeater relay and having a second energizing circuit which includes a back contact of said westbound repeater relay and a front contact of said eastbound repeater relay, and traffic controlling apparatus common to both said sections controlled by said code repeater relay.

12. In combination with a stretch of track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, a westbound traffic direction control relay for supplying rail current impulses of a first or of a second code to said first section in accordance with traffic conditions in advance thereof to

establish westbound traffic direction over said stretch, means effective when said first or said second code is supplied to said first section for supplying rail current impulses of said second code to said second section, an eastbound traffic direction control relay for supplying rail current impulses of said first or said second code to said second section in accordance with traffic conditions in advance thereof to establish eastbound traffic direction over said stretch, means effective when said first or said second code is supplied to said second section for supplying rail current impulses of said second code to said first section, means for selectively operating said westbound or said eastbound traffic direction control relay, two code detecting relays for each of said sections one responsive only to said second code and the other responsive to both said codes, and a block indication circuit for each traffic direction controlled by the two code detecting relays associated with the established traffic direction.

13. In combination with a stretch of track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, a traffic direction control relay effective when operated for supplying coded rail current impulses of an approach code to said first section to thereby establish westbound traffic direction over said stretch, means for operating said traffic direction control relay, means responsive to the presence of said approach code in said first section for supplying coded rail current impulses of a proceed code to said second section, a code detecting relay for said second section selectively responsive to said proceed code, and block indication apparatus for said stretch controlled by said code detecting relay.

14. In combination with a stretch of track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, means for cascading coded rail current impulses of given polarity over said stretch from said first to said second section so as to establish traffic in the direction from said second to said first section and permit a train to enter said stretch, means effective after a train has entered said first section and has vacated said second section for supplying coded rail current impulses of reverse relative polarity to said second section, a polarity responsive code detecting relay for said second section, and block indication apparatus for said stretch controlled by said code detecting relay.

15. In combination with a stretch of track over which traffic may move in either direction, an intermediate signal location within said stretch, a first track circuit section within said stretch on one side of said intermediate signal location, a second track circuit section also within said stretch on the other side of said intermediate signal location, means for cascading coded rail current impulses of given polarity over said stretch from said first to said second section so as to establish traffic in the direction from said second to said first section and permit a train to enter said stretch, means effective after a train has entered said first section and has vacated

said second section for supplying coded rail current impulses of reverse relative polarity to said second section, polarity responsive means for said second section operated by coded current of said reverse polarity, and signaling apparatus controlled by said polarity responsive means.

16. In combination with a stretch of track over which traffic may move in either direction, said stretch being divided into a plurality of block sections, manually controlled means for cascading coded rail current impulses from one to the other end of said stretch over said sections to detect unoccupancy and permit a train to enter the stretch, the coded rail current supplied to the entrance block section being of normal relative polarity, means effective when a train has vacated said entrance section and is occupying any portion of said stretch for supplying coded rail current impulses of reverse relative polarity to the entrance section, a polarized code detecting relay for said entrance section, and block indication apparatus for said stretch controlled by said polarized code detecting relay.

17. In combination with a stretch of track over which traffic may move in either direction, said stretch being divided into a plurality of block sections, manually controlled means for cascading coded rail current impulses from one to the other end of said stretch over said sections to detect unoccupancy and permit a train to enter the stretch, the coded rail current supplied to the entrance block section being of normal relative polarity, means effective when a train has vacated said entrance section and is occupying any portion of said stretch for supplying coded rail current impulses of reverse relative polarity to the entrance section, a polarized code detecting relay for said entrance section, means effective when the train has passed completely out of said stretch for restoring coded rail current of normal relative polarity to said entrance section, and block indication apparatus for said stretch controlled by said polarized code detecting relay.

18. In combination with a stretch of track over which traffic may move in either direction, said stretch being divided into a plurality of block sections, a west-bound traffic direction control relay effective when energized for causing coded rail current impulses to be supplied to the west-bound exit section and cascaded therefrom to the westbound entrance section for checking unoccupancy and permitting a westbound train to enter said stretch, the coded rail current supplied to said westbound entrance section being of normal relative polarity, an eastbound traffic direction control relay effective when energized for causing coded rail current to be supplied to said entrance section and cascaded therefrom to said exit section for checking unoccupancy and permitting an eastbound train to enter said stretch, the coded rail current supplied to said exit section being of said normal polarity, manually controlled means for selectively energizing said westbound or said eastbound traffic direction control relay according as the traffic direction being established is westbound or eastbound respectively, means effective when a westbound train within said stretch vacates said entrance section for supplying coded rail current of reverse relative polarity to said entrance section, means effective when an eastbound train within said stretch vacates said exit section for supplying coded rail current of said reverse polarity to said exit section, a polarized code detecting relay for each said entrance and said exit section, and

block indication apparatus for said stretch controlled by said polarized code detecting relays.

