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2,370,091

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed Sept. 25, 1941

4 Sheets-Sheet 1

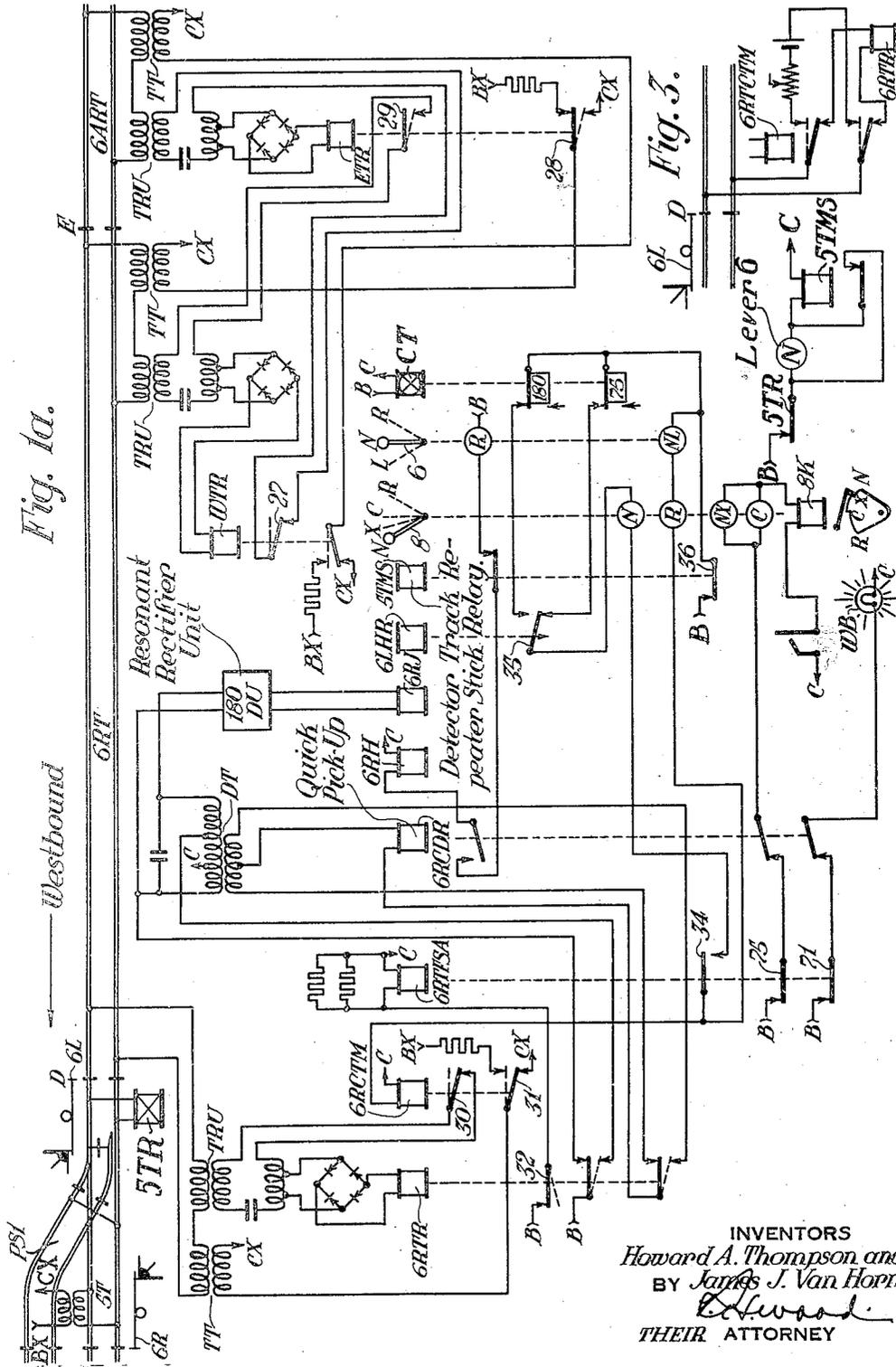
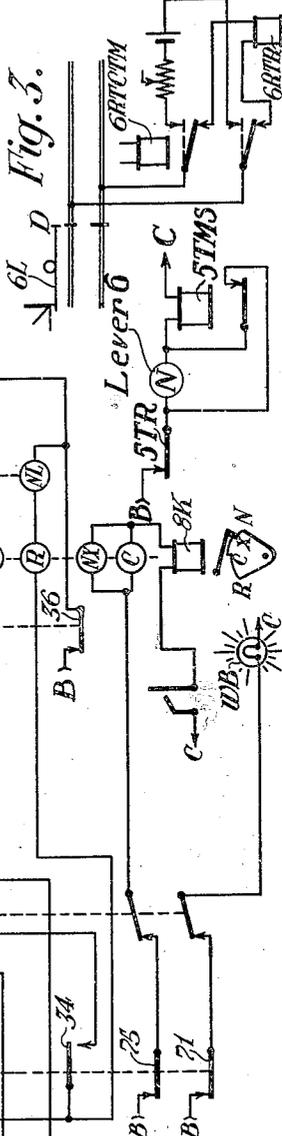


Fig. 3.



