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H. A. THOMPSON

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RAILWAY SIGNALING SYSTEM

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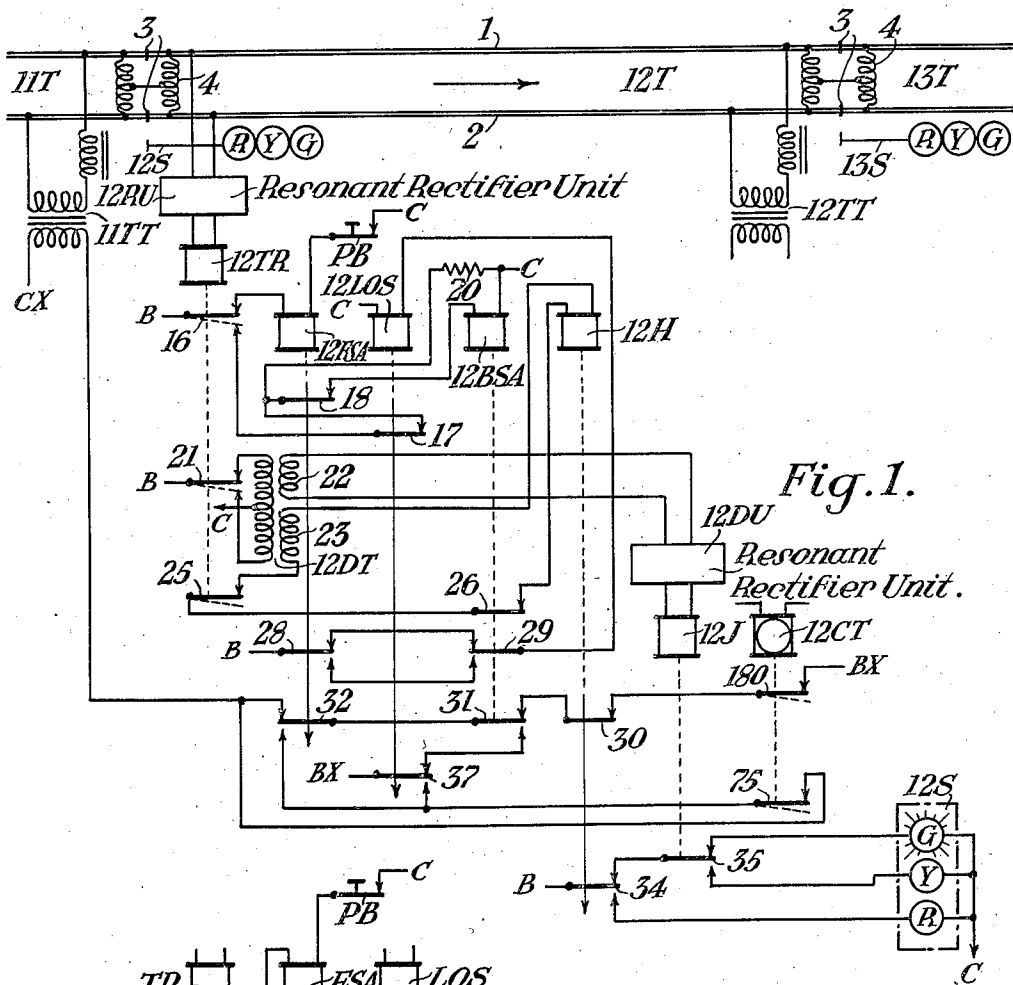


Fig. 1.

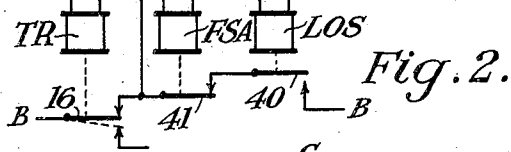


Fig. 2.

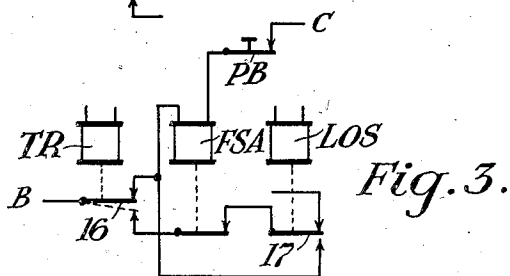


Fig. 3.

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UNITED STATES PATENT OFFICE

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RAILWAY SIGNALING SYSTEM

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14 Claims. (Cl. 246—38)

My invention relates to railway traffic controlling apparatus and particularly to a system employing coded energy in the track circuits thereof.

In United States Patent No. 2,213,420, issued to me on September 3, 1940, there is shown a system which is arranged so that in the event the insulated joints separating two track sections are defective, the equipment associated with the track section in advance of the defective joints operates to establish a "lockout" circuit to supply steady uncoded energy to the track rails of the track section in the rear of the defective joints to thereby prevent the display of a proceed indication by the signal for the section in advance of the defective joints, or by the cab signal apparatus on a locomotive in the section in the rear of the defective joints.

In the system shown in the patent identified above the steady energy supplied to the section in the rear of the defective joints causes the signal for that section to display its stop indication, while it also causes steady uncoded energy to be supplied to the track sections farther in the rear so that all of the signals in the rear of the defective insulated joints display stop indications, while the cab signal apparatus on a locomotive present in any of these sections will provide its most restrictive indication. This creates a safe condition, but it may unnecessarily delay traffic in the track stretch.

