

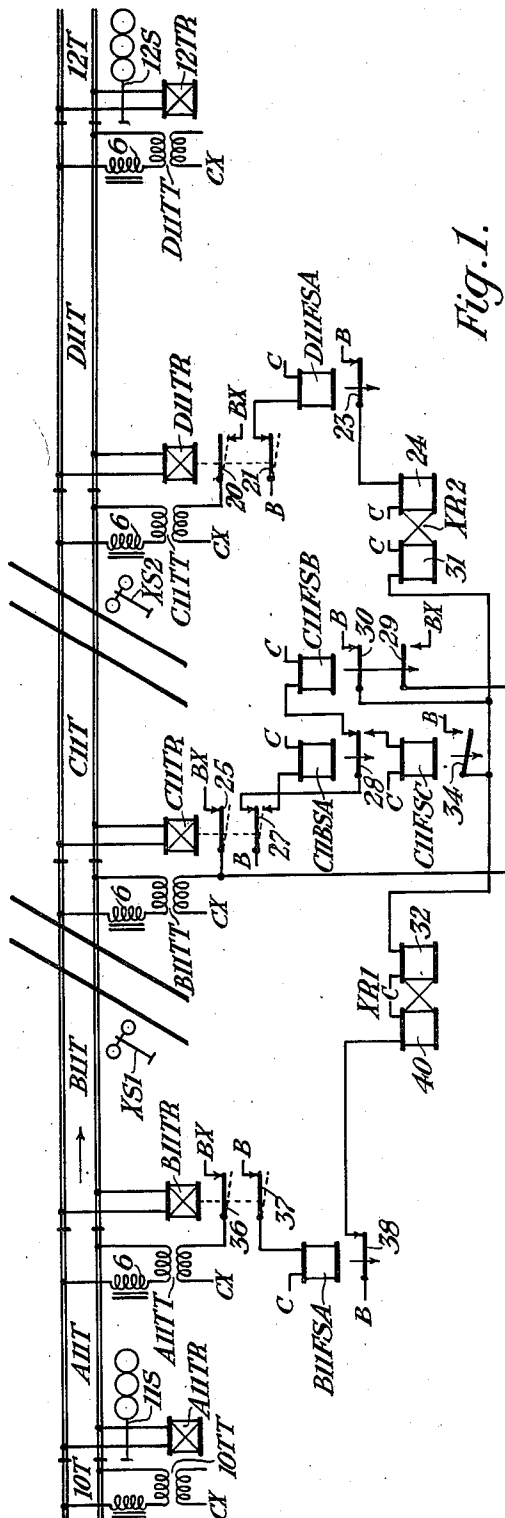
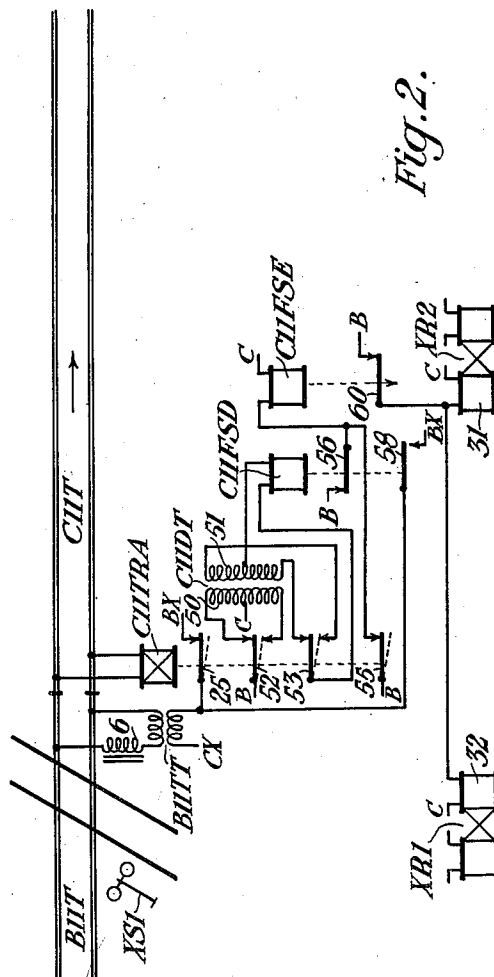
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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed March 12, 1940



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RAILWAY TRAFFIC CONTROLLING
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My invention relates to railway traffic controlling apparatus and particularly to means for controlling operation of highway crossing signals and adapted for use in connection with railway signaling systems employing coded or periodically interrupted current in the track circuits thereof.