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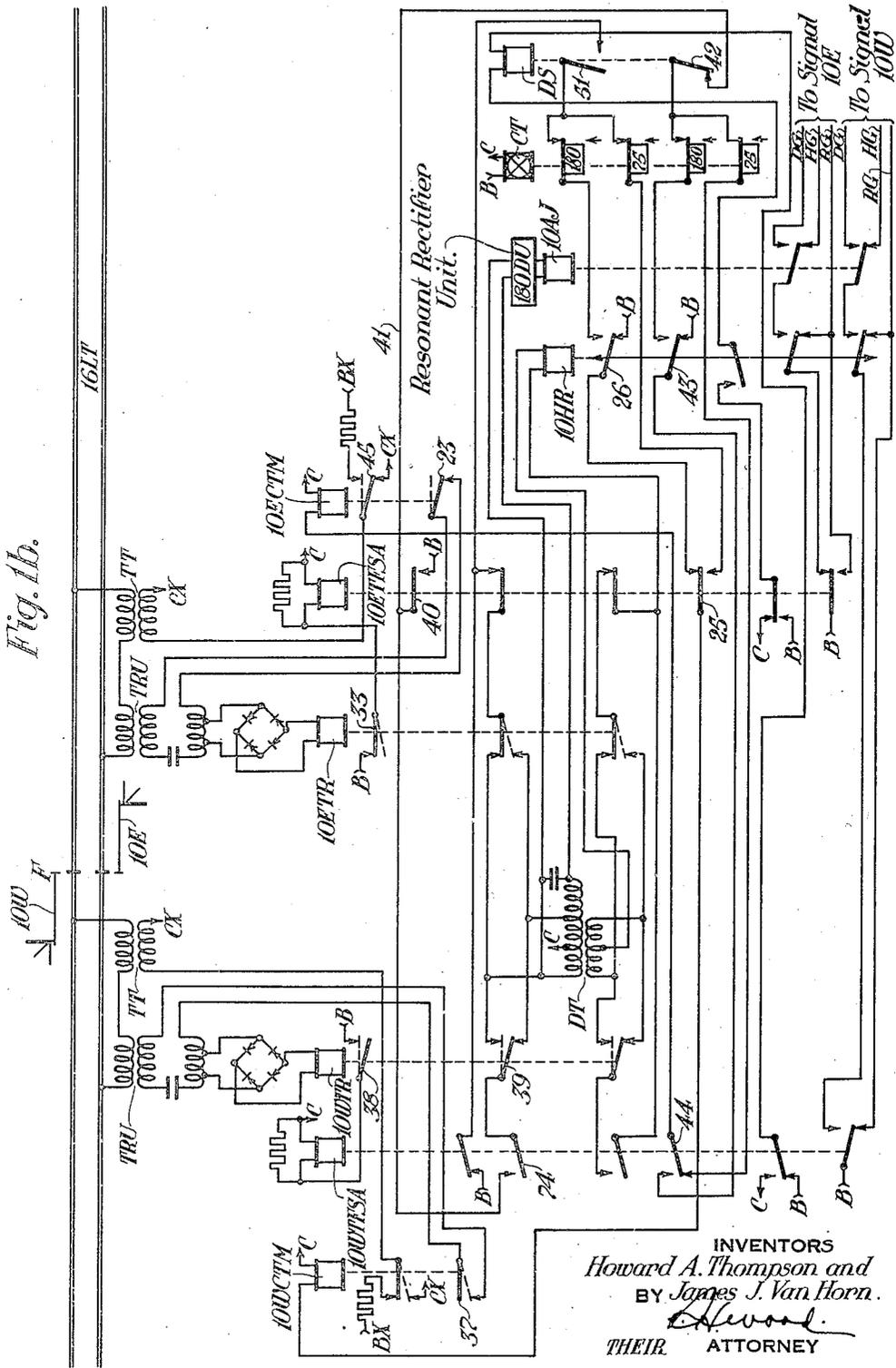
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4 Sheets-Sheet 2



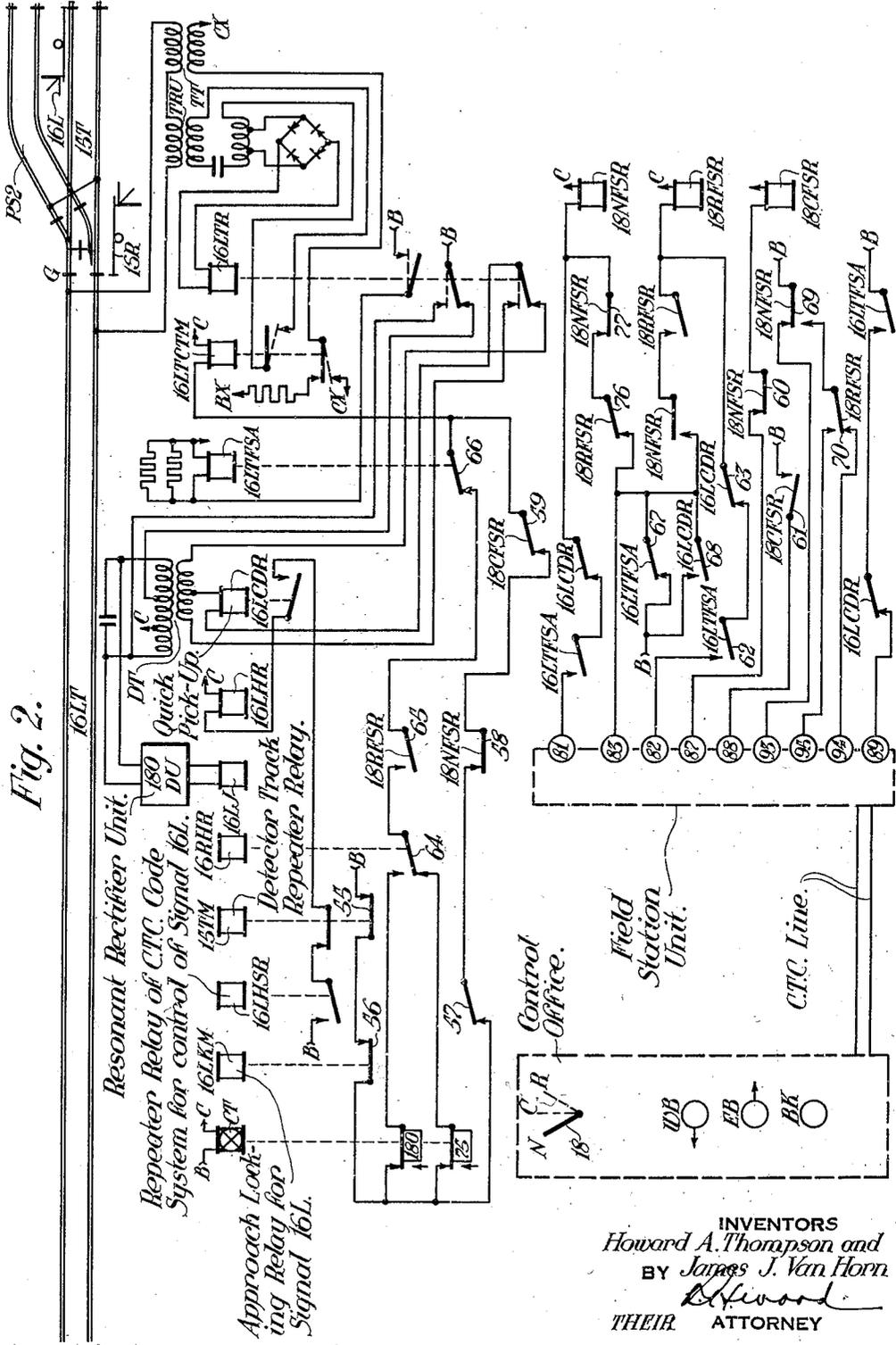


Fig. 2.

