May 29, 1956 T. W. TIZZARD 2,748,264

DIRECTIONAL RELAY CIRCUITS FOR CODED RAILWAY SIGNALING SYSTEMS

Filed Dec. 16, 1952 3 Sheets-Sheet 1

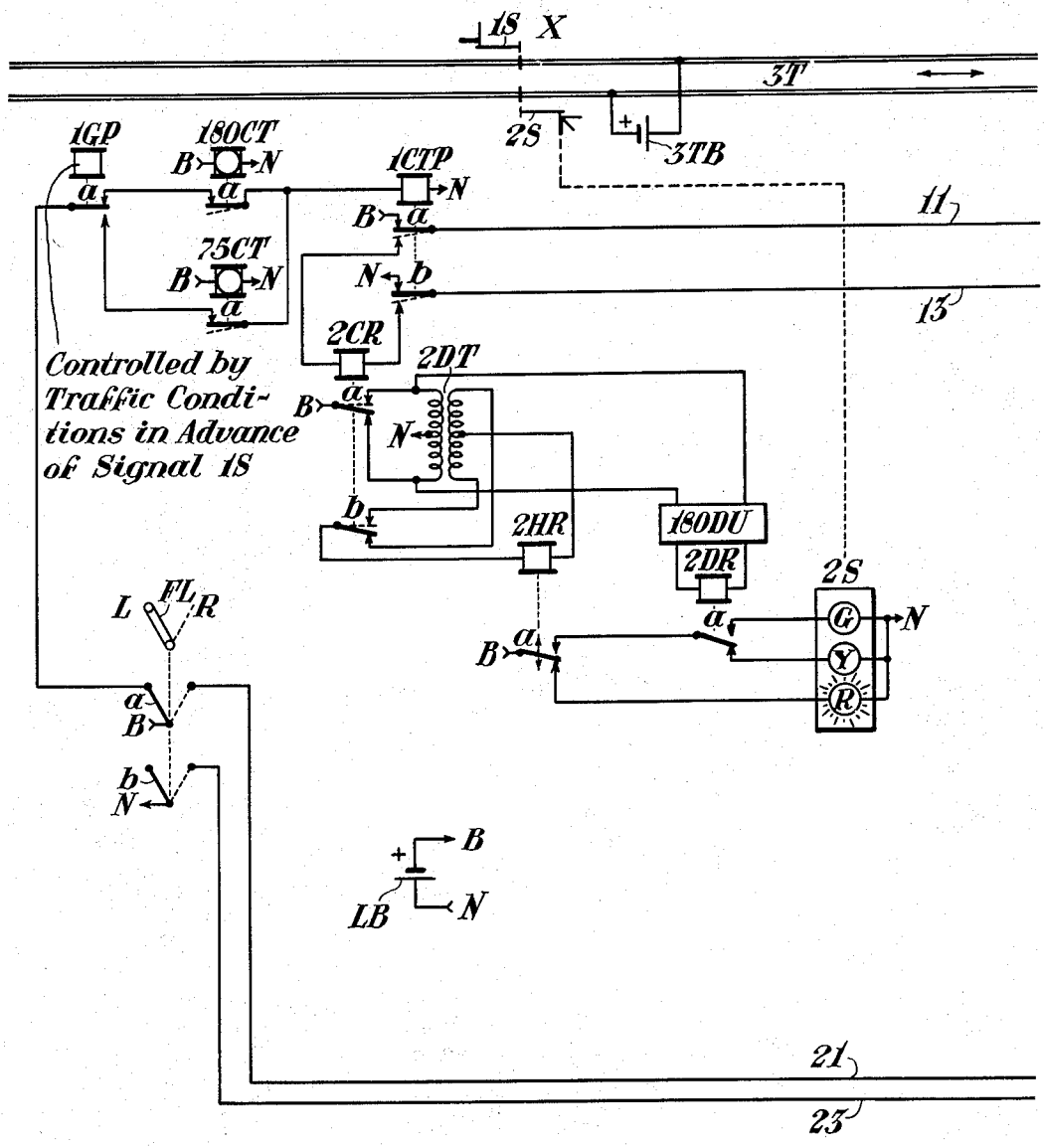


Fig. 1A.

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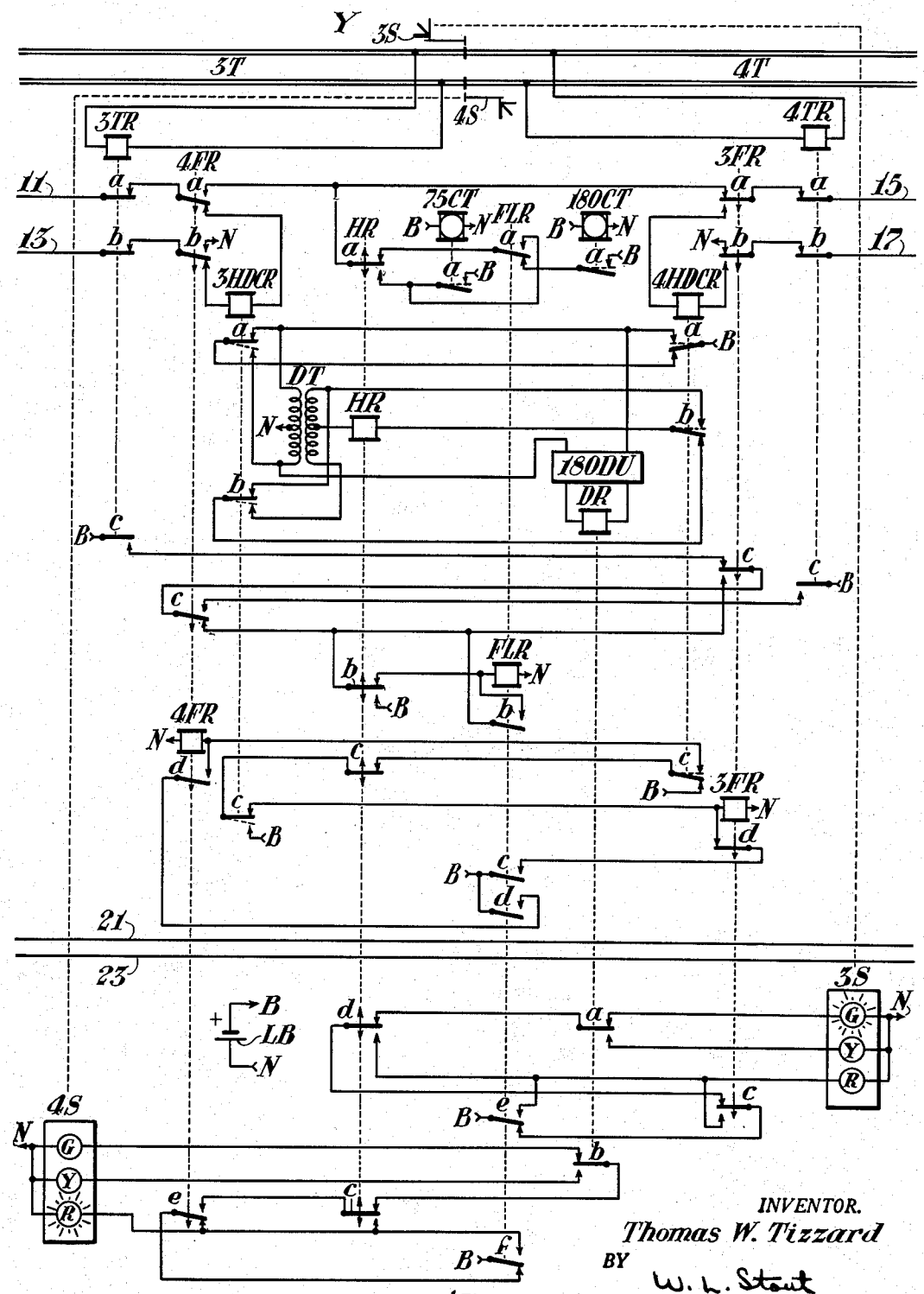