It is an object of this invention to provide means of the type described and in which steady energy is supplied to the track circuits to discontinue operation of highway crossing signals without conditioning the signals governing movement of trains in the track stretch to display a proceed indication.

A further object of the invention is to provide a system of the type described and employing a minimum of apparatus.

Another object of the invention is to provide apparatus of the type described and arranged in such manner that track relays in addition to those employed in the control of the signals governing movement of trains through the track stretch are not required.

Another object of my invention is to provide apparatus of the type described and adapted for use where more than one highway crossing is present within one track section, the equipment being arranged so that the proper operation of the signals at the highway intersections and of the signals governing movement of trains in the track stretch will take place regardless of the direction of movement of a train through the track stretch.

A further object of the invention is to provide an improved signaling system.

I shall describe one form of system embodying my invention together with a modification thereof and shall then point out the novel features in claims.

In the drawing

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

Fig. 2 is a fragmentary view showing a modified form of apparatus embodying my invention.

Referring to Fig. 1 of the drawing there is shown therein a stretch of railway track having a pair of track rails 1 and 2 over which traffic normally moves in the direction indicated by the arrow, that is, from left to right. The track stretch is divided into successive track sections for signaling purposes. One complete section, identified as section 11T, and parts of two other sections, identified as sections 10T and 12T, are shown. The section 11T includes intersections with two highways and at each of these intersections a crossing signal is provided to warn users of the highway of the approach of a train. The crossing signals are designated XS1 and XS2, while for the purpose of controlling the

crossing signals the track section 11T is subdivided into four subsections which are designated A11T, B11T, C11T and D11T.

Each of the principal track sections has at the entrance end thereof a wayside signal S which is capable of displaying a stop, a caution and a clear indication. Each section also has at the entrance end thereof a code following track relay TR which controls the signal for the associated track section, and also controls the supply of energy to the rails of the adjacent track section in the rear. Each of the subsections of section 11T is also provided with a code following track relay. As shown the track relays are of the alternating current type, each having a winding having its terminals connected to the track rails of the associated track section.

Each of the track sections has at the exit end thereof a track transformer TT. Each of these transformers has a secondary winding one terminal of which is connected to one track rail and the other terminal of which is connected to the other track rail of the associated track section through a current limiting reactor 6.

The primary windings of the track transformers are supplied with alternating current from a suitable source the terminals of which are designated BX and CX. The circuits of the primary windings of the track transformers are controlled by the track relays of the adjacent sections or subsections in advance.

The details of the control of the wayside signals and of the circuits of the track transformer primary windings are not a part of this invention, except as hereinafter explained in detail. Any appropriate form of coded signaling apparatus may be employed, and one form of system which may be used is shown in the application of F. H. Nicholson and L. R. Allison, Serial No. 210,744, filed May 28, 1938, for Railway traffic controlling apparatus.

Since the construction and operation of the signaling system is old and well-known, the details of the signaling system have not been shown in order to simplify the disclosure.

The highway crossing signals XS1 and XS2 are controlled by interlocking relays XR1 and XR2, respectively. The interlocking relays are of the type well-known in the art, and since the construction and operation of these relays, and of the circuits by which the relays control the crossing signals are well-known, the details of the relays and of the control circuits have not been shown in order to simplify the disclosure.

The track relays 12TR and A11TR have associated therewith suitable decoding apparatus, not shown, while the track relays B11TR and D11TR have associated therewith auxiliary relays FSA which have a slow releasing characteristic such that the relay contacts when picked up remain

picked up during the intervals between the picked-up periods of the contacts of the associated track relay.

The track relay C11TR has associated therewith slow releasing auxiliary relays C11BSA, C11FSA and C11FSC, which cooperate as hereinafter explained to control the circuits of windings of the interlocking relays XR1 and XR2.