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2,370,091

RAILWAY TRAFFIC CONTROLLING APPARATUS

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Application September 25, 1941, Serial No. 412,278

11 Claims. (Cl. 246—3)

Our invention relates to railway traffic controlling apparatus and is directed to the control of traffic in a single track, two-direction system of signaling in which manual control either at the two ends of the single track stretch or at a remote control point is used for controlling traffic passing over the stretch. Our system employs no control line wires except for the C. T. C. line circuit, if remote control is used, and is normally deenergized insofar as the presence of track circuit code is concerned, the only energy normally in the track being uncoded or steady current. This is used to provide the block unoccupied indication and to provide the unlock which is necessary before a reversal of the established traffic direction can be accomplished.

One object of our invention is to provide a non-line-wire system for coded track circuit operation in a single track, two-direction system which incorporates important safety features which are comparable to those which are present in line wire systems designed for this type of service. Another object of our invention is to employ steady energy transmitted over the track to provide traffic locking. A further object of our invention is to control such a system manually, at the two ends, or by means of C. T. C. control, or a combination of the two. Other objects, purposes and characteristic features of our invention will be apparent from the description which follows.

We accomplish the foregoing objects by normally transmitting steady track circuit energy in the direction in which traffic is established, under the control of a manually operable lever at each end of the single track stretch or at a remote control point, which energy must be detected at the exit end for the established traffic direction before a traffic lever reversal can be made at this end. Reversal of the traffic lever at the exit end (new entrance end) causes steady energy to be transmitted to the new exit end and when there detected, permits a reversal of the traffic lever at that end. The steady energy is discontinued by operation of the signal lever for clearing the entrance signal and when this effect reaches the exit end, code is transmitted from that end to the new entrance end. Receipt of code at the entrance end permits the entrance signal to clear so that traffic may enter the single track stretch. The steady energy is applied to the track circuits in the rear of the train so that the system is automatically restored to its normal condition upon the exit of the train from the stretch. By cutting off the steady en-

ergy at the entrance end, the signal may again be cleared for a following train movement.

Our present invention is an improvement on the invention disclosed in the copending United States applications, Serial No. 410,504, filed on September 12, 1941, by James J. Van Horn, now Patent No. 2,344,573, dated March 21, 1944, and Serial No. 411,481, filed on September 19, 1941, by Crawford E. Staples, now Patent No. 2,353,421, dated July 11, 1944, both for Railway traffic controlling apparatus.

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

In the accompanying drawings, Figs. 1a, 1b, and 1c when taken together, with Fig. 1a at the left, are a diagrammatic view showing one embodiment of our invention as applied to a stretch of single track railway extending between the passing sidings PS1 and PS2 at the two ends of the stretch. Fig. 2 is a diagrammatic view, also embodying our invention, and showing a modified form of the invention shown in Fig. 1, in which the apparatus at one end of the stretch is controlled from a remotely located control office over a C. T. C. line circuit. Fig. 3 shows the direct current track circuit modification for location D of Fig. 1a, of the apparatus embodying our invention.

Similar reference characters refer to similar parts in each of the several views.

Referring next to Figs. 1a, 1b, and 1c, we shall first describe the general features of operation in order to make the subsequent detailed circuit description more readily understandable.

In the form of the invention shown in Figs. 1a, 1b, and 1c, a traffic direction control lever is used at each end of the single track stretch. With both traffic levers 8 and 18 set for westbound traffic (N position) and the westbound entering signal 16L in the stop position, steady non-coded track circuit energy feeds from the east end and is repeated through all of the track circuits from location G at the east end to location D at the west end. This steady energy controls a through traffic block indicator light WB at the west end which informs the operator at that location that the entire stretch is clear. It is only when this steady energy is received throughout the entire stretch that the operator at the west end may reverse his traffic lever 8 to initiate the reversal of traffic. When it is desired to reverse this direction of traffic, the operator at the west end first contacts the operator at the east end (location G) and then moves his traffic lever 8 to the

reverse position R. The operator at the east end then moves his traffic lever 18 to the center position which cuts off the steady energy that has been flowing from east to west. This permits steady energy to flow from west to east throughout the entire stretch, and only when this steady energy is received at the east end, lighting the through traffic block indicator EB at that location, will the operator at the east end be able to complete the movement of his traffic lever 18 to the reverse position. When this has been accomplished, the operator at the west end moves his signal lever 6 to clear the eastbound signal. The moving of the signal lever cuts off the steady energy which has been flowing from west to east and when this energy has been removed, with the traffic lever 18 at the east end set for eastbound traffic, coded track circuit energy will be relayed through the entire stretch from location G to location D, and only when this coded track circuit energy is received at the west end will the eastbound signal 6R assume the clear position.

In the rear of an eastbound train, steady energy is fed from the west end through each track section as that track section becomes vacated. The operator at the west end may again clear his eastbound signal by operation of the signal lever 6 which cuts off the steady energy and allows coded track circuit energy to feed from east to west in the vacated track sections. This coded track circuit energy may originate either at the east end or at any intermediate signal location such as location F, in the rear of an eastbound train. The operation of changing the traffic direction from eastbound to westbound is similar to the operation just described and requires no added description.

It will be noted that a high degree of protection against the possibility of reversal of traffic with a train occupying the stretch is provided. Before a reversal of traffic can be initiated, steady energy must be flowing through the entire stretch in the established direction of traffic and this steady energy cannot be received at the exit end if there is a train within the stretch approaching that end. Then also, steady energy must be transmitted throughout the entire stretch in the opposite direction of traffic, that is, in the new traffic direction. Only when this is accomplished can coded track circuit energy be applied at the new exit end and only when this coded track circuit energy is relayed throughout the entire stretch to the new entrance end can the entrance signal for the new direction of traffic be cleared, the presence of coded energy again checking against an opposing move.

Fig. 1a shows the circuits involved for traffic locking at the west end of the territory and the circuits involved at the cut section E. Fig. 1b shows the circuit arrangement required at a double intermediate signal location F, and Fig. 1c shows the traffic locking circuits required at the east end of the territory. The double intermediate signal location is typical of all such locations irrespective of the number involved and likewise, the circuits shown for the cut section are typical for all cut sections irrespective of their number.