In United States Patent No. 2,215,904, issued September 24, 1940, to Ralph R. Kemmerer, and in United States Patent No. 2,235,134, issued March 18, 1941, to Leslie R. Allison and Frank H. Nicholson, there are shown non-cascading "lockout" circuit in which the supply of steady energy is not repeated beyond the section in the rear of the defective insulated joints. In these systems the signal at the defective insulated joints, and the adjacent section in the rear display stop indications, but the signals farther in the rear display proceed indications. This arrangement facilitates movement of traffic, but it still requires trains to traverse two track sections at slow speed.

It is an object of this invention to provide an improved system of the type described which operates so that in the event that the insulated joints separating two track sections are defective only the signal for the section in advance of the defective joints will be caused to display its stop or most restrictive indication, and so that the signal for the section in the rear of the defective joints will display a proceed indication.

A further object of the invention is to provide an improved signaling system which is arranged to detect feeding of energy over a defective joint, and which operates so that after this energy has been detected the equipment

cannot be restored to normal operation by any track circuit conditions, but can only be returned to normal operation by action of a signal maintainer.

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

In practicing my invention I modify the systems heretofore known by incorporating in the equipment for each track section a relay which is controlled in such manner as to detect the steadily energized condition of the associated track relay, and I employ this relay to control the supply of steady energy to the section in the rear. Should the normally coded energy supplied to one track circuit feed forwardly across a defective joint so that the lockout circuit becomes effective to supply steady energy to the rear, the relay added by this invention will detect the presence of this steady energy and will cut off the further supply of steady energy to the rear section and will cause coded energy to be supplied instead. In addition, when the system includes wayside signals the relay added by my invention also operates after it has detected the presence of steady energy to maintain the display of the most restrictive indication by the associated signal.

I shall describe one form of signaling system embodying my invention together with two modifications thereof which I may employ, and shall then point out the novel features thereof in claims.

In the drawing

Fig. 1 is a diagram showing a section of railway track equipped with signaling apparatus embodying my invention, and

Figs. 2 and 3 are fragmentary diagrams showing modifications which I may employ.

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

Referring to Fig. 1, there is shown therein a stretch of railway track having track rails 1 and 2 over which traffic normally moves in the direction indicated by an arrow, that is, from left to right. The rails of the track stretch are divided by insulated joints 3 into the customary successive track sections for signaling purposes.

Electric current is employed for propulsion purposes in the track stretch shown in Fig. 1 and for this reason alternating current energy is employed in the track circuits, while impedance bonds 4 of the customary form are provided to conduct propulsion current around each pair of insulated rail joints. As the description proceeds, however, it will be apparent that the apparatus of this invention is equally well suited for use on a steam road, in which case either direct or alternating current may be em-

ployed in the track circuits while the impedance bonds may be omitted.

In the diagram comprising Fig. 1 of the drawing one complete section, which is identified as section 12T, and parts of two other sections, identified as sections 11T and 13T, are shown. Each of these sections has located at the entrance end thereof a signal S for governing traffic in the track stretch. The signals illustrated are of the familiar color light type having a green or proceed lamp G, a yellow or caution lamp Y, and a red lamp R which may be considered a stop or slow speed indication. It should be understood, however, that the invention is not limited to the use of signals of this type and that any appropriate form of signal may be used. Likewise, the invention is not limited to a system employing wayside signals, but is equally applicable to track stretches without wayside signals and over which are operated locomotives equipped with cab signal apparatus of well known construction, such as that shown in United States Patent No. 1,986,679, issued January 1, 1935, to Lloyd V. Lewis.

The rails of each track section form a part of a track circuit to which coded alternating current signal control energy is supplied at the exit or leaving end from the secondary winding of a track transformer TT. The alternating current supplied to the track circuits is derived from a suitable source and may be distributed throughout the track stretch by a transmission line, not shown. The terminals of the power supply source are designated BX and CX, and it will be assumed that the energy supplied from this source is alternating current of a frequency of 100 cycles per second.

Each signal location is also provided with a suitable source of direct current, such as a primary or storage battery, not shown, the terminals of which are designated B and C.

The signaling system shown in Fig. 1 makes use of track circuit energy coded at two different frequencies. This coded energy is provided by code transmitters CT which interrupt the supply circuits for the associated track transformers a definite number of times per minute according to traffic or other conditions ahead. As shown, each code transmitter is provided with two circuit making and breaking contacts 75 and 180 which are continuously actuated by a motor or other suitable mechanism at speeds such as to provide 75 and 180 energy pulses per minute which are separated by periods of equal duration in which no energy is supplied.

Each track circuit includes a code following track relay TR connected across the section rails at the entrance end of the section. As shown, the track relay is of the direct current type and is connected to the track rails through a resonant rectifier unit RU. The unit RU includes a transformer, a capacitor and a reactor so arranged and proportioned as to freely pass 100 cycle signal control energy, but so as not to pass propulsion current of a different frequency. The unit RU includes, in addition, a rectifier which converts into direct current the alternating current supplied through the unit.

The track relay 12TR has associated therewith auxiliary relays 12FSA, 12BSA, 12H and 12J, a slow releasing control relay 12LOS, and a decoding transformer 12DT, while each of the other signals in the track stretch has associated therewith equipment corresponding to that associated with signal 12S.

The equipment is shown in the condition which it assumes when the track stretch is vacant. At such times energy of 180 code frequency is supplied to the track transformer 12TT by the equipment associated with section 13T. The equipment for section 13T operates in the same manner as that for section 12T.