Each of the track relays has associated therewith a local source of direct current the terminals of which are designated B and C in the drawing.

When the track stretch is vacant, energy of the 180 code frequency is supplied to the track relay 12TR and the equipment, not shown, associated with this relay operates to condition the signal 12S to display its clear indication, while energy of the 180 code frequency is supplied to the primary winding of the track transformer D11TT, and by this transformer to the rails of section D11T. This energy feeds to the winding of the track relay D11TR and produces code following operation of the track relay contacts. During the released periods of the contacts of the track relay D11TR, contact 20 establishes the circuit of the primary winding of track transformer C11TT, while this circuit is interrupted during the picked-up periods of the track relay contacts. Accordingly energy of the same code frequency is supplied to the rails of section C11T as is supplied to the track relay D11TR. However, the impulses of energy supplied to the rails of section C11T occur during the "off" intervals in the code supplied to the rails of section D11T. This "back-contact coding" at the cut section aids in preventing code distortion.

During the picked-up periods of the contacts of the track relay D11TR contact 21 establishes a circuit to supply energy from the local source of direct current to the winding of the relay D11FSA. This circuit is interrupted during the released periods of the track relay contacts, but the contacts of the relay D11FSA are slow enough in releasing to remain picked up during the intervals between the supply of impulses of energy to the relay winding. Accordingly as long as the contacts of the relay D11TR are responding to coded energy, the contact 23 of relay D11FSA is picked up and establishes the circuit of the winding 24 of interlocking relay XR2, while when the track relay D11TR is not responding to coded energy contact 21 interrupts the circuit of the winding of the relay D11FSA and contact 23 of relay D11FSA becomes released to interrupt the circuit of the winding 24 of relay XR2.

The energy of 180 code frequency supplied by the track transformer C11TT to the rails of section C11T feeds to the winding of the track relay C11TR and effects code following operation of the contacts of this relay. During the picked-up periods of the track relay contacts, contact 25 establishes the circuit of the primary winding of the track transformer B11TT. This circuit is interrupted during the released periods of the track relay contacts so that impulses of energy of the same code frequency are supplied to the rails of section B11T as are supplied to the track relay C11TR.

During the released periods of the contacts of the track relay C11TR contact 27 establishes the circuit of the winding of relay C11BSA. During the picked-up periods of the track relay contacts, contact 27 establishes the circuit of the winding of relay C11FSB if contact 28 of relay C11BSA is

picked up, while if contact 28 of relay C11BSA is released, contact 27 when picked up establishes the circuit of the winding of relay C11FSC.

The circuit of the winding of the relay C11BSA is interrupted during the picked-up periods of the track relay contacts, while the circuit of the winding of the relay C11FSB is interrupted during the released periods of the track relay contacts. The contacts of the relays C11BSA and C11FSB are slow enough in releasing, however, to remain picked up during the intervals between the supply of impulses of energy to their windings when the track relay C11TR is responding to coded energy.

The relay C11FSB has a contact 30, which when picked up establishes circuits to supply energy to the winding 31 of interlocking relay XR2 and to the winding 32 of interlocking relay XR1. Similarly the relay C11FSC has a contact 34 which when picked up establishes circuits to supply energy to these windings of the relays XR1 and XR2.

When the track section is vacant the track relay C11TR is supplied with coded energy so that relay C11FSB establishes the circuits of the windings 31 and 32 of the interlocking relays XR2 and XR1, while relay D11FSA establishes the circuit of the winding 24 of relay XR2. As both windings of the relay XR2 are energized, this relay operates in the usual manner to maintain the crossing signal XS2 inactive.

The energy supplied by the track transformer B11TT to the rails of section B11T feeds to the track relay B11TR and produces code following operation of the contacts of the relay. During the picked-up periods of the relay contacts, contact 36 establishes the circuit of the primary winding of the track transformer A11TT so that impulses of energy of the same code frequency are supplied to the rails of section A11T as are supplied to the relay B11TR.

In addition, during the picked-up periods of the contacts of the track relay B11TR, contact 37 establishes the circuit of the winding of relay B11FSA. This circuit is interrupted during the released periods of the track relay contacts, but the contact of relay B11FSA is slow enough in releasing to remain picked up during the intervals between the supply of impulses of energy to the relay winding.