19. In combination with a normally deenergized stretch of track over which traffic may move in either direction, an eastbound and a westbound track circuit for said stretch including the same track rails, a westbound track relay adjacent one end of said track circuit and a westbound source of rail current adjacent the other end, an eastbound track relay adjacent said other end and an eastbound source of current adjacent said one end, manually controlled traffic direction selecting means at a control office for selectively supplying rail current impulses from said westbound or said eastbound source to operate the associated track relay according as the traffic direction being established is westbound or eastbound respectively, and traffic locking means at said control office controlled by each of said track relays for preventing a reversal of the established direction during occupancy of said stretch.

20. In combination with a normally deenergized stretch of track over which traffic may move in either direction, an eastbound and a westbound track circuit for said stretch including the same track rails, a westbound track relay adjacent one end of said track circuit and a westbound source of rail current adjacent the other end, an eastbound track relay adjacent said other end and an eastbound source of current adjacent said one end, manually controlled traffic direction selecting means at a control office for selectively supplying rail current impulses from said westbound or said eastbound source to operate the associated track relay according as the traffic direction being established is westbound or eastbound respectively, an entrance signal adjacent each end of said stretch, said signals normally displaying a stop indication, means controlled by each track relay when operated for permitting the associated signal to be cleared, and traffic locking means at said control office effective when one or the other said signal is cleared for preventing a reversal of the established traffic direction.

21. In combination with a stretch of track over which traffic may move in either direction, said stretch having a turnout therein, an electric switch lock associated with said turnout, a first track circuit section on one side of said turnout and a second track circuit section on the other side of said turnout both within said stretch, manually controlled means for cascading coded rail current impulses from said first to said second section for establishing traffic in a given direction over said stretch, the coded rail current in said first section being of normal relative polarity, manually controlled means effective when said stretch is unoccupied for discontinuing the coded current in said second section and supplying coded rail current impulses of reverse relative polarity thereto, and means effective when coded rail current of normal polarity is present in said first section and coded rail current of reverse polarity is present in said second section for permitting an unlock of said electric switch lock.

22. In combination with a stretch of track over which traffic may move in either direction, a traffic governing device for permitting entry of traffic into said stretch from a location intermediate the two ends of the stretch, a track circuit junction adjacent said traffic governing device for establishing a first and a second track circuit section, means for transmitting coded rail cur-

rent impulses in a given direction over said first section and over said second section, means for reversing the direction in which coded rail current impulses are transmitted over said second section, and code detecting means adjacent said junction responsive to the presence of coded rail current flowing in said given direction over said first section and in the reverse direction over said second section for controlling said traffic governing device.

23. In combination with a normally deenergized stretch of track over which traffic may move in either direction, a traffic governing device for permitting entry of traffic into said stretch from a location intermediate the two ends of the stretch, a track circuit junction adjacent said traffic governing device for establishing a first and a second track circuit section, manually controlled means for transmitting coded rail current impulses in a given direction over said first section and over said second section, manually controlled means for reversing the direction in which coded rail current impulses are transmitted over said second section, and code detecting means adjacent said junction responsive to the presence of coded rail current flowing in said given direction over said first section and in the reverse direction over said second section for controlling said traffic governing device.

24. In combination with a normally deenergized stretch of track over which traffic may move in either direction, a traffic governing device intermediate the two ends of said stretch, a track circuit junction adjacent said traffic governing device for establishing a first and a second track circuit section, means for transmitting coded rail current impulses of normal relative polarity in a given direction over said first section and over said second section, means for discontinuing the normal polarity code in said second section and transmitting coded rail current impulses of reverse relative polarity in the reverse direction over said second section, and polarized code detecting means responsive to the presence of coded rail current of normal polarity flowing in said given direction in said first section and reverse polarity flowing in said reverse direction in said second section for controlling said traffic governing device.

25. In combination with a stretch of track over which traffic may move in either direction, a traffic governing device located intermediate the two ends of said stretch, a first section comprising a combined eastbound and westbound track circuit including the same track rails of said stretch and controlling the approach to said device from a given traffic direction, a second section comprising a combined eastbound and westbound track circuit including the same track rails of the stretch and controlling the approach to said device from the other traffic direction, means effective for transmitting coded rail current impulses over the westbound track circuit of said first section, means effective for transmitting coded rail current impulses over the eastbound track circuit of said second section, and means effective when said coded rail currents are simultaneously effective in said westbound and eastbound track circuits for controlling said traffic governing device.