The coded energy supplied to the transformer 12TT feeds to the track relay 12TR and produces code following operation of this relay. When the track relay contacts are in their picked-up positions, contact 16 establishes a circuit to supply energy to the first auxiliary relay 12FSA, while during the released periods of the track relay contacts energy is supplied to second auxiliary relay 12BSA over the circuit which is traced from terminal B through back contact 16 of relay 12TR, front contact 17 of relay 12LOS, front contact 18 of relay 12FSA, and winding of relay 12BSA to terminal C. At this time contact 18 of relay 12FSA also connects the snubbing resistor 20 across the terminals of the relay 12BSA to render the relay slow in releasing so that the relay contacts remain picked up during the picked-up periods of the track relay contacts. Similarly, the relay 12FSA is of a type the contacts of which are slow in releasing so that they remain picked up during the released periods of the track relay contacts.

As a result of code following operation of the track relay its contact 21 alternately establishes the circuits to energize the two portions of the primary winding of transformer 12DT so that impulses of energy are supplied to the secondary windings 22 and 23 of the transformer.

When the track relay contacts are picked up, its contact 25 establishes a circuit including front contact 25 of relay 12BSA to supply impulses of energy from the transformer secondary winding 23 to the relay 12H. The relay H is of a type which is slow in releasing so that its contacts remain picked up during the intervals between the supply of impulses of energy to the relay winding.

As the contacts of relays 12FSA and 12BSA are picked up, energy is supplied to the control relay 12LOS over the circuit which includes front contact 28 of relay 12FSA and front contact 29 of relay 12BSA.

As the contacts of relays 12FSA, 12BSA and 12H are picked up, energy of 180 code frequency is supplied to the primary winding of track transformer 11TT over the circuit which is traced from terminal BX through contact 180 of the code transmitter 12CT, front contact 30 of relay 12H, front contact 31 of relay 12BSA, front contact 32 of relay 12FSA, and primary winding of transformer 11TT to terminal CX. Accordingly, energy of 180 code frequency is supplied to the rails of section 11T.

At this time energy induced in the secondary winding 22 of transformer 12DT is supplied through the resonant rectifier unit 12DU to the relay 12J so that the contact of this relay is picked up. Accordingly, the green lamp G of signal 12S is lighted over the circuit which includes front contact 34 of relay 12H and front contact 35 of relay 12J.

The unit 12DU is similar in construction to the unit 12RU, but is arranged to pass sufficient energy to pick up the relay 12J when and only when the energy supplied thereto is of the frequency present when the track relay 12TR is responding to energy of 180 code frequency.

Operation of equipment on passage of a train through the track stretch

When a train moving in the normal direction of traffic enters section 12T, the track relay 12TR is shunted and its contacts remain in their released positions so that energy is not supplied to the relays 12FSA and 12H. Accordingly, after a short time interval the contacts of relay 12FSA release so that its contact 18 interrupts both the energizing circuit and the snubbing circuit for relay 12BSA, and the contacts of this relay thereupon quickly release so that contact 26 interrupts the circuit of relay 12H and its contacts release after a time interval.

On release of the contacts of relay 12FSA contact 28 interrupts the circuit of relay 12LOS, but this relay is slow enough in releasing to remain picked up until contact 29 of relay 12BSA releases and establishes the circuit of the relay 12LOS. Accordingly, the contacts of relay 12LOS remain picked up and energy of 75 code frequency is supplied to the track transformer 11TT over the circuit which is traced from terminal BX through front contact 37 of relay 12LOS, back contact 31 of relay 12BSA, back contact 32 of relay 12FSA, contact 75 of the code transmitter, and primary winding of the track transformer 11TT to terminal CX.

As hereinafter explained in connection with section 12T, the energy of 75 code frequency supplied to section 11T will cause the signal for that section to display its yellow or caution indication, while it will produce a similar aspect in the cab signal apparatus on a locomotive in section 11T.

On release of the contacts of relay 12H contact 34 interrupts the circuit of the green lamp G of signal 12S and establishes the circuit of the red lamp R, while on cessation of code following operation of the track relay 12TR relay 12J releases.

When the train enters section 13T, the equipment for this section operates in the same manner as that associated with section 12T so that the signal 13S displays its red indication, while the energy supplied to track transformer 12TT is changed from 180 to 75 code frequency.

When the train vacates section 12T, the energy of 75 code frequency feeds to the track relay 12TR and produces code following operation of the relay.

On picking up of the track relay contacts its contact 16 establishes the circuit to supply energy to relay 12FSA and the contacts of this relay pick up so that contact 32 interrupts the circuit traced above for supplying energy of 75 code frequency to the transformer 11TT, and establishes the circuit including front contact 37 of relay 12LOS and back contact 31 of relay 12BSA to supply steady uncoded energy to transformer 11TT. If the insulated joints 3 separating sections 11T and 12T are intact, the steady energy supplied to track transformer 11TT will not reach track relay 12TR and this relay will continue to respond to the coded energy supplied thereto from transformer 12TT.

After a short time interval, therefore, the track relay contacts will release and contact 16 establishes the circuit including front contact 17 of relay 12LOS and front contact 18 of relay 12FSA for energizing relay 12BSA. The contacts of relay 12BSA, therefore, pick up and its contact 26 is closed so that on the next movement of the track relay contacts to their picked-up po-

sitions energy is supplied to relay 12H, while contact 31 of relay 12BSA interrupts the circuit traced above for supplying steady energy to track transformer 11TT.

In addition, on picking up of the contacts of relay 12BSA its contact 29 establishes the circuit including front contact 28 of relay 12FSA for supplying energy to the relay 12LOS. In the interval between picking up of the contacts of relay 12BSA and picking up of the contacts of relay 12LOS, energy is not supplied to the relay 12LOS, but this relay is slow enough in releasing to keep its contacts picked up during this time interval.