Fig. 1B.

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Filed Dec. 16, 1952 3 Sheets-Sheet 3

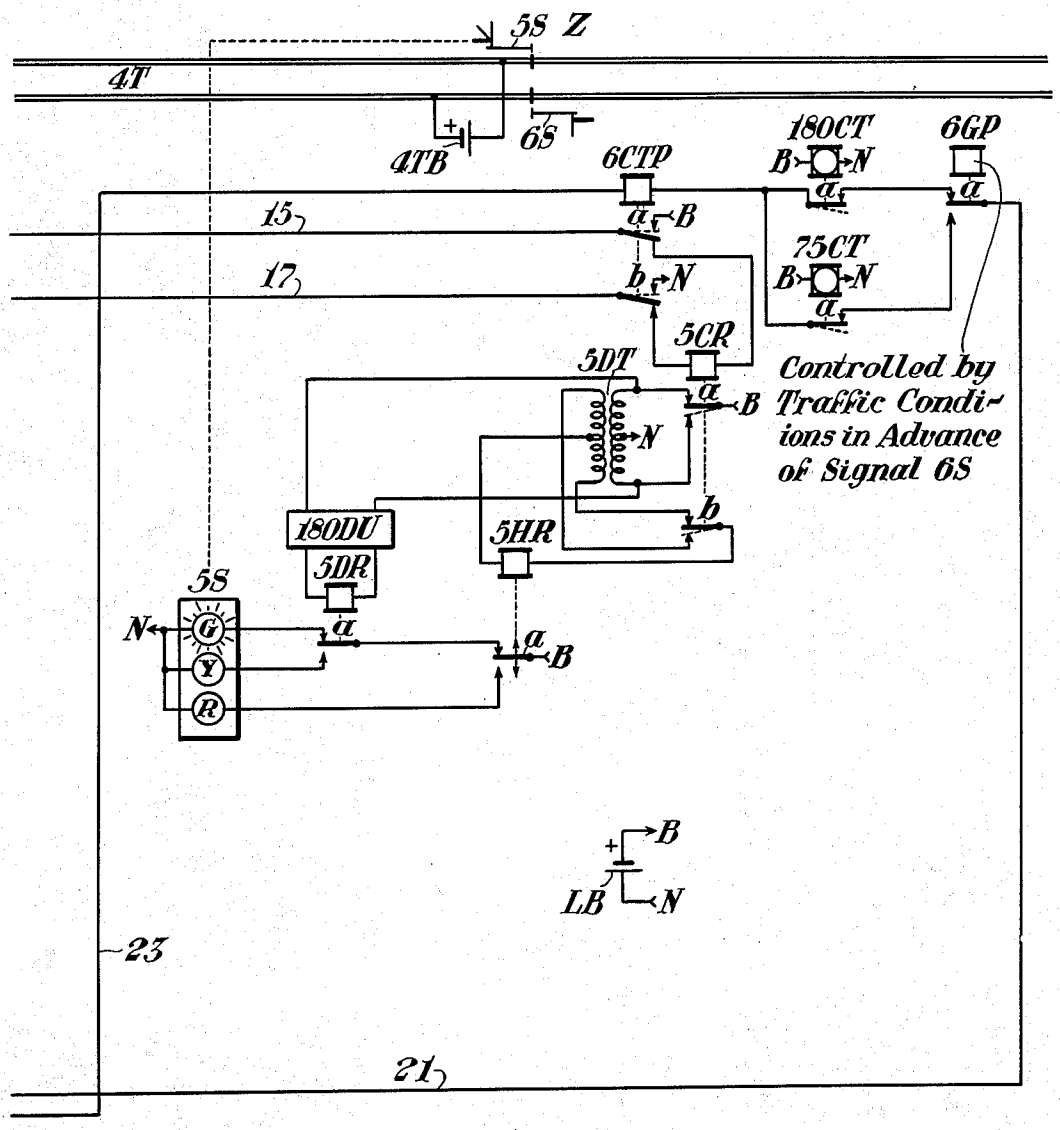


Fig. 1C.

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2,748,264

DIRECTIONAL RELAY CIRCUITS FOR CODED RAILWAY SIGNALING SYSTEMS

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Application December 16, 1952, Serial No. 326,228

5 Claims. (Cl. 246—33)

My invention relates to directional relay circuits for railway signaling systems, and particularly to a novel and improved means for controlling the directional stick relays in a single track railway signaling system of the type employing coded energy for governing the wayside signals in such a system.

In single track signaling systems, in which provision is made for following moves to permit trains to follow each other through a section of single track, it is necessary to provide, at each signal location, directional stick relays, one for each direction of traffic movement, which are usually arranged so that the relay is picked up by a train moving past the location in a particular direction. Contacts of the directional stick relays are incorporated into the signal control circuits so that the signals are governed in such manner as to permit following moves, when the directional stick relays are picked up, and to provide opposing signals with a control which maintains the opposing signals at stop for an approaching train movement.

Additionally, in railway signaling systems employing coded energy, it is usually necessary to provide code detecting relays which are constructed and arranged so that upon code following operation of a track or line relay, the code detecting relay will be energized as long as the code following relay maintains its contacts in operation, but the code detecting relay is released when the code following relay ceases its code following operation. Such code detecting relays are employed for governing various circuits for controlling the aspects of the signals, and for controlling the line circuits governing signals in advance or in the rear of a particular location.