The relay B11FSA has a contact 38 which when picked up establishes a circuit to energize the winding 46 of relay XR1. Accordingly when the track stretch is vacant the windings 40 and 32 of interlocking relay XR1 are both energized and this relay operates in the usual manner to maintain the crossing signal XS1 inactive.

The coded energy supplied to the rails of section A11T feeds to the track relay A11TR and produces code following operation of the contacts of the relay, while the decoding equipment, not shown, associated with the relay A11TR conditions the signal 11S to display its clear indication and energy of the 180 code frequency is supplied to the rails of section 10T.

Operation of equipment on passage of a train in normal direction of traffic

When a train moving in the normal direction of traffic, that is, from left to right, enters section A11T, the track relay A11TR is shunted and its contacts cease to follow code with the result that the decoding equipment, not shown, associated with the relay conditions the signal 11S to display its stop indication, while the energy

supplied to the rails of section 10T is changed from 180 code frequency to a different frequency, such as 75 code frequency.

When the train advances far enough to enter section B11T the track relay B11TR is shunted and its contact 36 interrupts the supply of energy to the transformer A11TT, while contact 37 interrupts the circuit of the winding of relay B11FSA. Accordingly contact 38 of relay B11FSA becomes released and interrupts the circuit of the winding 40 of interlocking relay XR1 so that the armature controlled by this winding becomes released and initiates operation of the crossing signal XS1 to warn users of the highway of the approach of a train.

When the train advances far enough to enter section C11T the contacts of the track relay C11TR become released and contact 25 interrupts the supply of energy to the track transformer B11TT, while contact 27 no longer periodically engages its front contact to supply energy to the winding of relay C11FSB. Accordingly, the contacts of relay C11FSB become released and contact 30 interrupts the circuits of the winding 32 of relay XR1 and of winding 31 of relay XR2, while contact 29 establishes a circuit to supply steady uncoded energy to the track transformer B11TT.

On interruption of the supply of energy to the winding 32 of relay XR1 the armature controlled by this winding is prevented from moving to its released position because the other armature of the relay has previously become released.

On interruption of the circuit of the winding 31 of interlocking relay XR2, the armature controlled by this winding becomes released and initiates operation of the crossing signal XS2 to warn users of the highway of the approach of a train.

On the supply of steady energy to the track transformer B11TT over the circuit established on release of contact 29 of relay C11FSB, steady energy is supplied to the rails of section B11T, but as long as any portion of the train remains in section B11T the track relay B11TR continues to be shunted. However, when the rear of the train vacates section B11T the steady energy supplied to the rails of the section feeds to the track relay B11TR and causes its contacts to pick up and remain picked up.

When contact 36 of track relay B11TR is picked up steady energy is supplied to the transformer A11TT, and by it to the rails of section A11T so that the contacts of the track relay A11TR become picked up. The signal 11S, however, continues to display its stop indication as long as steady energy is supplied to the track relay A11TR.

On picking up of contact 37 of the track relay B11TR the circuit for supplying energy to the winding of the relay B11FSA is established and contact 38 of this relay becomes picked up to establish the circuit of the winding 40 of relay XR1. The armature which is controlled by this winding thereupon becomes picked up to discontinue operation of the crossing signal XS1. This is proper since the train will have passed beyond the intersection which is protected by the crossing signal XS1.

On picking up of the armature controlled by the winding 40, because of the internal construction of the interlocking relay, the armature controlled by the winding 32 is prevented from moving to its released position even though the winding 32 is deenergized. Accordingly on picking

up of the armature controlled by the winding 40 operation of the crossing signal XS1 is discontinued.

As the train proceeds through the track stretch and enters section D11T the track relay D11TR is shunted and its contacts become released. On release of contact 20 of the track relay D11TR a circuit is established to supply steady uncoded energy to the transformer C11TT so that steady energy is supplied to the rails of section C11T, but as long as any portion of the train remains in section C11T the track relay C11TR continues to be shunted.