When the track relay contacts again pick up, energy is supplied to relay 12FSA to keep it picked up, while energy is supplied to relay 12H to pick up its contacts. On picking up of the contacts of relay 12H its contact 30 completes the circuit for supplying energy of 180 code frequency to track transformer 11TT, while its contact 34 interrupts the circuit of the red lamp R and establishes the circuit including back contact 35 of relay 12J for lighting the yellow lamp Y of signal 12S. The energy of 180 code frequency supplied to the rails of section 11T causes the signal for that section to display its green or clear indication, while it will cause the display of a similar indication by the cab signal apparatus on a locomotive present in this section.

On continued code following operation of the track relay energy is supplied to the relays 12FSA and 12H on movement of the track relay contacts to their picked-up positions, while energy is supplied to the relay 12BSA on movement of the track relay contacts to their released positions. Accordingly, as long as the track relay responds to coded energy, the contacts of the relays 12FSA, 12BSA and 12H are picked up, while contact 28 of relay 12FSA and contact 29 of relay 12BSA establish the circuit of the relay 12LOS so that its contacts are maintained picked up.

At this time, as the track relay 12TR is responding to energy of 75 code frequency, the frequency of the energy induced in the secondary winding 22 of decoding transformer 12DT is such that too little energy is supplied through the unit 12DU to the relay 12J to pick up the relay contact so that its contact 35 remains released and maintains the circuit of the yellow or caution lamp Y of signal 12S.

When the train advances far enough to vacate section 13T, the equipment associated with this section operates to change the aspect of signal 13S from red to yellow, and to change the energy supplied to track transformer 12TT from 75 to 180 code frequency. Accordingly, the track relay 12TR operates at a faster rate and relays 12FSA, 12BSA and 12H are maintained energized, while sufficient energy is supplied through the unit 12DU to the relay 12J to pick up the relay contact so that its contact 35 picks up and interrupts the circuit of the yellow lamp Y and establishes the circuit of the green lamp G of signal 12S. At this time energy of 180 code frequency continues to be supplied to the track transformer 11TT.

Operation of the equipment if an insulated joint breaks down as a result of passage of a train

When a train moving in the normal direction of traffic enters section 12T, the track relay 12TR is shunted and relays 12FSA, 12BSA and 12H release as explained above, while energy is supplied to relay 12LOS over the circuit established

by back contacts 28 and 29 of relays 12FSA and 12BSA. Accordingly, the circuit including front contact 37 of relay 12LOS, back contact 31 of relay 12BSA, back contact 32 of relay 12FSA, and contact 75 of the code transmitter 12CT is established to supply coded energy to the transformer 11TT.

For purposes of illustration it will be assumed that an insulated joint 3 separating sections 11T and 12T breaks down as a result of passage of a train. Because of the well-known autotransformer action of the impedance bonds, breaking down of one insulated joint permits energy supplied to the rails of section 11T to feed to the track relay 12TR.

Accordingly, when the train advances far enough for the rear of the train to be located some distance in advance of the entrance end of the track section 12T so that the train is ineffective to shunt the track relay 12TR with respect to energy feeding across the defective joint, the track relay 12TR will respond to energy supplied from transformer 11TT.

On the first movement of the track relay contacts to their picked-up positions contact 16 establishes the circuit to supply energy to the relay 12FSA, and the contacts of this relay pick up so that its contact 32 interrupts the circuit traced above for supplying energy of 75 code frequency to track transformer 11TT and establishes the circuit including front contact 37 of relay 12LOS and back contact 31 of relay 12BSA for supplying steady energy to the transformer 11TT. This steady energy feeds across the defective joint to the track relay 12TR and keeps the contacts of this relay in their picked-up positions so that contact 16 maintains the supply of energy to relay 12FSA, and does not engage its back contact to establish the circuit to supply energy to the relay 12BSA. Accordingly, the contacts of relay 12BSA remain released.

When the contacts of relay 12FSA are picked up and the contacts of relay 12BSA are released, the circuit of the relay 12LOS is interrupted, and after a short time interval, the contacts of this relay release so that its contact 37 interrupts the circuit traced above for supplying steady energy to the track transformer 11TT and establishes a circuit including contact 75 of the code transmitter to supply energy of 75 code frequency to the track transformer 11TT. In addition, on release of the contacts of relay 12LOS its contact 17 interrupts the circuit of relay 12BSA to prevent energization of this relay.

The coded energy supplied to track transformer 11TT feeds to the track relay 12TR and the contacts of this relay now follow code. However, on release of the track relay contacts energy is not supplied to relay 12BSA since the circuit of this relay is interrupted by contact 17 of relay 12LOS and relay 12BSA remains released so that its contact 26 interrupts the circuit of the relay 12H to thereby prevent the supply of energy to relay 12H on movement of the track relay contacts to their picked-up positions. Accordingly, on continued code following operation of the track relay 12TR subsequent to release of relay 12LOS energy is supplied to relay 12FSA on movement of the track relay contacts to their picked-up positions, while energy is not supplied to relays 12BSA and 12H so that relay 12BSA remains released and continues to interrupt the circuit of relay 12LOS, while relay 12H remains released and its contact 34 maintains the circuit of the red lamp R of signal 12S.

It will be seen, therefore, that this system is arranged so that on initial picking up of the track relay contacts steady energy is supplied to the section in the rear, and, if this steady energy feeds across a defective joint, it will keep the track relay picked up so that the relay LOS releases and cuts off the supply of steady energy to the section in the rear and causes coded energy of 75 code frequency to be supplied thereto. As hereinafter explained this energy of 75 code frequency supplied to section 11T causes the signal for that section to provide its caution indication, while it will produce a similar indication by the cab signal apparatus on a locomotive present in that section. In addition, release of relay 12LOS prevents completion of the cycle of picking up of the auxiliary relays and thereby insures that the signal 12S controlled thereby will continue to display its stop indication.