In previous practice, it has been customary to provide, at a double intermediate signal location, a pair of directional relays, and where the signaling system is of the coded type, it is also necessary to provide a pair of code detecting relays, one for each direction of traffic. Accordingly, to provide both the code detecting function and the directional stick function, a total of four relays has been required by previous systems.

It is accordingly an object of my invention to provide an improved arrangement for directional control circuits for railway signaling systems, in which only three relays are required at a double intermediate location to provide both for detecting the code following operation of a code following track or line relay, and to also provide the directional stick features necessary to permit following moves.

A further object of my invention is to provide improved directional control circuits for railway signaling systems.

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

I shall describe one form of railway signaling system embodying my invention and shall then point out the novel features thereof in claims.

In practicing my invention, I provide, in a railway signaling system of the type employing coded track or coded

line circuits for the control of the signals, at each double intermediate signal location therein, a first and a second directional code detecting relay, together with a traffic stick relay. The circuits are arranged in such manner that the traffic stick relay is picked up when a train moves by the double intermediate location in either direction, and remains picked up until the trains vacate the section in advance of the intermediate signal location, for the particular direction of traffic in which the train is moving. The directional code detecting relays are provided with a pick up circuit which includes contacts of the code following relays, and a stick circuit which is governed by the traffic stick relay, so that the directional code detecting relays are picked up by code following operation of the associated code following relay, and will remain picked up as a result of the picking up of the traffic stick relay, when a train passes the intermediate signal location.

In the accompanying drawings, Figs. 1A, 1B and 1C, when arranged in consecutive order from left to right, with Fig. 1A at the left, show a diagrammatic view of a stretch of single track railway, equipped with a signaling system embodying directional control circuits which illustrate a preferred embodiment of my invention. In this application only the portions of the wayside apparatus necessary for an understanding of my invention have been shown and the remainder of the equipment may be arranged in any of several arrangements well known in railway signaling art.

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

Referring to the drawings, I have here shown a stretch of single track extending between a location X, Fig. 1A, and a location Z, Fig. 1C, with an intermediate location Y, Fig. 1B. Traffic may move through this stretch of single track in either direction as indicated by the double headed arrow. For the purposes of this description, a train moving from left to right shall be considered as eastbound, and trains moving from right to left shall be considered as westbound.

The movement of eastbound trains into the stretch of single track is governed by signal 2S, Fig. 1A, and the movement of westbound trains into the single track stretch is governed by signal 5S, Fig. 1C. The intermediate signals 3S and 4S, at location Y, Fig. 1B, govern the movements of trains while in the stretch in the westbound and eastbound directions, respectively. Additionally, at each end of the stretch there is provided a signal governing train movements out of the stretch, such as signal 1S at location X and signal 6S at location Y. The control of signals 1S and 6S does not enter into the operation of my invention since it forms no portion thereof, and it will be assumed that the signals 1S and 6S may be governed in any manner in accordance with traffic conditions in advance of the signal.

As shown in the drawings, the signals 2S, 3S, 4S and 5S are of the well-known color light type, having a green lamp G, a yellow lamp Y and a red lamp R, which lamps when lit indicate clear, caution and stop, respectively. The signals associated with the movement of traffic into and through the single track stretch, namely signals 2S, 3S, 4S and 5S, are governed by a system of direct current neutral track circuits and coded line wire circuits, which will be explained in detail hereinafter. As shown by the drawings, the track section 3T between location X and location Y is provided with a direct current track circuit including the track battery 3TB connected across the rails of section 3T at the left-hand end thereof, and a track relay 3TR connected across the section rails at the right-hand end thereof. Similarly, the section 4T extending between locations Y and Z is provided with a direct current track circuit including the track battery 4TB connected across the rails of the right-hand end of the track

section and a track relay 4TR connected across the rails at the left-hand end of the section.

The operation of the signals for traffic movement in either direction is governed by means of track circuits in conjunction with coded energy supplied over line wires such as wires 11 and 13 extending between locations X and Y and the line wires 15 and 17 extending between locations Y and Z.

The apparatus at location X includes a signal repeating relay 1GP governed by signal 1S, which is controlled by traffic conditions in advance of signal 1S, coding devices 180CT and 75CT which operate to generate the coded energy for transmission over the line circuit, a code transmitting relay 1CTP, which governs the supply of energy to the line wires 11 and 13, a code following line relay 2CR which is adapted to be operated by coded energy supplied thereto over line wires 11 and 13, a decoding transformer 2DT having associated therewith a code decoding relay 2HR and a clear signal control relay 2DR governed by a decoding unit 180DU of conventional type. A similar arrangement of apparatus is provided at the eastern location Z, including signal repeating relay 6GP, coding devices 180CT and 75CT, code transmitting relay 6CTP, code following line relay 5CR, code decoding transformer 5DT, code decoding relay 5HR, 180 decoding unit 180DU, and clear signal control relay 5DR.

At the intermediate signal location Y, there are provided coding devices 180CT and 75CT and code following line relays 3HDCR and 4HDCR which respond to coded energy supplied to the windings of the relays over the respective line circuits associated with the relays. The code following operation of relays 3HDCR and 4HDCR is detected by means of decoding transformer DT, code decoding relay HR, 180 code decoding unit 180DU and clear signal control relay DR. Additionally, there is provided a traffic stick relay FLR, which is arranged to be picked up when a train passes the intermediate signal location, and a first and second directional code detecting relays 4FR and 3FR, which are governed jointly by the operation of the contacts of relays 3HDCR and 4HDCR, in conjunction with the traffic stick relay FLR.

The periodically operating contacts of the code following relays and the coding devices are distinguished from those of the other relays by dotted lines indicating the alternative position of the contacts, and the contacts of slow acting relays are identified in the conventional manner by the vertical arrows thereon, the direction of the arrows indicating the direction in which the relays are slow in operating. Energy for the operation of the apparatus other than the track circuits is furnished by suitable sources of direct current, such as the batteries LB shown at each location, the positive and negative terminals of which are designated by the reference characters B and N, respectively.

Although various arrangements well-known in the art may be used for selecting the direction in which traffic is to move through the stretch of single track equipped with a signaling system as here shown, a simplified arrangement which is suitable for illustrating the operation of the system is shown in the drawings, and it is to be understood that various arrangements, particularly those of the well-known centralized traffic control type may be employed. As here shown, the direction of traffic is governed by a traffic lever FL, Fig. 1A, which may occupy either a left-hand or L position, or a right-hand or R position. When the traffic lever is in its left-hand or L position, the apparatus is conditioned to permit train movement through the stretch from right to left, that is, westbound, and when the traffic lever FL is in the right-hand or R position the apparatus is conditioned to permit traffic movements from left to right or eastbound.