26. In combination with a stretch of track over which traffic may move in either direction, a traffic governing device intermediate the two ends of said stretch, a track circuit junction

adjacent said traffic governing device for establishing a first and a second track circuit section, manually controlled means for causing coded rail current impulses of normal relative polarity to be supplied to said first section and cascaded into said second section for establishing traffic in a given direction over said stretch, manually controlled means for discontinuing the supply of said coded current of normal polarity in said second section and supplying coded rail current of reverse relative polarity thereto, and polarized code detecting means for each said section for controlling said traffic governing device.

27. In combination with a stretch of track over which traffic may move in either direction, a traffic governing device intermediate the two ends of said stretch, a track circuit junction adjacent said traffic governing device for establishing a first and a second track circuit section, manually controlled means at a control office for causing coded rail current impulses of normal relative polarity to be supplied to said first section and cascaded into said second section for establishing traffic in a given direction over said stretch, manually controlled means in the trackway for discontinuing the supply of said coded current to the second section, manually controlled means also at said control office for supplying coded rail current of reverse relative polarity to said second section, and polarized code detecting means for each said section for controlling said traffic governing device.

28. In combination with a stretch of track over which traffic may move in either direction, said stretch being divided into a plurality of track circuit sections, a track switch located within said stretch, an electric switch lock for said track switch, means for cascading coded rail current impulses of normal relative polarity over said sections to establish traffic in a given direction over said stretch, means for discontinuing the supply of said coded rail current to the sections beyond said track switch location and cascading coded rail current impulses of reverse relative polarity over the deenergized sections in a direction toward said track switch, a directional stick relay for said given traffic direction, a repeater relay for said directional stick relay, a polarized track relay for one of said sections in which the polarity of said coded rail current has been reversed, a pick-up circuit for said directional stick relay including a normal polar contact of said polarized track relay, a pick-up circuit for said repeater relay including the reverse polar contact of said polarized track relay and a front contact of said directional stick relay, a stick circuit for said repeater relay including said reverse polar contact and a front contact of the repeater relay, an auxiliary energizing circuit for said directional relay including a front contact of said repeater relay, and a circuit for said electric switch lock controlled over a front contact of said repeater relay.

29. In combination with a stretch of track over which traffic may move in either direction, said stretch being intersected by a highway, a track circuit junction adjacent the highway intersection for establishing a first and a second

track circuit section, means for cascading coded rail current impulses of a relatively fast code over said sections to establish traffic in a given direction over said stretch and permit a train to enter the stretch, a code detecting relay for each said section operated by said fast code, highway crossing apparatus, means effective when either code detecting relay is operated for rendering said highway crossing apparatus inoperative, whereby when a train enters one of said sections and causes the associated code detecting relay to release said highway crossing apparatus will become operative, means effective when the train vacates one of said sections for supplying coded rail current impulses of a relatively slow code to the vacated section, said code detecting relays being inoperative on said slow code, a detecting relay for said vacated section responsive to said slow code, and means controlled by said last-named detecting relay for restoring said highway crossing apparatus to its inoperative condition.

30. In combination with a stretch of track over which traffic may move in either direction, said stretch being intersected by a highway, a track circuit junction adjacent the highway intersection for establishing a first and a second track section, means effective when said stretch is unoccupied for supplying coded rail current impulses of a relatively slow code to said two sections, a code detecting relay for each of said sections operated by said slow code, highway crossing apparatus, means controlled by both said detecting relays when operated for maintaining said highway crossing apparatus inoperative, traffic direction control means for transmitting coded rail current impulses of a relatively fast code over said sections to establish traffic in a given direction over said stretch, a code detecting relay for each of said sections operated by said fast code but not by said slow code, means controlled by said fast code detecting relays for discontinuing the supply of said slow code in the associated section, means controlled by both said fast code detecting relays for also maintaining said highway crossing apparatus inoperative, means effective when a train enters one of said sections and releases the fast code detecting relay associated therewith for rendering said highway crossing apparatus operative, and means controlled by said fast code detecting relay effective when a train vacates said one section for restoring said highway crossing apparatus to its inoperative condition.

31. In combination with a stretch of track over which traffic may move in either direction, a traffic governing device at a location intermediate the two ends of the stretch, means for transmitting rail current over said stretch in a given direction both in advance and in the rear of said location, means for reversing the direction in which the rail current is transmitted in the rear of said location, and means responsive to the rail current flowing in the given direction in advance of said location and in the reverse direction in the rear of said location when said currents are jointly effective for controlling said traffic governing device.

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