We shall now describe the circuits more in detail. With traffic lever 18 in its normal position and signal lever 16 occupying any position from normal (N) to righthand (R), inclusive, battery is connected to the winding of relay 16LCTM

through a front contact 20 of relay 15TMS, which is a stick repeater for the approach track circuit section 15T, to hold relay 16LCTM steadily energized. The circuit control for relay 15TMS is well known and is shown, for example, in Fig. 1c of United States Patent No. 2,141,074, granted to H. S. Young on December 20, 1938. In that patent, repeater relay 1TS corresponds with relay 15TMS and is seen to have an energizing circuit which extends over a front contact of the detector track relay and the lever contact which is closed in the normal position of the lever, as well as a stick circuit which excludes the lever contact and includes a front contact of the repeater relay itself. (Corresponding circuits control the relay 5TMS at the other end of the stretch.) The energization of relay 16LCTM opens the circuit of the resonant transformer-rectifier unit TRU at that location at its back contact 21 to prevent energization of the track relay 16LTR and it also causes non-coded track circuit energy to be applied to the track transformer TT over its front contact 22. At the intermediate signal location F, relay 10ECTM is deenergized so that the circuit of the resonant transformer-rectifier unit for relay 10ETR is closed at back contact 23, and the primary winding of its associated track transformer TT is shunted over the back point of contact 45 of relay 10ECTM. This allows relay 10ETR to be steadily energized. The energization of relay 10ETR energizes relay 10ETFSA continuously. Relay 10WCTM is continuously energized over the front point of contact 25 of relay 10ETFSA and the back point of contact 26 of relay 10HR. The continuous energization of relay 10WCTM opens the resonant transformer-rectifier circuit for relay 10WTR and applies steady non-coded energy to the track transformer feeding westward.

At the cut section location E, this steady non-coded energy continuously energizes relay ETR which has its resonant transformer-rectifier circuit closed through a back contact 27 of relay WTR. The energization of relay ETR closes a circuit over the front point of its contact 28 so as to apply non-coded energy to the track transformer feeding westward. The transformer-rectifier circuit of relay WTR has been opened at back contact 29 with the energization of relay ETR and now remains open. As shown, relay 6RCTM at location D is deenergized. Accordingly, the circuit of the resonant transformer-rectifier unit for the track relay 6RTR at that location is closed at back contact 30 of relay 6RCTM, and the primary winding of the track transformer is shunted over the back point of contact 31 of this relay, allowing the track relay to be continuously energized. The energization of relay 6RTR energizes relay 6RTFSA over its front contact 32, whereupon the energization of relay 6RTFSA closes the circuit to the through traffic block indicator light WB over its front contact 71 and the back contact 73 of relay 6RCRDR, thus indicating that the stretch is clear.

For permitting a westward train movement with the two traffic levers 8 and 18 at the two ends occupying the normal position, the operator at the east end will move signal lever 16 to the left. This opens the circuit of relay 16LCTM, deenergizing that relay which disconnects the steady non-coded track circuit energy from the primary of the track transformer TT at the front point of its contact 22, thus discontinuing the steady track circuit energy which

has been feeding westward. At the intermediate signal location F, relay 10ETR now becomes deenergized which, in turn, deenergizes relay 10ETFSA at front contact 33. The deenergization of relay 10ETFSA deenergizes relay 10WCTM at the front point of its contact 25, thus removing the noncoded energy which had been connected to the track transformer feeding westward. At the cut section location E, relay ETR is now deenergized and so disconnects non-coded energy at the front point of contact 28 from the track transformer feeding westward at that location.

At location D, relay 6RTR becomes deenergized which causes relay 6RTFSA to become deenergized at the front point of contact 32. The deenergization of relay 6RTFSA closes a coding circuit for relay 6RCTM over the back contact 34 of relay 6RTFSA and the normal contact N on the traffic lever 8 (closed in the N position of the lever), to battery over either the front point of contact 35 of relay 6LHR (the home relay for signal 6L) and the 180 code contact of the code transmitter CT, or over the back point of the same contact of relay 6LHR and the 75 code contact of the code transmitter, and finally a front contact 36 of relay 5TMS which is a stick repeater of the track relay for the detector track section 5T. The energized or deenergized position of the home relay 6LHR for signal 6L depends on traffic conditions to the west of location D, as will be obvious. This coding circuit causes relay 6RCTM to be periodically energized and deenergized at the 75 or 180 code rate in accordance with traffic conditions in advance. When relay 6RCTM is energized, energy is connected to the primary winding of the track transformer TT over the front point of contact 31 to feed coded energy eastward. The transformer-rectifier circuit for relay 6RTR is open at back contact 30 when relay 6RCTM is energized.

The coded energy which is now applied at the west end of the block will be detected by relay WTR at the cut section which relay will follow the code impressed upon the track circuit 6RT. This operation takes place because the circuit of the transformer-rectifier unit controlling the track relay WTR is closed through the back contact 29 of relay ETR. The energization of relay WTR opens the circuit of the transformer-rectifier unit controlling the track relay ETR at back contact 27, so that relay ETR will not respond to energy applied to the track circuit 6ART east of the cut section during the time that relay WTR is energized. Energy is now applied to the track circuit east of the cut section during the time that relay WTR is energized, so that the code received from the west side of the cut section is transmitted to the east side where it will be detected by relay 10WTR at the intermediate signal location F.

The absence at the intermediate signal location of steady energy from the east end of the block resulted in the previous deenergization of relays 10ETR, 10ETFSA, and 10WCTM so that the circuit for the transformer-rectifier unit controlling relay 10WTR is closed at the back contact 37 of relay 10WCTM to permit relay 10WTR to respond to the coded energy. The energization of relay 10WTR causes the energization of relay 10WTFSA at front contact 38. With relay 10ETFSA deenergized and relay 10WTFSA energized so that back contact 40 and front contact 74 are both closed, battery is applied to the decoding transformer DT alternately through the

front and back points of contact 39 of relay 10WTR, so that the decoding relay 10HR will respond to the coding action of relay 10WTR in the usual manner.

Relay 10ECTM will now be energized to follow 180 code by the circuit from battery through the back contact 40 of relay 10ETFSA, wire 41, normal polar contact 42 of the directional stick relay DS (to check that the latter relay has responded to the energization of the 10WTFSA and 10HR relays so that its polar contacts are closed in the proper position for a following westbound move), 180 code contact on the coder CT, and the front points of contacts 43 and 44 of relays 10HR and 10WTFSA, respectively. Coded energy is therefore applied to the track circuit 16LT east of the intermediate signal location during the time that the front point of contact 45 of relay 10ETCM is closed. The transformer-rectifier unit for relay 10ETR is open at the back point of contact 23 of relay 10ECTM so that this relay will not respond to the code impressed on the track circuit 16LT.