The code responsive apparatus at each signal location is substantially similar and its operation will be understood from a description of the operation of the apparatus associated with the code following relay 2CR at location X. The recurrent operation of contact *a* of code following relay 2CR causes energy to be supplied to the primary winding of transformer 2DT, thereby inducing an alternating current in the secondary winding of the transformer, this current having a frequency the same as the rate of operation of the contacts of the code following relay 2CR. This alternating current energy is rectified mechanically by the operation of contact *b* of relay 2CR as described in detail in Letters Patent of the United States No. 2,237,788, issued to Frank H. Nicholson et al. on April 8, 1941. The mechanically rectified energy is supplied to the winding of code decoding relay 2HR, and the parts are arranged and constructed so that the energy supplied to the winding of relay 2HR will be effective to pick up the contacts of the relay as long as the contacts *a* and *b* of the code following relay 2CR are recurrently operating between their picked up and released positions. Additionally, energy is supplied to the decoding unit 180DU, which is of a type well-known in the art, constructed and arranged so that when energy is supplied thereto at the rate of 180 impulses per minute, sufficient energy is supplied from the output of the decoding unit to the winding of the clear control relay 2DR, so that the contacts of this relay are picked up. Accordingly, it will be seen that the contacts of relay 2HR are picked up at any time that the contacts of code following relay 2CR are operating, while the contacts of relay 2DR are picked up when and only when the contacts of code following relay 2CR are being operated 180 times per minute.

It is believed that the description of the apparatus embodying my invention will be made more clear by describing its operation under various traffic conditions.

As shown in the drawings, the stretch of track is unoccupied and the traffic lever FL is in the L or left-hand position, so that the system is conditioned to permit train movements westbound. At this time, a circuit for energizing code transmitting relay 1CTP is completed by a circuit which may be traced from terminal B at contact *a* at traffic lever SL, closed in the L position, over front contact *a* of signal repeating relay 1GP, front contact *a* of the coding device 180CT, and through the winding of relay 1CTP to terminal N. The coding devices are each continuously energized from the associated direct current source, so that their contacts operate recurrently at the rate designated by the prefix associated with the reference characters. Accordingly, it will be seen that the supply of energy to the winding of relay 1CTP is coded at the rate of 180 times per minute, and accordingly, the contacts of relay 1CTP will be operated at a corresponding rate. When front contacts *a* and *b* of relay 1CTP pick up, a circuit is established which supplies energy over the line wires 11 and 13 to the relay 3HDCR at location Y. This circuit may be traced from terminal B at front contact *a* of relay 1CTP, over line wire 11, front contact *a* of relay 3TR, back contact *a* of relay 4FR, through the winding of relay 3HDCR, back contact *b* of relay 4FR, front contact *b* of relay 3TR, line wire 13 and over front contact *b* of relay 1CTP to terminal N. When the contacts of relay 1CTP release, the supply of energy over the circuit traced above is interrupted and the contacts of relay 3HDCR will be released. Recurrent operation of the contacts of relay 3HDCR at location Y is detected by the code responsive apparatus including the transformer DT, code decoding relay HR, the code decoding unit 180DU and the clear control relay DR. At this time, relay 4HDCR is continuously released, and a circuit is established over back contact *a* of relay 4HDCR, and contact *a* of relay 3HDCR for supplying energy to the primary winding of the transformer DT. The secondary winding of transformer DT is connected to the winding of relay HR by the mechanical rectification circuit including the contact *b* of relay 3HDCR and back

contact *b* of relay 4HDCR, so that at this time energy is supplied to the code decoding relay HR and its contacts are picked up. Additionally, since the contacts of relay 3HDCR are operating 180 times per minute in response to the coded energy supplied thereto over the line circuit, clear control relay DR will have its contacts picked up also.

At this time, a circuit is established for supplying energy to the winding of the directional code detecting relay 3FR which circuit may be traced from terminal B at back contact *c* of relay 4HDCR, over front contact *c* of relay HR, front contact *c* of relay 3HDCR, which relay is being recurrently operated 180 times per minute, and through the winding of relay 3FR to terminal N. Relay 3FR is selected and arranged so that its contacts are sufficiently slow in releasing that the contacts will remain picked up during the short intervals between the supply of impulses of energy through the winding of the relay. Accordingly, the contacts of relay 3FR are picked up at this time.

At this time, a lighting circuit is established for lighting the green lamp G of signal 3S, the circuit being traced from terminal B at back contact *e* of relay FLR, over front contact *c* of relay 3FR, front contact *d* of relay HR, front contact *a* of relay DR, and through the green lamp G to terminal N, so that signal 3S displays a clear aspect with the apparatus in the conditions shown.

With relay HR picked up in response to the code following operation of relay 3HDCR, and the relay FLR released at this time, a circuit is established for supplying energy over the line circuit including line wires **15** and **17** to the winding of the code following relay 5CR at location Z. This circuit may be traced from terminal B at front contact *a* of the coding device 180CT, over back contact *a* of relay FLR, front contact *a* of relay HR, front contact *a* of relay 3FR, front contact *a* of relay 4TR, line wire **15**, back contact *a* of relay 6CTP, through the winding of relay 5CR, over back contact *b* of relay 6CTP, line wire **17**, front contact *b* of relay 4TR, and front contact *b* of relay 3FR to terminal N. Accordingly, the code following relay 5CR will operate its contacts at the rate of 180 times per minute, and the operation of contacts *a* and *b* of relay 5CR will cause the code responsive apparatus to respond in such manner that relays 5HR and 5DR will be energized and their contacts picked up at this time. It will be seen that the winding of relay 5CR is continuously connected to the line wires **15** and **17** over the back contacts of the code transmitting relay 6CTP at location Z, since relay 6CTP is continuously deenergized at this time by virtue of the fact that the circuit for governing this relay is open at the contacts of the traffic lever FL at the opposite end of the stretch.

With the contacts of relays 5HR and 5DR picked up, a circuit is established over front contacts *a* of these two relays for supplying energy to the green lamp G of signal 5S, so that signal 5S displays a clear aspect.

At location X, relay 2CR is deenergized and accordingly relays 2HR and 2DR are released, so that signal 2S has its red lamp lighted at this time, indicating stop. At location Y, relay 4FR is released at this time, so that the red lamp R of signal 4S is lighted by energy supplied over a circuit including back contact *f* of relay FLR and back contact *e* of relay 4FR.