On release of contact 21 of the relay D11TR the circuit for supplying energy to the winding of the relay D11FSA is interrupted and its contact 23 becomes released to interrupt the circuit of the winding 24 of relay XR2. On deenergization of the winding 24 the armature controlled by this winding moves towards its released position, but, because of the internal construction of the interlocking relay, this armature is prevented from moving all of the way to its released position.

When the train advances far enough to vacate section C11T the steady energy supplied to the rails of section C11T feeds to the track relay C11TR and causes the contacts of this relay to become picked up and to thereafter remain picked up.

On picking up of contact 25 of the relay C11TR a circuit is established to supply steady energy to the transformer B11TT. However, at this time steady energy is already being supplied to the transformer B11TT over the circuit established by contact 29 of relay C11FSB.

On picking up of contact 27 of relay C11TR the circuit of the winding of relay C11BSA is interrupted and after a short time interval the contact 28 of this relay becomes released. In the time interval between picking up of contact 27 of the track relay C11TR and release of contact 28 of relay C11BSA a circuit is established to supply energy to the winding of relay C11FSB and the contacts of this relay become picked up.

On picking up of the contacts of relay C11FSB contact 29 interrupts the circuit which it controls for supplying energy to the transformer B11TT, but at this time energy is supplied to the transformer over the circuit established by contact 25 of the track relay C11TR so that the supply of energy to the transformer is not interrupted.

In addition on picking up of the contacts of relay C11FSB contact 30 establishes a circuit to supply energy to the winding 31 of interlocking relay XR2 and to winding 32 of interlocking relay XR1. As a result the armature controlled by winding 32 of relay XR1 becomes picked up and this relay is restored to its normal condition, while the armature controlled by winding 31 of relay XR2 becomes picked up and discontinues operation of the crossing signal XS2.

On release of contact 28 of relay C11BSA while contact 27 of track relay C11TR is picked up the circuit for supplying energy to the winding of the relay C11FSB is interrupted, while the circuit for supplying energy to the winding of the relay C11FSC is established and contact 34 of this relay becomes picked up and establishes circuits for supplying energy to the winding 32 of interlocking relay XR1, and to the winding 31 of interlocking relay XR2.

Because of the slow releasing characteristic of the contacts of relay C11FSB the contacts of this relay remain picked up for a time interval sub-

sequent to interruption of the supply of energy to the relay winding by release of contact 28 of relay C11BSA. The relays C11FSB and C11FSC are selected so that on release of contact 28 of relay C11BSA with resultant interruption of the supply of energy to the winding of relay C11FSB and establishment of the circuit to supply energy to the winding of relay C11FSC, the contacts of relay C11FSB will remain picked up until after the contacts of relay C11FSC become picked up. Accordingly at this time the supply of energy to the windings 31 and 32 of the interlocking relays XR2 and XR1 is maintained and there is no possibility that the armatures controlled by these windings will become momentarily released after they have once become picked up.

When the train advances far enough in the track stretch to enter the section 12T the track relay 12TR is shunted and the decoding equipment, not shown, associated therewith operates to condition the signal 12S to display its stop indication and to change the energy supplied to the track transformer D11TT from 180 to 75 code frequency. As long as any portion of the train remains in section D11T the track relay D11TR continues to be shunted, but when the rear of the train vacates section D11T energy of the 75 code frequency supplied to the track rails of this section by the transformer D11TT feeds to the track relay D11TR and produces code following operation of the relay contacts.

During the picked-up periods of the contact 21 energy is supplied to the winding of relay D11FSA and contact 23 of this relay becomes picked up and energy is supplied to the winding 24 of interlocking relay XR2 so that the armature controlled by this winding becomes picked up and the interlocking relay is restored to its normal condition.

As a result of code following operation of the track relay D11TR coded or periodically interrupted energy of the 75 code frequency is supplied to the transformer C11TT, and by it to the rails of section C11T from which it feeds to the track relay C11TR.

On movement of contact 27 of relay C11TR to its released position energy is supplied to the winding of the relay C11BSA and contact 28 of this relay becomes picked up to establish the circuit of the winding of relay C11FSB so that on subsequent movements of the track relay contact 27 to its picked-up position energy is supplied to the winding of the relay C11FSB with the result that contacts 29 and 30 of this relay become picked up.