This system is also arranged so that the equipment associated with the track section in the rear of a defective insulated joint will display its yellow or caution indication.

For the purposes of illustration it will be assumed that an insulated joint 3 separating sections 12T and 13T breaks down as a result of passage of a train and that the equipment for section 13T operates as described in detail above in connection with section 12T to detect the defective condition of the insulated joints.

As explained above, when any part of the train is present in section 12T, current from the track transformer 12TT is shunted from the track relay 12TR, while when the train enters section 13T, the track relay for that section is shunted and the equipment controlled thereby operates to supply energy of 75 code frequency to the track transformer 12TT.

When the train vacates section 12T, the energy of 75 code frequency supplied to transformer 12TT feeds to the track relay 12TR and the first impulse of coded energy picks up the contacts of this relay so that its contact 16 establishes the circuit of the relay 12FSA, while on the first "off" period in the code the track relay contacts release so that energy is supplied to relay 12BSA and contact 29 of this relay picks up and reestablishes the circuit of the relay 12LOS.

When the train advances far enough for the rear of the train to be located some distance in advance of the entrance end of section 13T, the train is no longer effective to shunt the track relay for section 13T with respect to energy feeding from the track transformer 12TT across the defective joint.

On the first movement of the contacts of the track relay for section 13T to their picked-up position energy is supplied to the relay 13FSA, not shown, and its contacts pick up to cut off the supply of coded energy to transformer 12TT and to cause steady energy to be supplied thereto. In addition, on picking up of the contacts of relay 13FSA the circuit of relay 13LOS is interrupted and the release time of this relay begins.

The steady energy supplied to the transformer 12TT causes the contacts of track relays 12TR and 13TR to remain picked up and maintain the circuits of the associated relays FSA.

After a time interval the relay 13LOS releases and cuts off the supply of steady energy to transformer 12TT and causes coded energy to be supplied thereto, while it also interrupts the circuit of relay 13BSA to prevent energization of this relay on subsequent code following operation of the track relay 13TR.

On the supply of steady energy to relay 12TR its contacts remain picked up so that energy is not supplied to relay 12BSA and this relay releases after a time interval. This period is relatively long as the snubbing circuit for the relay is maintained by contact 18 of relay 12FSA. Until relay 12BSA releases energy is supplied to relay 12LOS so that the release period of this relay 12LOS does not begin until after release of relay 12BSA. As pointed out above, the release period of relay 13LOS begins as soon as relay 13FSA picks up. As a result, the relay 12LOS will remain picked up and will maintain the circuit of the relay 12BSA until after the relay 13LOS releases and causes coded energy to be supplied to transformer 12TT. Accordingly, on the first "off" interval in the coded energy supplied after release of the contacts of relay 13LOS, the contacts of relay 12TR release and energy is supplied to relay 12BSA to pick up the relay contacts if they have released, or to maintain them picked up if they have not released. The contacts of relay 12BSA, therefore, either maintain the circuit of relay 12LOS or re-establish it before it has been interrupted long enough for the relay 12LOS to have become released and interrupt the circuit of the relay 12BSA.

On continued supply of coded energy to the relay 12TR, therefore, on movement of the track relay contacts to their picked-up positions energy is supplied to relay 12FSA and is also supplied from the transformer 12DT to relay 12H, while on movement of the track contacts to their released positions energy is supplied to relay 12BSA.

As relays 12FSA, 12BSA and 12H are picked up, energy of 180 code frequency is supplied to transformer 11TT, while as relay 12H is picked up, its contact 34 establishes the circuit of the yellow lamp Y of signal 12S.

On the supply of coded energy to relay 13TR subsequent to release of relay 13LOS this track relay follows code and during the picked-up periods of its contacts energy is supplied to the relay 13FSA, but during the released periods of the track relay energy is not supplied to relay 13BSA as the circuit of this relay is interrupted by relay 13LOS. Accordingly, relay 13BSA will interrupt the circuit of relay 13H and this relay will maintain the circuit of the red lamp of signal 13S.

From the foregoing it will be seen that when an insulated joint separating two sections breaks down as a result of passage of a train, this system operates to supply steady energy to the section in the rear to test the joints, but after a short period the supply of steady energy is cut off and coded energy is again supplied, and this coded energy causes the display of a yellow or caution indication by the signal for the section in the rear of the defective joints, or by the cab signal apparatus on a locomotive present in that section.

Operation of equipment if an insulated joint breaks down when the track stretch is vacant

For purposes of illustration it will be assumed that one of the joints separating sections 11T and 12T breaks down at a time when the track stretch is vacant. As the stretch is assumed to be vacant, energy of 180 code frequency is supplied to transformer 12TT, while the auxiliary relays associated with track relay 12TR are all picked up so that signal 12S displays its green or clear indication and energy of 180 code frequency is supplied to the transformer 11TT.

If at the time the insulated joint separating

sections 11T and 12T breaks down the impulses of energy supplied to section 11T are out of step with those supplied to section 12T, the impulses of energy supplied to section 11T and feeding over the defective insulated joint to track relay 12TR will fill in the "off" periods in the code supplied to section 12T so that the track relay 12TR will be maintained picked up all, or substantially all, of the time.