The code applied to the track circuit 16LT is detected by the transformer-rectifier unit at location G and causes the energization of relay 16LTR, since the transformer-rectifier unit has its circuit closed through the back contact 21 of relay 16LCTM. The latter relay has been in the deenergized position since lever 16 was moved to the left, opening the NR contact which is closed only when the lever 16 is in its N or its R position or is intermediate these two positions. Relay 16LTFSA will accordingly be energized over the front contact 46 of relay 16LTR and will retain its front contacts closed during the coding operation of relay 16LTR. The action of relay 16LTR in alternately closing its front and back contacts applies energy to the decoding transformer DT for energizing the code detecting relay 16LCDR in the usual manner. Relay 16LCDR is designed to have a quick pick-up characteristic so that it will be energized at the same time as relay 16LTFSA, whether coded or non-coded energy is being received by relay 16LTR. If non-coded energy is being received, relay 16LCDR will subsequently release and prepare the circuits for the traffic lever lock 18K over its back contact 47, and for the eastbound indication light EB over its back contact 48. The traffic lever lock 18K for lever 18 prevents a reversal of this lever unless the lock is energized at the time. As will be apparent, the circuit for lock 18K can be completed only if steady energy is being received at location G (relay 16LTFSA energized) since when code is received, relay 16LCDR will open the lock circuit at its back contact 47. In the present case, coded energy is being received at location G so that the lock 18K is deenergized and lever 18 is locked against reversal. Relay 16LCDR will remain energized and will complete the circuit for relay 16LHR which when energized permits the display of a proceed indication by signal 16L. This circuit includes an L contact on the signal lever 16 and front contacts 49 and 50 of relays 15TMS and 16LCDR. As 180 code is being received, relay 16LJ which is selectively responsive to 180 code but not to 75 code will also be energized in the usual manner through the resonant rectifier unit so that a clear indication will be displayed by signal 16L.

When a westbound train accepts and passes signal 16L, relay 15TMS, which is a track repeater stick relay for the approach section 15T will be deenergized and will remain in this con-

dition until lever 16 is restored to its normal position with the track circuit 15T unoccupied. Relay 16LCTM will then become steadily energized over the front contact 20 of relay 15TMS, the NR contact on lever 16, and the normal contact N on lever 18. With relay 16LCTM continuously energized, non-coded energy is applied to the east end of the track stretch to feed westward in the rear of the train in the same manner as previously described when the application of steady energy throughout the stretch was traced. When the train passes the intermediate signal 10W and before it vacates the track section 16LT, relay 10ECTM will be responding to 75 code. The circuit for this relay is battery, back contact 40 of relay 10ETFSA, wire 41, normal polar contact 42 of relay DS, 75 code contact of the coder CT, and back point of contact 44 of relay 10WTFSA. Thus, when the train vacates the track section 16LT, coded energy of 75 code will be impressed across the track circuit due to the operation of relay 10ECTM at this code rate.

As has been pointed out before, the transformer-rectifier unit for relay 10ETR is open at the time when code is applied so that this relay will not respond to the code. During the off interval of the code, relay 10ECTM will be deenergized to close the circuit of the transformer-rectifier unit TRU for relay 10ETR. At the same time, the primary winding of the track transformer TT is shunted, so that relay 10ETR may respond to the non-coded energy impressed on the track circuit 16LT at location G.

If a following train movement is to be made in the westbound direction, the movement of signal lever 16 to the L position will cause the deenergization of relay 16LCTM with the consequent removal of non-coded energy from the east end of the track circuit 16LT, as previously described. The absence of non-coded energy at the intermediate signal location will cause the deenergization of relays 10ETR and 10ETFSA and will cause the energization of relay 10ECTM over the same circuit as previously traced. Accordingly, coded energy of 75 code will be applied to the track circuit 16LT. This code will be detected by the track relay 16LTR in the same manner as described for the detection of 180 code when the entire stretch was unoccupied.

The control of 75 code applied to the track circuit 16LT in approach to signal 10W for a following move is determined by the position of the polar contacts of relay DS. It will be noted that this relay is energized so as to close its normal contact 42 when relay 10WTFSA is energized, relay 10ETFSA is deenergized, and when relay 10HR is energized. This is the condition existing when a westbound train is approaching signal 10W with the track sections 6RT and 6ART between signal 10W and signal 6R unoccupied. For an eastbound train approaching signal 10E, relays 10ETFSA and 10HR would be energized, thus causing the reverse polar contact 51 of relay DS to close.

We shall next follow the movement of the first train through the remainder of the stretch. Assuming that lever 16 is normal and that a following train movement is not being made, steady energy will be fed westward from signal 16R up to signal 10W, as previously described. With the westbound train occupying section 6ART or 6RT between signal 10W and signal 6R, relays 10ETR and 10ETFSA at the intermediate signal location will be energized continuously. Relay 10WCTM will also be energized over the circuit which in-

cludes the front point of contact 25 of relay 10ETFSA and the back point of contact 26 of relay 10HR. Relay 10HR, it will be appreciated, responds only to code and will, of course, be deenergized during the time that the westbound train is between signals 10W and 6R. The energization of relay 10WCTM applies non-coded energy to the track circuit 6ART west of the intermediate signal location as previously described. This non-coded energy will be detected by relay ETR at the cut section when the train vacates the track circuit 6ART between the cut section and signal 10W. Under this condition, the train being between location E and location D, relay WTR will be deenergized and the circuit for the transformer-rectifier unit of relay ETR will accordingly be complete and will enable this relay to respond to the non-coded energy. With relay ETR energized, non-coded energy will be applied to the west side of the insulated joints (track section 6RT) at the cut section. As previously noted, the transformer-rectifier unit for track relay WTR is open at the back contact of relay ETR so that relay WTR will not respond to the non-coded energy impressed across the track.

When the rear end of the train vacates the track circuit 6RT, relay 6RCTM will remain deenergized because its control circuit is open at the front contact 36 of relay 5TMS. This permits relay 6RTR to respond to steady energy impressed on the track circuit 6RT. The energization of relay 6RTR permits the energization of relay 6RTFSA which, in turn, also opens the circuit of relay 6RCTM, thus continuing the withholding of coded energy from the track circuit 6RT when relay 5TMS picks up. As relay 6RTFSA is now energized and relay 6RCRDR is deenergized (relay 6RCRDR is energized only when code is being received), the west-bound indication light WB which indicates the unoccupied condition of the block will be illuminated to inform the operator of this fact so that a reversal of traffic may be effected, if desired.