On picking up of contact 28 of relay C11BSA the circuit of the winding of relay C11FSC is interrupted, and after a short time interval contact 34 of this relay becomes released. The contact 34 is slow enough in releasing to remain picked up and maintain the circuits of the windings 31 and 32 of the interlocking relays XR2 and XR1 until after contact 30 of relay C11FSB becomes picked up to establish a circuit to energize these relay windings. Accordingly, the windings of the interlocking relays are maintained energized during the period in which code following operation of the track relay C11TR is initiated and the interlocking relays, therefore, maintain the crossing signals XS1 and XS2 inactive.

On picking up of contact 29 of relay C22FSB the circuit controlled thereby for supplying steady uncoded energy to the track transformer B11TT is interrupted, and as a result of code

following operation of track relay contact 25 coded or periodically interrupted energy of the same frequency, in this instance the 75 code frequency, is supplied to the track transformer B11TT as is supplied to the relay C11TR.

On the supply of coded energy to the transformer B11TT, coded energy is supplied to the rails of section B11T, and therefrom to the track relay B11TR. On the resultant code following operation of the contacts of the track relay B11TR contact 26 interrupts the circuit of the track transformer A11TT so that coded or periodically interrupted energy is supplied to the rails of section A11T. At this time contact 37 of relay B11TR intermittently interrupts the circuit of the winding of the relay B11FSA, but the contact of this relay remains picked up during the intervals between the supply of impulses of energy to the relay winding.

On the supply of coded energy of the 75 code frequency to the track relay A11TR the decoding equipment, not shown, associated with this relay operates to condition the signal 11S to display its caution indication, while the energy supplied to the transformer 10TT is changed from the 75 to the 180 code frequency.

When the train advances far enough in the track stretch to clear section 12T the equipment associated with the section in advance of section 12T operates to supply energy of the 75 code frequency to section 12T, while the decoding equipment, not shown, associated with track relay 12TR operates to condition the signal 12S to display its caution indication and to change the energy supplied to the track transformer D11TT from 75 to 180 code frequency.

On this change in the code supplied to relay D11TR this relay operates to repeat the higher code frequency to section C11T, while the track relays for sections C11T and B11T similarly repeat the supply of energy of the higher code frequency to the sections in the rear so that energy of the 180 code frequency is supplied to the relay A11TR.

On the supply of energy of the 180 code frequency to the relay A11TR the decoding equipment, not shown, associated with the relay operates to condition the signal 11S to display its clear indication.

At this time as the track relays B11TR, C11TR and D11TR are responding to coded energy, the equipment associated with these relays maintains the circuits of the windings of the interlocking relays to thereby condition these relays to maintain the crossing signals inactive.

The operation of the equipment on passage of a train in the normal direction of traffic having been explained, its operation in response to movement of a train in the reverse direction of traffic will now be considered.

Operation of equipment on movement of a train in the reverse direction of traffic

When a train moving in the reverse direction, that is, from right to left, enters section 12T the relay 12TR is shunted and the signal 12S is conditioned to display its stop indication, while the energy supplied to the transformer D11TT is changed from 180 to 75 code frequency. As a result there is a change in the rate of operation of the contacts of the track relay D11TR, and of the track relays for the other subsections so that relay A11TR is supplied with energy of the 75 code frequency and the signal 11S is conditioned to display its caution aspect.

At this time, as the track relays for the various subsections are responding to coded energy, the circuits of the windings of the interlocking relays are maintained and the interlocking relays operate to maintain the crossing signals inactive.

When the train enters section D11T the track relay D11TR is shunted and its contact 20 establishes the circuit to supply steady uncoded energy to the transformer C11TT, while contact 21 interrupts the circuit of the winding of relay D11FSA so that contact 23 becomes released and interrupts the supply of energy to the winding 24 of the interlocking relay XR2. The armature controlled by this winding thereupon becomes released and initiates operation of the crossing signal XS2 to warn users of the highway of the approach of a train.