Accordingly, it will be apparent from the foregoing that at this time the system is in condition to permit a westbound train to proceed through the stretch, signals 3S and 5S indicating clear and the opposing signals 2S and 4S indicating stop.

When a westbound train passes signal 5S, the wheels and axles of the train shunt the energy supplied from the track battery 4TB to the track relay 4TR, and accordingly the contacts of this relay will become released. When contacts *a* and *b* of relay 4TR release, the supply of coded energy over the line wires **15** and **17** to the winding of code following relay 5CR is cut off and the contacts of relay 5CR release and remain released, with the result that the contacts of the code decoding relay 5HR and the clear signal control relay 5DR are both released. The release of contact *a* of relay 5HR interrupts the supply of energy to the green lamp G of signal 5S and establishes an obvious circuit for supplying energy to the red lamp R of the signal.

When the westbound train passes signal 3S and occupies section 3T, the wheels and axles of the train will shunt the supply of energy from the winding of the track relay 3TR and accordingly the contacts of relay 3TR will release and remain released. When contacts *a* and *b* of relay 3TR release, they interrupt the supply of coded energy to the winding of the code following relay 3HDCR, and accordingly the contacts of this relay will release and remain released. At this time, the supply of energy to the winding of the directional code detecting relay 3FR is interrupted by contact *c* of relay 3HDCR remainng released, but the relay 3FR is sufficiently slow in releasing so that its contacts will not drop immediately. When contact *c* of relay 3TR releases, a circuit is established for supplying energy to the winding of the traffic stick relay FLR, which circuit may be traced from terminal B at back contact *c* of relay 3TR, over front contact *c* of relay 3FR which is deenergized at this time but the contacts of which are still picked up, back contact *c* of relay 4FR, front contact *b* of relay HR which is slow in releasing and is not released immediately upon the cessation of operation of the contacts of the code following relay, and through the winding of relay FLR to terminal N. When relay FLR picks up, its contact *b* establishes a stick circuit for the relay which may be traced over back contact *c* of relay 3TR, front contact *c* of relay 3FR, back contact *c* of relay 4FR, and front contact *b* of relay FLR. Subsequently, the contacts of relay HR will release, and when contact *b* of relay HR releases it interrupts the previously traced pickup circuit for relay FLR, and establishes an additional stick circuit for the relay which may be traced from terminal B at back contact *b* of relay HR, over front contact *b* of relay FLR, and through the winding of the relay to terminal N.

The picking up of the contacts of relay FLR establishes a stick circuit for maintaining the winding of relay 3FR energized, which circuit may be traced from terminal B at front contact *c* of relay FLR, over front contact *d* of relay 3FR, and through the winding of relay 3FR to terminal N. Accordingly, it will be seen that at this time, with a westbound train passing signal 3S, relay FLR will pick up its contacts, and establish a stick circuit for maintaining the contacts of relay 3FR picked up, even though the pickup circuit for relay 3FR has been opened by the fact that relay 3HDCR has ceased following code and its contact *c* remains released at this time.

When relay FLR picks up, its front contacts *e* and *f* establish the supply of energy to the red lamps R of signals 3S and 4S, so that both of these signals will display red aspects at this time.

When the westbound train has moved out of section 4T, and occupies only section 3T, energy from the track battery 4TB will reenergize the winding of track relay 4TR, so that the contacts of relay 4TR will pick up. With the contacts *a* and *b* of relay 4TR picked up, a circuit is now established for supplying coded energy to the winding of code following relay 5CR at location Z. This circuit may be traced from terminal B at front contact *a* of coding device 75CT, over back contact *a* of relay HR, front contact *a* of relays 3FR and 4TR, line wire **15**, back contact *a* of relay 6CTP, through the winding of relay 5CR, back contact *b* of relay 6CTP, line wire **17**, and front contacts *b* of relays 4TR and 3FR to terminal N. Accordingly, the contacts *a* and *b* of relay 5CR will be operated at the 75 code rate, with the result that relay 5HR will pick up its contacts but relay 5DR will remain released. With contact *a* of relay 5HR picked up and contact *a* of relay 5DR released, an obvious circuit is established for supplying

energy to the yellow lamp Y of signal 5S. Accordingly, it will be seen that signal 5S will display a caution aspect at this time so that a following westbound train can move into section 4T and follow the previous westbound train through the stretch. Accordingly, as is customary, a red or stop aspect is displayed on signal 3S with the train occupying section 3T, while the signal 5S is displaying a yellow or caution aspect at the entrance end of the stretch. When the westbound train proceeds past signal 1S at the western end of the stretch, signal 1S will display a stop aspect, and the signal repeating relay 1GP, will be released. With contact *a* of relay 1GP released, the supply of energy to the winding of relay 1CTP is carried over contact *a* of coding device 75CT rather than contact *a* of coding device 180CT, so that relay 1CTP now operates its contacts at the rate of 75 times per minute. However, since the rear of the train still occupies section 3T, no coded energy is supplied to the winding of code following relay 3HDCR at location Y, and the contacts of this relay remain released. When the rear of the train vacates section 3T, so that the train has vacated the entire stretch, the coded energy supplied over the line wires 11 and 13 will be supplied over front contacts *a* and *b* of relay 3TR, which is again picked up, so that relay 3HDCR will again commence operation with its contacts operating 75 times per minute in response to coded energy supplied from location X. In response to the operation of contacts *a* and *b* of relay 3HDCR, relay HR will become picked up, but relay DR will remain released.

When contact *b* of relay HR picks up, the stick circuit which was previously energizing relay FLR is interrupted and relay FLR will release, since the pickup circuit for this relay is interrupted with the contacts of relays 3TR and 4TR both picked up.

The release of contact *c* of relay FLR will interrupt the stick circuit for relay 3FR, but at this time energy is being supplied to the winding of relay 3FR by the circuit including back contact *c* of relay 4HDCR, front contact *c* of relay HR, and front contact *c* of relay 3HDCR which is now following code. Accordingly, relay 3FR will remain energized at this time. With contact *e* of relay FLR released, contact *c* of relay 3FR picked up, contact *d* of relay HR picked up, and contact *a* of relay DR released, a circuit is established over these contacts for supplying energy to the yellow lamp Y of signal 3S, so that signal 3S will display a yellow aspect for a following train movement.

Signal 4S will continue to display a red aspect at this time, since the red lamp R is energized by the circuit including back contact *f* of relay FLR and back contact *e* of relay 4FR.