Having described the relay operations involved in a westbound train movement, we shall next assume that traffic is to be reversed for an eastbound movement. With steady energy being received at location D from the east end of the block, relay 6RTFSA at the west end will be energized so that the operator may move lever 8 to its reverse position since the lever lock 8K can now be energized over front contact 75 of relay 6RTFSA. After lever 8 has been moved, the operator may communicate with the operator at the east end of the block, instructing him to move his traffic lever 18 to the center position. This movement of traffic lever 18 will cause the deenergization of relay 16LCTM and the removal of uncoded energy from the track circuit 16LT at the east end of the block. When the absence of steady energy from the east end is detected at the west end of the block, relays 6RTR and 6RTFSA at location D will be deenergized, whereupon relay 6RCTM will be continuously energized over the circuit which includes the reverse contact R on lever 8, the NL contact on lever 6 (which is closed only when the lever 6 is in its N or its L position or is intermediate these two positions), and front contact 36 of relay 5TMS. This non-coded energy applied at the west end of the block will be detected and transmitted through the cut section and intermediate signal location in the same manner as previously described for the application of non-coded energy when the westbound direction of traffic was be-

ing established. The receipt of non-coded energy by relay 16LTR will pick up this relay and will cause the energization of relay 16LTFS. Relay 16LCDR will pick up when relay 16LTR closes the front point of its contact 52 but will soon release when relay 16LTR retains this front contact closed, as there will then be no change in the direction of current through the decoding transformer DT to continue the energization of relay 16LCDR. When relay 16LCDR closes its back contact 48, the indication light EB at the east end of the block will be illuminated, thus informing the operator to complete the reversal of his traffic lever 18. Non-coded energy will remain applied to the track circuit at the west end of the block until the lever 6 which controls signal 6R is moved to the R position, whereupon relay 6RCTM at location D will be deenergized to remove the non-coded energy. Lever 6 should not be moved to the R position until the operator at the east end informs the west end operator that traffic lever 18 has been reversed. As long as the non-coded energy is received at location G, relays 16LTR and 16LTFS will remain energized. When the non-coded energy is removed, the circuit is completed for relay 16LCTM through a back contact 53 of relay 16LTFS, the reverse contact R on lever 18, the front or the back point of contact 54 of relay 16RHR, and the 180 or 75 code contact, respectively, on the code transmitter CT. Coded energy is now applied to the track circuit 16LT at the east end of the block. This coded energy will be detected at the intermediate signal location and coded energy of the proper code frequency will be applied to the track sections between signal 10E and signal 6L in the same manner as already described for the westbound direction.

The operation involving restoration of the traffic levers to their normal position for a westbound move will be similar to that described for the change from westbound to eastbound, so that no additional description is necessary.

Referring now to Fig. 2, this figure shows an application of our traffic locking circuit wherein the apparatus at one end of the stretch is controlled from a control office at a remote point by a system of C. T. C. control. The operation duplicates that obtained when mechanically locked levers are used, as was previously discussed, and the apparatus of Fig. 2 is intended to replace the apparatus at location G of Fig. 1c.

Relays 18NFSR, 18RFSR and 18CFSR are C. T. C. controlled traffic direction relays and these relays repeat the N, R, and C positions, respectively, of the traffic lever 18 at the control office. The communication system by means of which the C. T. C. operator at the control office governs the traffic relays 18NFSR, 18RFSR and 18CFSR may be of any suitable type, but preferably it is of the selective code type in which communication is established intermittently by means of impulse codes transmitted over a single pair of line wires from the control office to the field station. The details of such a communication system do not enter actively into our present invention and it is deemed sufficient for an understanding of the present invention to point out that movement of the traffic lever 18 to the different positions results in the transmission of suitable codes to the field station for selectively energizing the traffic relay corresponding with the lever position. Moreover, the operation of these traffic relays and other apparatus at the field station location results in the transmission

of suitable indication codes over the C. T. C. line to the control office, for operating the westbound and eastbound indication apparatus as well as providing the unoccupied block indication. The apparatus at the control office prevents a reversal of the established traffic direction except under proper traffic conditions, as will be pointed out hereinafter. 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. In order to simplify the disclosure as much as possible, the terminals of the field station unit have been designated with terminal numbers which correspond with the terminal wires in the above Lewis patent which control analogous functions.

With the traffic lever 18 normal, relay 18NFSR will become energized, relays 18RFSR and 18CFSR being deenergized, and if the relay which controls signal 16L (16LHSR) is deenergized, relay 16LCTM will be energized over the circuit from battery, front contacts 55 and 56 of relays 15TM and 16LKM, respectively, back contact 57 of relay 16LHSR, front contact 58 of relay 18NFSR and back contact 59 of relay 18CFSR. Relay 15TM is the repeater relay for the detector track section 15T, and relay 16LKM is the approach locking relay for signal 16L.

The receipt of steady energy at the west end of the block will permit the reversal of traffic lever 18 in the usual manner. After the reversal of the traffic lever 18, the operator at the control office which governs the east end of the stretch would be so advised and would thereupon transmit a code from the C. T. C. machine with traffic lever 18 on center to pick up relay 18CFSR through the code equipment, and a front contact 60 of relay 18NFSR. Relay 18NFSR will continue energized as its stick circuit is complete from battery, through back contacts 67 and 76 of relays 16LTFS and 18RFSR, and front contact 77 of relay 18NFSR. Relay 18CFSR will remain energized through its own front contact 61, a portion of the code equipment circuits not shown but which include terminals 83 and 87 of the field station unit and the front contact 60 of relay 18NFSR, thus opening the steady energy circuit of relay 16LCTM. This relay, in turn, removes steady energy from the east end of the stretch and allows steady energy to flow from the west end of the stretch to the east end. This is because relay 6RCTM at the west end is continuously energized over a front contact of relay 5TMS, the NL contact on lever 6 and the R contact on lever 8. The receipt of steady energy at the east end of the stretch will cause the energization of relay 16LTFS with the relay 16LCDR deenergized, thus completing a circuit to terminal 89, to illuminate the block indication light BK on the C. T. C. machine.

Upon receipt of this indication, the operator may move lever 18 to the reverse position and transmit a code which will energize relay 18RFSR and deenergize relays 18CFSR and 18NFSR. The circuit for relay 18RFSR is through a front contact 62 of relay 16LTFS and a back contact 63 of relay 16LCDR, which is the condition when steady energy is being received from the west end of the stretch.

When the lever movement for clearing the eastbound entrance signal 6R at the west end of the stretch is made, steady energy will be removed from that end, thus deenergizing relay

16LTFSFA at the east end and completing the coding circuit of relay 16LCTM from battery, front contacts 55 and 56 of relays 15TM and 16LKM, 180 code contact and front point of contact 64 of relay 16RHR, or 75 code contact and back point of contact 64 of relay 16RHR, front contact 65 of relay 18RFSR and back contact 66 of relay 16LTFSFA. The coding action of relay 16LCTM impresses coded energy on the track circuit 16LT which is repeated in the usual manner to the west end of the block.

It will be noted that the stick circuits of relays 18NFSR and 18RFSR include a back contact 67 of relay 16LTFSFA in multiple with a front contact 68 of relay 16LCDR. Thus, either of these relays when energized will be retained in that condition independently of the code equipment, unless steady energy is being received at the east end of the block.