If at the time the insulated joint becomes defective the impulses of code supplied to the two sections are substantially in step with each other, they will soon become out of step. This will be true because the code transmitters which create the code for the two sections are driven by electric motors of the squirrel cage induction type, and these motors will not operate at exactly the same speed for any substantial period of time. Accordingly, if track relay 12TR is not held picked up an abnormally large proportion of the time immediately upon breaking down of the joint, the track relay will soon be held up an abnormally large proportion of the time because of the increase in the time during which energy is supplied to the track relay when the two codes get out of step.

In consequence of the lengthened picked-up periods of track relay 12TR contact 16 will not engage its back contact, or will engage it for such short time intervals that energization of relay 12BSA is reduced below the value effective to maintain the relay picked up. As the track relay is maintained picked up most of the time, energy is supplied to the relay 12FSA to maintain it picked up.

On release of relay 12BSA its contact 31 interrupts the circuit for supplying energy of 180 code frequency to the transformer 11TT and establishes the circuit including front contact 37 of relay 12LOS, back contact 31 of relay 12BSA, and front contact 32 of relay 12FSA for supplying steady energy to transformer 11TT. In addition, on release of relay 12BSA its contact 29 interrupts the circuit of relay 12LOS and the release period of this relay begins.

Furthermore, on release of relay 12BSA its contact 26 interrupts the circuit of relay 12H so that it releases and causes signal 12S to display its red indication.

The steady energy supplied to transformer 11TT feeds across the defective joint to relay 12TR so that this relay is maintained constantly picked up to thereby maintain the circuit of relay 12FSA and to prevent the supply of energy to relay 12BSA. After a short time interval relay 12LOS releases and interrupts the circuit of relay 12BSA, while it also cuts off the supply of steady energy to section 11T and causes energy of 75 code frequency to be supplied thereto. This energy feeds across the defective joint to relay 12TR and combines with the energy of 180 code frequency supplied from transformer 12TT so that track relay 12TR is maintained picked up most of the time and energy, therefore, is supplied to relay 12FSA to keep it picked up and thus keep relay 12LOS released. Even if the contacts of the track relay release at times, energy will not be supplied to relay 12BSA as the circuit of this relay is interrupted by contact 17 of relay 12LOS. Relay 12BSA, therefore, will remain released and will prevent energization of relay 12H so that the signal 12S will continue to display its red indication.

On release of relay 12BSA and the supply of steady energy to section 11T the track relay for

this section is held picked up, but as explained above, the relay 11LOS associated therewith does not start to release until after relay 11BSA releases, while the release time of relay 11BSA does not start until after relay 12BSA releases and initiates the supply of steady energy to section 11T, and the relay 11LOS is certain to remain picked up until after relay 12LOS releases and causes coded energy to again be supplied to section 11T. This coded energy of 75 code frequency will cause the signal for section 11T to display its yellow or caution indication.

Restoring equipment to normal operation after a defective joint has been detected

The system of this invention is arranged so that after the equipment for a section detects the presence of a defective joint, the equipment cannot be restored to normal operation until the defective joint is repaired and the circuit of the relay FSA is interrupted by means provided for this purpose.

As previously explained, after a defective joint has been detected, relay FSA is energized while relays BSA and LOS are deenergized. As relay LOS in deenergized, it interrupts the circuit of relay BSA, and as relay BSA is deenergized and FSA is energized, the circuit of LOS is interrupted. Accordingly, as long as the track relay follows coded energy, relay FSA will be maintained picked up while relays BSA and LOS will remain released. This will be true even after the defective joint is repaired so that the track relay is no longer supplied with energy feeding across the defective joint.

In order to restore the equipment to normal operation the signal maintainer or other authorized person depresses the push button PB and thus interrupts the circuit of relay FSA so that it releases and its contact 28 establishes the circuit of relay LOS. Relay LOS thereupon picks up and establishes the circuit of relay BSA. After the push button is released and restores the circuit of FSA, this relay picks up on the first movement of the track relay contacts to their picked-up position, while the equipment thereafter functions in the normal manner.

Modifications shown in Figs. 2 and 3

In the system shown in Fig. 1 after a defective joint has been detected, the relay FSA is energized by current supplied thereto when the track relay contacts are picked up. As long as the joint is defective and the section in advance of the joint is vacant, the track relay is supplied with energy from two sources, one of these sources being the track transformer for the section with which the track relay is associated, and the other source being the energy supplied over the defective joint. Accordingly, under normal conditions the track relay will be energized most of the time so that relay FSA will be energized most of the time, and the intervals during which the track relay contacts are released and interrupt the circuit of relay FSA are infrequent and are much shorter than the release time of relay FSA. This relay FSA, therefore, will remain picked up and interrupt the circuit of relay LOS.

However, where the alternating current for two adjoining track sections is supplied from two different sources, the frequency of this energy may be slightly different and the phase relationship of the two sources of energy may be such that the half cycle impulses of alternating

current from the different sources substantially neutralize each other.

Under these conditions the track relay will release, but unless the track relay remains released for a substantial period, the system of Fig. 1 operates to prevent the display of a proceed indication by the signal for the section in advance of the defective joint, or a change in the energy supplied to the section in the rear of the defective joint.

Under some conditions the track relay may remain released longer than the release period of relay FSA, and if this occurs relay FSA will release and establish the circuit of relay LOS. On the next movement of the track relay contacts to their pick-up positions relay FSA will pick up and cause steady energy to be supplied to the section in the rear to keep the track relay picked up until LOS releases and interrupts the circuit of BSA.

If the frequency relationship of the two sources is at a critical value, the periods in which the two sources neutralize or offset each other, and the periods in which they supplement each other, may occur at intervals such that the "lockout" condition will be interrupted after it has been established, and the modification shown in Fig. 2 is arranged to eliminate this possibility.