With relay HR again energized, and relay FLR deenergized, the circuit including contacts *a* of these two relays, for supplying energy to the line circuit including the line wires 15 and 17 is reestablished, so that coded energy at the 180 code rate is supplied over the line circuit to the code following relay 5CR, with the result that this relay now operates its contacts at the rate of 180 times per minute. Relay 5DR will now be picked up in addition to relay 5HR, and with relays 5HR and 5DR picked up the signal 5S will again display a green aspect so that a following train entering the single track stretch at this time will receive a green or clear aspect at signal 5S, and a yellow aspect from signal 3S, since the train is assumed to be holding signal 1S at stop.

When the train progresses sufficiently far in advance of signal 1S, the signal 1S will clear by control circuits not shown, so that its repeating relay 1GP will be picked up, thus causing the code transmitting relay 1CTP to again be operated at the 180 code rate. Accordingly, the coded energy supplied over the line wires 11 and 13 to the code following relay 3HDCR location line will be at the rate of 180 impulses per minute, with the result that relay DR will be picked up at location Y in addition to the relay HR, thus reestablishing the circuit previously traced for supplying energy to the green lamp G of signal 3S. This restores the apparatus to its normal condition as shown in the drawings.

With the apparatus in its normal condition as shown and the stretch unoccupied, it will now be assumed that the direction of traffic is to be reversed. Accordingly, the traffic lever FL is operated from the L to the R position. When contact *a* of lever FL is operated to its R position, the circuit previously traced for energizing the code transmitting relay 1CTP at location X is interrupted, with the result that coded energy is no longer supplied to the line wires 11 and 13, and back contacts *a* and *b* of relay 1CTP continuously connect the winding of relay 2CR to the line circuit to receive coded energy therefrom.

At location Y, relay 3HDCR will no longer be energized and its contacts will release and remain released. After a time interval, relays HR, DR and 3FR will each release, with the result that the supply of energy to the green lamp G of signal 3S is cut off, and a circuit is established for supplying energy to the red lamp R of signal 3S. This circuit may be traced from terminal B at back contact *e* of relay FLR, over back contact *c* of relay 3FR, and through the red lamp R of signal 3S. Additionally, with relay 3FR released the supply of coded energy to the line wires 15 and 17 at location Y is interrupted, so that relay 5CR at location Z will release and remained released, with the result that relays 5HR and 5DR will both release, the contact *a* of relay 5HR interrupting the circuit for supplying energy to the green lamp of signal 5S and establishing an obvious circuit for supplying energy to the red lamp R of the signal.

With the contacts *a* and *b* of lever FL closed in the R position, energy is supplied over the line circuit including the line wires 21 and 23 extending from location X to location Z, to energize the winding of code transmitting relay 6CTP over a selected one of the contacts of the coding devices 180CT or 75CT, according as relay 6GP is energized or deenergized. It will be assumed at this time that the section in advance of signal 6S is unoccupied and the relay 6GP is picked up, so that energy is supplied to relay 6CTP over front contact *a* of relay 6GP and front contact *a* of coding device 180CT. Relay 6GTP will now commence operating its contacts at the rate of 180 times per minute.

Each time that the contacts of relay 6CTP pick up, energy is supplied to the winding of relay 4HDCR at location Y by a circuit which may be traced from terminal B at front contact *a* of relay 6CTP, over line wire 15, front contact *a* of relay 4TR, back contact *a* of relay 3FR, winding of relay 4HDCR, back contact *b* of relay 3FR, front contact *b* of relay 4TR, line wire 17, and front contact *b* of relay 6CTP to terminal N. The recurrent operation of the contacts *a* and *b* of relay 4HDCR will cause energy to be supplied to the windings of relays HR and DR, so that these relays will now pick up in response to the code following operation of relay 4HDCR.

At this time, since contact *c* of relay 3HDCR is continuously released, a circuit is established for supplying energy to the winding of relay 4FR, which circuit may be traced from terminal B at back contact *c* of relay 3HDCR, over front contact *c* of relay HR, front contact *c* of relay 4HDCR, and through the winding of relay 4FR to terminal N. As previously pointed out in connection with relay 3FR, the relay 4FR is slow in releasing, so that the contacts will remain picked up during the short intervals in which the contact *c* of relay 4HDCR is open.

With relay 4FR and relay HR picked up, a circuit is established for supplying energy to the green lamp G of signal 4S, which circuit may be traced from terminal B at back contact *f* of relay FLR, over front contact *e* of relay 4FR, front contact *c* of relay HR, front contact *b* of relay DR, and through the green lamp G of signal 4S to terminal N.

At this time, coded energy is supplied to the line wires 11 and 13 to energize the code following relay 2CR at location X by a circuit which may be traced from terminal B at front contact *a* of coding device 180CT, back contact *a* of relay FLR, front contact *a* of relay HR, front contact *a* of relay 4FR, front contact *a* of relay 3TR, line wire 11, back contact *a* of relay 1CTP, through the winding of relay 2CR, over back contact *b* of relay 1CTP, line wire 13, front contact *b* of relay 3TR, and front contact *b* of relay 4FR to terminal N. Accordingly, the contacts of relay 2CR at location X will be operated 180 times per minute with the result that relays 2HR and 2DR will be picked up and an obvious circuit established over the contacts of these relays for supplying energy to the green lamp G of signal 2S.

It will be seen that with the apparatus in the condition described above, signals 2S and 4S will display a green or clear aspect for eastbound train movements.

It will now be assumed that an eastbound train approaches location X, and passes signal 2S to enter the stretch of single track equipped with signaling systems. When the train passes signal location 2S, the wheels and axles shunt the track circuit 3T, with the result that track relay 3TR at location Y is released. The release of contacts *a* and *b* of relay 3TR cuts off the supply of coded energy to the code following relay 2CR at location X, with the subsequent release of relays 2HR and 2DR, the contact *a* of relay 2HR interrupting the circuit for supplying energy to the green lamp G of signal 2S and establishing an obvious circuit for supplying energy to the red lamp R of the signal.