On the supply of steady energy to the track transformer C11TT subsequent to shunting of the track relay D11TR, steady energy feeds to the track relay C11TR and maintains the contacts of this relay constantly picked up with the result that contact 25 establishes a circuit to supply steady uncoded energy to the transformer B11TT. Accordingly the contacts of track relay B11TR are held in their picked-up position and contact 36 repeats the supply of steady energy to section A11T. The track relay A11TR, therefore, no longer responds to coded energy and the signal 11S is conditioned to display its stop indication, while energy of the 75 code frequency is supplied to section 19T to condition the signal for that section to display its caution indication.

On the supply of steady energy to the track relay C11TR contact 27 of the relay remains picked up and does not engage its back contact to supply energy to the winding of the relay C11BSA with the result that after a brief time interval the contact 28 of relay C11BSA becomes released. Release of contact 28 interrupts the circuit of the winding of relay C11FSB and establishes the circuit for supplying energy to the winding of relay C11FSC so that the contacts of relay C11FSB become released and the contact of relay C11FSC becomes picked up. The contacts of the relay C11FSB are slow enough in releasing to remain picked up until after the contact of relay C11FSC becomes picked up. Accordingly contact 30 of relay C11FSB maintains the circuits of the windings 31 and 32 of interlocking relays XR2 and XR1 until contact 34 of relay C11FSC becomes picked up to establish circuits for supplying energy to these windings. The armature controlled by winding 32 of relay XR1, therefore, remains picked up and maintains the crossing signal XS1 inactive at this time.

Similarly as a result of the supply of steady energy to the track relay B11TR, contact 37 is held picked up and maintains the circuit of the winding of relay B11FSA, while contact 38 of relay C11FSA is held picked up to maintain the circuit of the winding 40 of interlocking relay XR1 so that the armature controlled by this winding is held picked up to maintain the crossing signal XS1 inactive.

It will be seen, therefore, that when a train moving in the reverse direction of traffic enters section D11T, the crossing signal XS2 is placed in operation, while steady energy is supplied to the rails of the subsections C11T, B11T and A11T to maintain the crossing signal XS1 inactive and to condition the signal 11S to display its stop indication.

When the train advances far enough to enter the section C11T the track relay C11TR is shunted and its contacts become released. Release of contact 25 interrupts the circuit which it controls for supplying steady energy to the track transformer B11TT, but at this time contact 29 of relay C11FSB is released, and accordingly the supply of steady energy to the track transformer B11TT is maintained after release of the contacts of the track relay C11TR.

On release of the contact 27 of relay C11TR the circuit for supplying energy to the winding of the relay C11FSC is interrupted, and after a time interval contact 34 of relay C11FSC becomes released to interrupt the circuits of the windings 31 and 32 of interlocking relays XR2 and XR1.

As a result of deenergization of winding 32 of interlocking relay XR1 the crossing signal XS1 starts to operate, while on deenergization of winding 31 of interlocking relay XR2 the armature controlled by this winding moves towards its released position, but is prevented from moving all of the way to this position because the armature controlled by the winding 24 of the relay is already in its released position.

As the train continues and the rear of the train vacates section 12T, the coded energy supplied to the rails of this section feeds to the track relay 12TR and produces code following operation of the relay with the result that signal 12S is conditioned to display a proceed aspect, while energy of the 180 code frequency is supplied to the rails of section D11T. When the rear of the train vacates section D11T the track relay D11TR responds to coded energy and supplies energy of 180 code frequency to the rails of section C11T, while energy is supplied to the winding of relay D11FSA so that contact 23 becomes picked up to supply energy to the winding 24 of the interlocking relay XR2. The armature controlled by winding 24 thereupon becomes picked up to discontinue operation of the crossing signal XS1.

When the train advances into section B11T the track relay B11TR is shunted and its contact 36 remains in its released position so that energy is not supplied to the rails of section A11T and the contacts of the track relay A11TR become released, while the signal 12S continues to display its stop indication.

On release of contact 37 of relay B11TR the circuit of the winding of relay B11FSA is interrupted and contact 38 of the relay becomes released to interrupt the supply of energy to the winding 40 of interlocking relay XR1. The armature controlled by this winding thereupon moves towards its released position, but is prevented from moving all of the way to that position because the armature controlled by winding 32 is already in its released position.