Referring to Fig. 2, it will be seen that in this modification when the relay LOS releases, its contact 40 establishes a circuit to energize the relay FSA so that thereafter this relay is energized independently of the track relay contact, and the relay will remain energized regardless of whether or not the track relay remains picked up. As the relay FSA is maintained energized, it will interrupt the circuit of relay LOS so that relay LOS interrupts the circuit of relay BSA. It will be seen, therefore, that the modification shown in Fig. 2 operates to prevent interruption of the "lockout" condition once it has been established.

If desired, the circuit governed by contact 40 of relay LOS for supplying energy to relay FSA may include a front contact 41 of relay FSA to thereby prevent picking up of relay FSA in the event of release of LOS at a time when FSA is released.

The modification shown in Fig. 2 is otherwise the same as that shown in Fig. 1 and a detailed description thereof is unnecessary.

In Fig. 3 of the drawing there is shown another means which I may employ to maintain the relay FSA energized after release of relay LOS to thereby prevent interruption of the "lockout" condition after it has been established. In this modification contact 17 of relay LOS when released establishes a circuit over which energy is supplied to the relay FSA when the track relay TR is released. Accordingly, after release of relay LOS the relay FSA is energized directly over track relay contact 16 during the picked-up periods of the track relay, while during the released periods of the track relay contacts relay FSA is energized over the circuit established by contact 17 of relay LOS. The relay FSA, therefore, will remain picked up at all times and will maintain the "lockout" condition.

A front contact of the relay FSA may be included in the circuit controlled by contact 17 of relay LOS for supplying energy to relay FSA to prevent energization of relay FSA on release of relay LOS when the contacts of relay FSA are released.

The modifications shown in Figs. 2 and 3 in-

clude the push button PB to effect release of the contacts of relay FSA after release of the contacts of relay LOS to thereby restore the equipment to its normal condition.

Although I have illustrated and described only one form of railway signaling system embodying my invention, together with two modifications thereof which I may employ, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow releasing control relay, a circuit including a back contact of said first auxiliary relay for supplying energy to said control relay, a circuit including a front contact of said second auxiliary relay for also supplying energy to the said control relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of said first auxiliary relay and of said control relay for supplying energy to the second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of the rearward section, a circuit including front contacts of said first auxiliary relay and of said control relay and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, and a circuit including front contacts of said first and second auxiliary relays for supplying coded energy to the rails of said rearward section.

2. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow releasing control relay, a circuit including a back contact of said first auxiliary relay for supplying energy to said control relay, a circuit including a front contact of said second auxiliary relay for also supplying energy to said control relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of said first auxiliary relay and of said control relay for supplying energy to the second auxiliary relay, a circuit including a back contact of one of the auxiliary relays for supplying coded energy to the rails of the rearward section, a circuit including front contacts of said first auxiliary relay and said control relay and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, a circuit including front contacts of said first and second auxiliary relays for supplying coded energy to the rails of said rearward section,

and manually controlled means for interrupting the circuit of the first auxiliary relay.

3. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first, a second and a third auxiliary relay, a circuit including a back contact of the first auxiliary relay for supplying energy to the third auxiliary relay, a circuit including a front contact of the second auxiliary relay for also supplying energy to the third auxiliary relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of the first and third auxiliary relays for supplying energy to the second auxiliary relay, a circuit including back contacts of the first and second auxiliary relays and a front contact of the third auxiliary relay for supplying coded energy to the rails of the rearward section, a circuit including front contacts of the first and third auxiliary relays and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, a circuit including front contacts of said first and second auxiliary relays for supplying coded energy to the rails of said rearward section, a circuit including a back contact of said third auxiliary relay for also supplying coded energy to the rails of said rearward section, and manually operable means for governing the circuit of one of said auxiliary relays.

4. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow releasing control relay, a circuit including a back contact of the said first auxiliary relay for supplying energy to said control relay, a circuit including a front contact of the second auxiliary relay for also supplying energy to said control relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of the first auxiliary relay and of said control relay for supplying energy to the second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy of a first code frequency to the rails of said rearward section, a circuit including front contacts of the first auxiliary relay and of said control relay and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, and a circuit including front contacts of the first and second auxiliary relays for supplying coded energy of a second code frequency to the rails of said rearward section.

5. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said for-

ward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow releasing control relay, a circuit including a back contact of the first auxiliary relay for supplying energy to said control relay, a circuit including a front contact of the second auxiliary relay for also supplying energy to said control relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of the first auxiliary relay and of said control relay for supplying energy to the second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of the rearward section, a circuit including front contacts of the first auxiliary relay and of said control relay and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, a circuit including front contacts of said first and second auxiliary relays for supplying coded energy to the rails of said rearward section, a signal governing traffic in said forward section, and means responsive to continued code following operation of the track relay subsequent to picking up of the contacts of the second auxiliary relay for controlling said signal.

6. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first, a second and a third auxiliary relay, a circuit including a back contact of the first auxiliary relay for supplying energy to the third auxiliary relay, a circuit including a front contact of the second auxiliary relay for also supplying energy to the third auxiliary relay, a circuit including a front contact of the track relay for supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay and front contacts of the first and third auxiliary relays for supplying energy to the second auxiliary relay, a circuit including back contacts of the first and second auxiliary relays and a front contact of the third auxiliary relay for supplying coded energy of a first code frequency to the rails of said rearward section, a circuit including front contacts of the first and third auxiliary relays and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, a circuit including a back contact of said third auxiliary relay for supplying coded energy of said first code frequency to the rails of said rearward section, a fourth auxiliary relay, means responsive to continued code following operation of the track relay subsequent to picking up of the contacts of said second auxiliary relay for energizing said fourth auxiliary relay, a signal for said forward section controlled by said fourth auxiliary relay, and a circuit including a front contact of said fourth auxiliary relay for supplying coded energy of a second code frequency to the rails of said rearward section.

7. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints

into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay are picked up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay, and a contact of said control relay which is closed when the contacts of said relay are in their first position over which steady energy may be supplied to the rails of said rearward section, and means responsive to continued code following operation of the track relay subsequent to picking up of the contacts of said first auxiliary relay for also supplying coded energy to the rails of said rearward section.

8. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay are picked up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay, and a contact of said control relay which is closed when the contacts of said relay are in their first position over which steady energy may be supplied to the

rails of said rearward section, and means effective when the contacts of said control relay are in their second position to supply coded energy to the rails of said rearward section.

9. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay are picked up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including back contacts of said first and second auxiliary relays and a contact of said control relay closed when the contacts of said control relay are in their first position for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position over which steady energy may be supplied to the rails of said rearward section, a circuit including a contact of said control relay closed when the contacts of said relay are in their second position for supplying coded energy to the rails of said rearward section, and means responsive to continued code following operation of said track relay subsequent to picking up of the contacts of said first auxiliary relay for also supplying coded energy to the rails of said rearward section.

10. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay are picked up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of

the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including a back contact of the second auxiliary relay for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay and a contact of said control relay which is closed when the contacts of said relay are in their first position over which steady energy may be supplied to the rails of said rearward section, and means responsive to continued code following operation of said track relay subsequent to picking up of the contacts of said first auxiliary relay for also supplying coded energy to the rails of said rearward section.

11. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay are picked up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a contact of said control relay which is closed when the contacts of said control relay are in their second position for also supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay, and a contact of said control relay which is closed when the contacts of said relay are in their first position over which steady energy may be supplied to the rails of said rearward section, and means responsive to continued code following operation of the track relay subsequent to picking up of the contacts of said first auxiliary relay for also supplying coded energy to the rails of said rearward section.

12. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means

for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a first and a second auxiliary relay, a slow acting control relay having contacts movable between a first and a second position, the circuit of said control relay being governed by said auxiliary relays in such manner that when the contacts of both of said relays are released the contacts of said control relay occupy their first position and so that when the contacts of the first relay pick up while the contacts of the second auxiliary relay are released the contacts of said control relay move to their second position after a time interval, a circuit including a front contact of the track relay for supplying energy to the winding of the first auxiliary relay, a circuit including a contact of said control relay which is closed when the contacts of said control relay are in their second position for also supplying energy to the first auxiliary relay, a circuit including a back contact of the track relay, a front contact of the first auxiliary relay and a contact of said control relay closed when the contacts of said relay are in their first position for supplying energy to the winding of said second auxiliary relay, a circuit including a back contact of one of said auxiliary relays for supplying coded energy to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay, a back contact of the second auxiliary relay, a contact of said control relay which is closed when the contacts of said relay are in their first position over which steady energy may be supplied to the rails of said rearward section, means responsive to continued code following operation of the track relay subsequent to picking up of the contacts of said first auxiliary relay for also supplying coded energy to the rails of said rearward section, and manually operable means for interrupting the circuit of said first auxiliary relay.

13. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, means for supplying coded energy to the rails of said forward section, a code following track relay having a winding receiving energy over the rails of said forward section, a circuit including a front contact of the track relay for supplying energy to a first auxiliary relay, a circuit including a back contact of the track relay and a front contact of said first auxiliary relay for supplying energy to a second auxiliary relay, a circuit including a back contact of one of said

auxiliary relays for supplying coded energy of a first code frequency to the rails of said rearward section, a circuit including a front contact of the first auxiliary relay and a back contact of the second auxiliary relay over which steady energy may be supplied to the rails of said rearward section, means responsive to continued code following operation of the track relay subsequent to picking up of the second auxiliary relay for supplying energy of a second code frequency to the rails of said rearward section, and a control relay governed by contacts of the first and second auxiliary relays in such manner that when the contacts of the auxiliary relays are out of correspondence the contacts of the control relay move to a position in which a contact of the control relay interrupts the circuit over which steady energy may be supplied to the rails of said rearward section and in which the control relay governs the supply of energy to the control relay to maintain the contacts of the relay in such position.

14. In a coded railway signaling system, in combination, a stretch of railway track having a pair of track rails divided by insulated joints into a plurality of successive track sections including a forward and a rearward section, a code following track relay having a winding receiving energy over the rails of said forward section, a circuit over which coded energy of a first code frequency is supplied to the rails of said rearward section when said track relay is not responding to coded energy, means effective on initial picking up of the track relay contacts following a period in which the track relay has not been responding to coded energy to establish a circuit over which steady energy may be supplied to the rails of said rearward section, means responsive to continued code following operation of the track relay subsequent to initial picking up of the track relay contacts to interrupt the circuit over which steady energy may be supplied to the rails of said rearward section and to establish a circuit to supply coded energy of a second code frequency to the rails of said rearward section, a control relay effective when released to interrupt said circuit over which steady energy may be supplied to the rails of said rearward section, and to prevent the supply of coded energy of said second code frequency to the rails of said rearward section, and means effective when said track relay is steadily released or is responding to coded energy for supplying energy to the winding of said control relay provided the contacts of said control relay are picked up.

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