When the eastbound train passes signal 4S, the wheels and axles of the train shunt the supply of energy to the track relay 4TR and the relay releases its contacts. Contacts *a* and *b* of relay 4TR interrupt the supply of coded energy from the line wires 15 and 17 to the winding of the code following relay 4HDCR, so that the relays HR and DR are deenergized. However, as previously pointed out these relays are slow in releasing their contacts so that contacts of relay HR remain picked up for a short time interval afer the cessation of supplying energy to the winding of the relay. When contact *c* of relay 4TR releases, it establishes a circuit for picking up the traffic stick relay FLR, which circuit may be traced from terminal B at back contact *c* of relay 4TR, over front contact *c* of relay 4FR, over back contact *c* of relay 3FR, over front contact *b* of relay HR, and through the winding of relay FLR to terminal N. When relay FLR picks up, its contact *b* establishes a first stick circuit for the relay which may be traced from terminal B at back contact *c* of relay 4TR, over front contact *c* of relay 4FR, back contact *c* of relay 3FR, front contact *b* of relay FLR, and through the winding of relay FLR to terminal N. Upon the subsequent release of relay HR, a second stick circuit is established for relay FLR, which circuit may be traced from terminal B at back contact *b* of relay HR, over front contact *b* of relay FLR, and through the winding of relay FLR to terminal N. Accordingly, it will be seen that the entrance of the train into section 4T causes the relay FLR to be picked up, and a stick circuit is established for maintaining the relay energized as long as relay HR is released, which will continue as long as the section 4T is occupied by an eastbound train. The release of contact *c* of code following relay 4HDCR interrupts the supply of impulses of energy to the winding of relay 4FR over the pickup circuit previously traced for this relay, and as previously pointed out, this relay is sufficiently slow in releasing so that it will maintain its contacts picked up at least until the time required for relay FLR to pick up. When the relay HR releases, the front contact *c* of relay HR further interrupts the circuit for supplying energy to the winding of relay 4FR. However, when relay FLR picks up upon the entrance of the train into section 4T, a stick circuit is established for relay 4FR which includes a front contact *d* of relay FLR and front contact *d* of relay FR, so that relay 4FR is maintained energized as long as relay FLR is picked up. Accordingly, relay 4FR remains continuously picked up as the train moves from section 3T into section 4T. With contact *a* of relay HR released, the circuit for supplying coded energy to line wires 11 and 13 is transferred from coding device 180CT to coding device 75CT, so that when the rear of the train vacates section 3T, and the contacts *a* and *b* of relay 3TR pick up, coded energy at the 75 code rate is supplied to the line circuit by a circuit including back contact *a* of relay HR and contact *a* of coding device 75CT. Accordingly, the code following relay 2CR at location X will be operated at the 75 code rate so that relay 2HR will be picked up at this time and the relay 2DR will be released, thus establishing an obvious circuit for supplying energy to the yellow lamp Y of signal 2S. Thus, it will be seen that the signal 2S will display a caution aspect at this time so that a following train can enter the single track stretch. At location Y, the signals 3S and 4S will both be displaying a red aspect at this time with the train occupying section 4T, since circuits for supplying energy to the red lamps R of each signal are completed at this time by front contacts *e* and *f* of relay FLR.

When the eastbound train passes signal 6S, relay 6GP will be released, so that relay 6CTP will now be operated by energy supplied over front contact *a* of coding device 75CT, with the result that the contacts *a* and *b* of relay 6CTP are operated at the 75 code rate thus supplying energy coded at this frequency to line wires 15 and 17.

When the rear of the train vacates section 4T, track relay 4TR is picked up, so that coded energy is supplied over the line wires 15 and 17 to the winding of code following relay 4HDCR, and its contacts are operated at 75 code rate.

With the contacts *a* and *b* of relay 4HDCR operating at the 75 code rate, the code decoding relay HR will be picked up, but the clear signal control relay DR will remain released at this time. With contact *c* of relay 4TR picked up and contact *b* of relay HR picked up, the previously traced stick circuit for energizing relay FLR will be interrupted, and the pickup circuit will be opened at back contact *c* of relay 4TR, so that relay FLR will release.

The release of contact *d* of relay FLR will open the stick circuit including front contact *d* of relay 4FR but relay 4FR will now be energized by the circuit including back contact *c* of relay 3HDCR, front contact *c* of relay HR, and the front contact *c* of the code following relay 4HDCR, with the result that relay 4FR remains picked up at this time.

The red lamp R of signal 3S is energized at this time by a circuit including back contact *e* of relay FLR and back contact *c* of relay 3FR, so that signal 3S continues to display a red aspect. Signal 4S will display a yellow aspect at this time, since the yellow lamp Y is supplied with energy by a circuit which includes back contact *f* of relay FLR, front contact *e* of relay 4FR, front contact *c* of relay HR, and back contact *b* of relay DR.

The coded energy supplied to the line circuit including line wires 11 and 13 extending between locations X and Y is now supplied at the rate of 180 impulses per minute, over the circuit including contact *a* of coding device 180CT, back contact *a* of relay FLR, and front contact *a* of relay HR. Accordingly, at location X, code following relay 2CR will operate its contacts at the 180 code rate, so that relays 2HR and 2DR are both picked up, and their contacts *a* establish a circuit for supplying energy to the green lamp G of signal 2S. It will be seen at this time the signal 2S will display a green aspect for an eastbound train, while signal 4S will display a yellow aspect indicating that signal 6S is still at stop.

When the eastbound train advances a sufficient distance beyond signal 6S, the relay 6GP will pick up, and its contact *a* will transfer the circuit for supplying coded energy

to the winding of code transmitting relay 6CTP from the coding device 75CT to the coding device 180CT, with the result that the contacts of relay 6CTP are operated at the 180 code rate. Accordingly, the energy supplied over the line circuit including line wires 15 and 17 from location Z to location Y is changed to the 180 code rate, and the contacts of relay 4HDCR will now operate at this frequency.

With relay 4HDCR operating at the 180 code rate the code detecting relay HR will be picked up and code control relay DR will be picked up, so that the contact *a* of relay DR will cut off the supply of energy to yellow lamp Y of signal 4S, and establish the circuit for supplying energy to the green lamp G of the signal. It will be seen that the signal 4S will now display a clear aspect for an eastbound train movement.

The reversal of the direction of traffic to the westbound direction, accomplished by operating the traffic lever FL from its R to its L position, causes the apparatus to operate in a manner similar to that previously described when the traffic was changed from westbound to an eastbound direction, and it is believed that a detailed description is deemed unnecessary.

It is to be understood that although only one set of intermediate signals 3S and 4S is shown in the drawings, the invention is not limited to this arrangement and any number of intermediate signals may be provided if necessary. Also, as previously pointed out the arrangement of the directional relay control circuit is not limited to use with a system in which coded line circuits are employed but may also be employed with signalling systems of the coded track circuit type.

It is to be noted that several circuits are provided for checking the proper operation of the relays, particularly the traffic stick relay FLR. The circuits for governing signals 3S and 4S are arranged in such a manner that if relay FLR becomes picked up for any reason whether by passage of a train or by erroneous operation due to other causes, both signals 3S and 4S will display a red or stop aspect. Additionally, even though control relay HR is picked up, if relay FLR should pick up with relay HR picked up, the contact *a* of relay FLR will cause the supply of coded energy to the line circuit to be transferred from the 180 code rate to the 75 code rate. Accordingly, it will be seen that if relay FLR is picked up for any reason, whether or not a train is occupying the section, the signals 3S and 4S will both display a red or stop aspect and the coded energy supplied over the line circuits extending in both directions from location Y will be coded at the 75 code rate, so that signals 2S and 5S can only display a yellow aspect.