To establish traffic for the westbound direction with the block unoccupied and the eastbound entrance signal at stop, steady energy would be received at the east end, thus permitting a code to be sent to energize relay 18NFSR and to de-energize relay 18RFSR. The energization of relay 18NFSR completes the steady energy circuit of relay 16LCTM to apply steady energy to the stretch feeding west for the unlock of the traffic lever at the other end so that this lever may be restored to its normal position after first being moved to center to remove the steady energy feeding from west to east.

Directional lights WB and EB on the C. T. C. machine are controlled in the usual manner over contacts of relays 18NFSR and 18RFSR and the coded line circuit.

The modification of a portion of the apparatus at location D which is shown in Fig. 3 shows how this apparatus can be adapted for direct current track circuit operation. Obviously, although alternating current track circuits are shown in Figs. 1 and 2, the invention is not limited to alternating current operation since the various track transformers can be replaced by direct current sources in well-known manner.

From the foregoing description, it will be apparent that we have provided a traffic control system for a stretch of single track railway which does not require control line wires and which provides an unusually high degree of safety and freedom from interference with the movement of traffic in the established direction, comparable with that obtained in systems which employ line wire control for the traffic locking functions. By employing uncoded track circuit energy during the time that the track circuits are inactive, a substantial power saving is accomplished and it becomes possible to provide the operator with a block indication which at all times informs him whether the stretch is unoccupied or occupied, without the necessity for first transmitting current over the stretch to obtain this information. The presence of steady energy in the track at all times when the stretch is unoccupied provides a constant check on the integrity of the track circuits so that track circuit failures can be detected and corrected before such time as a train approaches an entrance signal and causes the system to be set into operation. It will be noted that actually three checks are provided as to the integrity of the system before a train is permitted to enter the stretch. These are as follows. First, steady energy is relayed over the track circuits of the stretch in the direction of traffic and must be detected at the exit end before a traffic lever

reversal can be effective. Removal of the steady energy must then be detected at the entrance end. Second, steady energy is transmitted over the track circuits of the stretch in the new traffic direction and must be detected at the new exit end before the traffic reversal is completed and code can be applied at the new exit end. Third, code is transmitted over the track circuits of the stretch and must be detected at the new entrance end before the entrance signal can be cleared and a train permitted to enter the stretch in the reverse traffic direction. Accordingly, clearing of the entrance signal provides a guarantee that the stretch is not occupied by a train approaching from the other end and that the track circuit apparatus of the system is functioning properly. By using a C. T. C. line circuit, the traffic direction apparatus at one or both ends of the system can be governed from a control office at a remote location, the same safety checks which prevent interference with authorized movement of traffic being as effective in the case of C. T. C. control as in the case of direct manual control at the two ends of the stretch.

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

Having thus described our invention, what we claim is:

1. In combination with a stretch of track over which traffic may move in either direction, a first and a second manually controlled traffic direction lever adjacent one and the other end of said stretch and having a normal and a reverse position corresponding with traffic in the normal and reverse direction respectively over said stretch, means effective when both said levers occupy said normal position for transmitting uncoded rail current in the normal traffic direction from one to the other end of said stretch, means effective when said uncoded current is detected at said other end for permitting a reversal of said second traffic lever, means controlled by said first traffic lever effective when said second lever is reversed for discontinuing the supply of said uncoded rail current at said one end, means effective when the absence of said uncoded current is detected at said other end for transmitting uncoded rail current in the reverse traffic direction from said other end to said one end of the stretch, means effective when said uncoded current is detected at said one end for permitting a reversal of said first traffic lever, an entrance signal at said other end, control means for said signal, means effective when said control means is operated for discontinuing the supply of said uncoded current at said other end, means effective when the absence of said uncoded current is detected at said one end for transmitting coded rail current from said one end to said other end, and means effective when said coded current is detected at said other end for clearing said entrance signal.

2. In combination with a stretch of track over which traffic may move in either direction, a first and a second manually controlled traffic direction lever adjacent one and the other end respectively of said stretch, means controlled by said first lever for normally transmitting uncoded rail current in a given direction from one to the other end of said stretch, means responsive to the receipt of said uncoded current at said other end for permitting a reversal of said second lever,

means controlled by said first lever for discontinuing the supply of said uncoded current at said one end, means effective after said second lever is reversed and the supply of uncoded current at said one end is discontinued for transmitting uncoded current in the reverse direction from said other to said one end of said stretch, detecting means responsive to the receipt of said uncoded current at said one end for permitting a reversal of said first lever, means controlled by said first lever when reversed for transmitting coded rail current from said one to said other end of the stretch, and traffic governing means responsive to the receipt of said coded current at said other end.

3. In combination with a stretch of track over which traffic may move in either direction, a first and a second manually controlled traffic direction lever adjacent one and the other end respectively of said stretch, means controlled by said first lever for normally transmitting uncoded rail current in a given direction from one to the other end of said stretch, detecting means energized in response to the receipt of said uncoded current at said other end, locking means for preventing a reversal of said second lever unless said detecting means is energized, means for discontinuing the supply of said uncoded current at said one end, means effective after said second lever is reversed and the supply of said uncoded current at said one end is discontinued for transmitting uncoded current in the reverse direction from said other to said one end of said stretch, an entrance signal at said other end, means controlled by said first lever effective after said uncoded current is detected at said one end for transmitting coded rail current in said given direction from said one end to said other end of the stretch, and means effective after said coded current is detected at said other end for clearing said entrance signal.

4. In combination with a stretch of track over which traffic may move in either direction, means for normally transmitting current of a first character in a given direction from one to the other end of said stretch to provide an unoccupied block indication for said stretch, a first and a second manually controlled traffic direction lever adjacent one and the other end respectively of said stretch, means responsive to the receipt of current of said first character at said other end for permitting a reversal of said second lever, means including said first lever for discontinuing the supply of said current at said one end, means controlled by said second lever when reversed effective after said current is discontinued for transmitting rail current of said first character in the reverse traffic direction from said other to said one end, means responsive to the receipt of said current at said one end for permitting a reversal of said first lever, means at said other end for discontinuing said last-named current, means controlled by said first lever when reversed effective after said last-named current is discontinued for transmitting rail current of a second character in said given direction from said one to said other end, and means responsive to the receipt of current of said second character at said other end for governing the entry of traffic at said other end.

5. In combination with a stretch of track over which traffic may move in either direction, means for normally transmitting uncoded rail current in a given direction from one to the other end of said stretch to provide a block unoccupied indication, first and second manually governed traffic direction control means adjacent one and the

other end respectively of said stretch, means responsive to the receipt of said uncoded current at said other end for permitting operation of said second traffic direction control means, means effective after said second traffic direction control means is operated and said stretch is unoccupied for transmitting uncoded current in the reverse direction from said other to said one end of said stretch, means responsive to the receipt of said uncoded current at said one end for permitting operation of said first traffic direction control means, means at said other end for discontinuing the supply of said uncoded current, means controlled by said first traffic direction control means when operated effective after said uncoded current is discontinued for transmitting coded rail current in said given direction from said one to said other end of the stretch, means responsive to the receipt of said coded current at said other end for governing the entry of traffic at said other end of the stretch, and traffic locking means at said one end effective for preventing the supply of said coded current at said one end unless said uncoded current is first detected at said one end.