Although I have herein shown and described only one form of directional relay control circuits for railway signaling systems embodying my invention, it is to be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a coded railway signaling system, in combination, a stretch of railway track comprising adjoining first and second track sections, a first and a second code following relay located at the adjoining ends of said first and said second track sections, said first and said second code following relays being operated at times by coded energy supplied thereto from the remote ends of said first and said second sections respectively, according to traffic conditions in and beyond the associated section, a first and a second directional code detecting relay associated with said first and said second code following relays, circuit means governed by the recurrent operation of said code following relays for energizing the associated directional code detecting relays, a code decoding lays for energizing said traffic stick relay, circuit means code following relays, a traffic stick relay, circuit means including contacts of said directional code detecting relays for energizing said traffic stick relay, circuit means for maintaining said traffic stick relay energized when said code decoding relay is released, stick circuit means including a front contact of said traffic stick relay for maintaining said first and said second directional code detecting relays energized as long as said traffic stick relay is energized, and traffic governing means controlled by said directional code detecting relays.

2. In a coded railway signaling system, in combination, a stretch of railway comprising adjoining first and second track sections, a first and a second code following relay located at the adjoining ends of said first and second track sections, said first and said second code following relays being operated at times by coded energy supplied thereto from the remote ends of said first and said second sections respectively, according to traffic conditions in and beyond the associated section, a first and a second directional code detecting relay associated with said first and said second code following relays, circuit means governed by the recurrent operation of said code following relays for energizing said directional code detecting relays, a code decoding relay energized by the recurrent operation of either of said code following relays, a traffic stick relay, a pickup circuit for said traffic stick relay including a front contact of said first directional code detecting relay and a back contact of said second directional code detecting relay and a front contact of said code decoding relay, a stick circuit for said traffic stick relay including a back contact of said code decoding relay, stick circuit means including a front contact of said traffic stick relay for maintaining said first and said second directional code detecting relays energized as long as said traffic stick relay is energized, and traffic governing means controlled by said directional code detecting relays.

3. In a coded railway signaling system, in combination, a stretch of railway comprising adjoining first and second track sections, a first and a second code following relay located at the adjoining ends of said first and said second track sections, said first and said second code following relays being operated at times by coded energy supplied thereto from the remote ends of said first and said second sections respectively, according to traffic conditions in and beyond the associated section, a code decoding relay energized in response to the code following operation of either of said code following relays, a first and a second directional code detecting relay associated with said first and said second code following relays, a pickup circuit for said first and said second directional code detecting relays including a front contact of the associated code following relay and a front contact of said code decoding relay, a traffic stick relay, circuit means including contacts of said directional code detecting relays for energizing said traffic stick relay, circuit means for maintaining said traffic stick relay energized when said code decoding relay is released, a stick circuit for each of said directional code detecting relays including a front contact of the directional code detecting relay and a front contact of said traffic stick relay, and traffic governing means controlled by said directional code detecting relays.

4. In a coded railway signaling system, in combination, a stretch of railway comprising adjoining first and second track sections, a first and a second code following relay located at the adjoining ends of said first and said second track sections, said first and said second code following relays being operated at times by coded energy supplied thereto from the remote ends of said first and said second sections respectively, according to traffic conditions in and beyond the associated section, a code decoding relay energized in response to the code following operation of either of said code following relays, a first and a second directional code detecting relay associated with said first and said second code following

relays, a pickup circuit for said first and said second directional code detecting relays including a front contact of the associated code following relay and a front contact of said code decoding relay, a traffic stick relay, a pick-up circuit for said traffic stick relay including a front contact of said first directional code detecting relay and a back contact of said second directional code detecting relay and a front contact of said code decoding relay, a stick circuit for said traffic stick relay including a back contact of said code decoding relay, a stick circuit for said first and said second directional code detecting relays including a front contact of the directional code detecting relay and a front contact of said traffic stick relay, and traffic governing means controlled by said directional code detecting relays.

5. In a coded railway signaling system, in combination, a stretch of railway comprising adjoining first and second sections, each of said sections having a track circuit, a first and a second track relay governed by the track circuit of the associated section, a first line circuit extending the length of said first section and having in series therewith front contacts of said first track relay, a second line circuit extending the length of said second section and having in series therewith front contacts of said second track relay, coding means located at the remote ends of said sections for at times supplying coded energy to said line circuits in accordance with traffic conditions and for at other times connecting the winding of a remote code following relay to said line circuit, a first and a second directional code detecting relay, a first and a second code following line relay, means for connecting the winding of said first code following line relay to said first line circuit when the contacts of said first directional code detecting relay are released and for connecting a source of coded energy to said first line circuit when the contacts of said first directional code detecting relay are picked up, means for connecting the winding of said second code following line relay to said second line circuit when the contacts of said second directional code detecting relay are released and for connecting said source of coded energy to said second line circuit when the contacts of said second directional code detecting relay are picked up, a code decoding relay which has its contacts picked up or released according as said first or said second code following line relay is or is not recurrently operating its contacts, a traffic stick relay, a first pickup circuit for said traffic stick relay including a back contact of said first track relay, a front contact of said second directional code detecting relay, a back contact of said first directional code detecting relay, and a front contact of said code decoding relay; a second pickup circuit for said traffic stick relay including a back contact of said second track relay, a front contact of said first directional code detecting relay, a back contact of said second directional code detecting relay, and a front contact of said code decoding relay; a stick circuit for said traffic stick relay including a back contact of said code decoding relay and a front contact of said traffic stick relay; a pickup circuit for said first directional code detecting relay including a front contact of said second code following line relay, a front contact of said code decoding relay, and a back contact of said first code following line relay; a stick circuit for said first directional code detecting relay including a front contact of said traffic stick relay and a front contact of said first directional code detecting relay; a pickup circuit for said second directional code detecting relay including a front contact of said first code following line relay, a front contact of said code decoding relay, and a back contact of said second code following line relay; a stick circuit for said second directional code detecting relay including a front contact of said traffic stick relay and a front contact of said second directional code detecting relay; a first and a second wayside signal located at the adjoining ends of said track sections, said first wayside signal governing train movements into said second section and said second wayside signal governing train movements into said first section, control means for said first wayside signal including a contact of said first directional code detecting relay, a contact of said code decoding relay, and a contact of said traffic stick relay, and control means for said second wayside signal including a contact of said second directional code detecting relay, a contact of said code decoding relay and a contact of said traffic stick relay.

No references cited.