6. In combination with a stretch of track over which traffic may move in either direction, means for normally transmitting uncoded rail current in a given direction from one to the other end of said stretch provided said stretch is vacant, detecting apparatus adjacent said other end energized in response to receipt of said uncoded current at said other end, means at said one end for discontinuing the supply of said uncoded current to thereby deenergize said detecting apparatus, manually governed traffic direction control means adjacent said other end, means controlled by said traffic direction means effective when said detecting apparatus is deenergized for transmitting coded rail current from said other to said one end of said stretch provided said stretch is vacant, code responsive means adjacent said one end energized in response to said coded current, traffic governing means controlled by said code responsive means when energized, and locking means for said traffic direction means controlled by said detecting apparatus.

7. In combination with a stretch of track over which traffic may move in either direction, first and second manually governed traffic direction control means adjacent one and the other end respectively of said stretch, means effective when said first traffic direction control means is reversed and said stretch is unoccupied for transmitting uncoded current from said one to said other end of said stretch, a normally inoperative code transmitting relay adjacent said other end, a track relay adjacent said other end energized on said uncoded current over a back contact of said code transmitting relay, means at said one end for discontinuing the supply of said uncoded current, locking means for preventing a reversal of said second traffic direction control means, means effective when said track relay is energized for rendering said locking means ineffective, means controlled by said second traffic governing means when reversed and said uncoded current is discontinued for operating said code transmitting relay to thereby transmit coded rail current from said other to said one end of the stretch, a code responsive track relay at said one end operated by said coded current, and means effective when said last-named track relay is operated for governing the entry of traffic into said stretch at said one end.

8. In combination with a stretch of track over which traffic may move in either direction, first

and second manually governed traffic direction control means adjacent one and the other end respectively of said stretch, means effective when said first traffic direction control means is reversed and said stretch is unoccupied for transmitting uncoded current from said one to said other end of the stretch, a normally inoperative code transmitting relay adjacent said other end, a track relay adjacent said other end energized on said uncoded current over a back contact of said code transmitting relay, locking means for preventing a reversal of said second traffic direction control means, means effective when said track relay is energized for rendering said locking means ineffective, a slow acting repeater relay for said track relay, means at said one end for discontinuing the supply of said uncoded current, means including a back contact of said repeater relay and controlled by said second traffic direction control means when reversed and said uncoded current is discontinued for operating said code transmitting relay to thereby transmit coded rail current from said other to said one end of the stretch, a code responsive track relay at said one end operated by said coded current, and means effective when said last-named track relay is operated for governing the entry of traffic into said stretch at said one end.

9. In combination with a stretch of track over which traffic may move in either direction, a first manually controlled traffic direction lever adjacent one end of said stretch, a second manually controlled traffic direction lever at a remotely located control office, said second lever having a normal and a reverse position, a normal and a reverse traffic direction control relay adjacent the other end of said stretch for repeating the normal and reverse position respectively of said second lever, an energizing circuit for said normal control relay controlled by said second lever when occupying said normal position, means effective when said normal control relay is energized for transmitting uncoded rail current from said other to said one end of the stretch to permit a reversal of said first lever, means at said other end for discontinuing said uncoded current, means effective when said first lever is reversed and said uncoded current is discontinued for transmitting uncoded rail current from said one to said other end of the stretch, a detecting relay energized when said uncoded current is received at said other end, an energizing circuit for said reverse control relay controlled by said second lever when occupying said reverse position and including a front contact of said detecting relay, a stick circuit for said normal control relay including its own front contact and a back contact of said reverse control relay, whereby said reverse control relay cannot be energized unless uncoded current is first detected at said other end and when energized opens the stick circuit for said normal control relay so as to deenergize that relay, means controlled by said reverse control relay when energized for transmitting coded rail current from said other to said one end, and traffic governing means responsive to the receipt of said coded current at said one end.

10. In apparatus for controlling traffic moving over a single track two-direction stretch of railway, the combination for controlling the apparatus adjacent one end of said stretch from a remote control location comprising, a manually

controlled traffic direction lever at said control location having a normal and a reverse position corresponding with traffic in the normal and the reverse direction respectively over said stretch, means for transmitting uncoded rail current over said stretch to said one end provided said stretch is vacant, a detecting relay adjacent said one end energized in response to the receipt of said uncoded current at said one end, a normal and a reverse traffic direction control relay adjacent said one end for controlling traffic in the normal and the reverse direction respectively over said stretch, a pick-up circuit for said normal control relay effective when said lever occupies its normal position and including a front contact of said detecting relay, a pick-up circuit for said reverse control relay effective when said lever occupies its reverse position and also including a front contact of said detecting relay, a stick circuit for each said control relay including a front contact of the relay itself and a back contact of the other control relay, means at said other end for discontinuing said uncoded current to thereby deenergize said detecting relay, and means including a front contact of said reverse control relay effective when said detecting relay is deenergized for supplying coded energy to the rails of said track stretch at said one end thereof.

11. In apparatus for controlling traffic moving over a single track two-direction stretch of railway, the combination for controlling the apparatus adjacent one end of said stretch from a remote control location comprising, a manually controlled traffic direction lever at said control location having a normal and a reverse position corresponding with traffic in the normal and the reverse direction respectively, means for transmitting uncoded rail current over said stretch to said one end provided said stretch is vacant, a detecting relay adjacent said one end energized in response to the receipt of said uncoded current at said one end, a normal and a reverse traffic direction control relay adjacent said one end for controlling traffic in the normal and the reverse direction respectively over said stretch, a pick-up circuit for said normal control relay effective when said lever occupies its normal position and including a front contact of said detecting relay, a pick-up circuit for said reverse control relay effective when said lever occupies its reverse position and also including a front contact of said detecting relay, a stick circuit for each said control relay including a front contact of the relay itself and a back contact of the other control relay, means at said other end for discontinuing said uncoded current to thereby deenergize said detecting relay, means including a front contact of said reverse control relay effective when said detecting relay is deenergized for transmitting coded rail current from said one end over said stretch, means at said other end of said stretch responsive to receipt of coded current over the rails of said stretch and governing the entry of traffic into said stretch at the other end, and means including a front contact of said normal control relay for transmitting uncoded rail current from said one end over said stretch to said other end provided said stretch is vacant.

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