When the rear of the train vacates section C11T, coded energy feeds to the track relay C11TR and produces code following operation of the contacts thereof, and on movement of the contact 27 of the track relay to its picked-up position energy is supplied to the winding of relay C11FSB over the circuit which includes front contact 28 of relay C11BSA. Contact 28 of relay C11BSA is picked up at this time since energy is supplied to the winding of this relay when the track relay contacts are released, while on continued code following operation of the track relay contacts the windings of the relays C11BSA and C11FSB are alternately energized and the contacts of both of these relays are picked up.

On picking up of contact 29 of relay C11FSB the circuit controlled thereby for supplying steady energy to the track transformer B11TT is interrupted, and thereafter coded energy is supplied to the track transformer over the circuit controlled by contact 25 of track relay C11TR.

On picking up of contact 30 of relay C11FSB energy is supplied to the winding 32 of interlocking relay XR1 to pick up the armature controlled by this winding, and thereby cut off operation of the crossing signal XS1. Energy is also supplied to the winding 31 of relay XR2 and the armature controlled by this winding becomes picked up to restore the relay XR2 to its normal condition.

As the train continues and enters the section A11T the track relay A11TR is shunted and its contacts remain released even after the rear of the train vacates section B11T so that coded energy is supplied to the rails of section A11T. Accordingly the signal 11S continues to display its stop indication.

When the rear of the train vacates section B11T the track relay B11TR responds to coded energy and contact 36 establishes the circuit to supply impulses of energy to the track transformer A11TT, while contact 37 establishes the circuit to supply impulses of energy to the winding of relay B11FSA. On picking up of the contact 38 of relay C11FSA energy is supplied to the winding 40 of relay XR1 and the armature controlled by this winding becomes picked up to restore the relay to its normal condition.

When the train advances far enough to vacate section A11T coded energy feeds to the track relay A11TR and the signal 11S is conditioned to display its clear indication.

It will be seen, therefore, that the system provided by this invention is arranged to insure proper operation of both the highway crossing signals and the railway traffic controlling signals on movement of a train through the track stretch in either direction.

This system is also arranged so that if the equipment does not function in the intended manner a dangerous condition will not be created.

The code following track relays B11TR and C11TR are arranged so that their contacts when picked up establish circuits to supply energy to the rails of the adjacent section in the rear, while a contact of each of these relays is operative when picked up to establish a circuit to supply energy to a relay which supplies energy to a winding of an interlocking relay.

If a code following track relay is equipped with metal to metal contacts there is a possibility that these contacts may fuse together and remain in their picked-up position when the relay winding is not energized. If this occurs a crossing signal will not operate on the approach of a train.

If, for example, the contacts of the relay B11TR fuse together and remain picked up steady energy will be supplied to the rails of section A11T, while energy will also be supplied to the winding of relay B11FSA. The supply of energy to the relay B11FSA will be continued even if a train moving in the normal direction of traffic enters section B11T and shunts the track relay B11TR since it is assumed that the relay contacts are fused together and do not become disengaged on shunting of the track relay. Accordingly contact 37 will maintain the circuit to supply energy to the winding of relay B11FSA, while contact 38 of relay B11FSA maintains the supply of energy to the winding 40 of interlocking

relay XR1. The relay XR1, therefore, maintains the crossing signal XS1 inactive.

However, when the contacts of the relay B11TR are held in their picked-up position, steady energy is supplied to the track relay A11TR and the equipment associated with this relay conditions the signal 11S to display its stop indication, while the energy supplied to the rails of section 10T is such as to condition the signal for that section to display a restrictive proceed indication. Accordingly, if under these conditions a train passes through the track stretch it will be compelled to stop or greatly reduce its speed before passing signal 11S, and, therefore, will be traveling at a slow speed when it enters section B11T and approaches the intersection when the crossing signal is not operating. As the train is traveling at a slow speed it does not present a great hazard to users of the highway even though the crossing signal is not operating, while the engineer of the train has ample time to blow the locomotive whistle and warn users of the highway.

Similarly, if the contacts of relay C11TR fuse together steady energy will be supplied to the rails of section B11T, while energy will be supplied to the winding of relay C11FSC so that its contact 34 is picked up and establishes the circuit to supply energy to the winding 31 of interlocking relay XR2.

As a result of the supply of steady energy to the rails of section B11T, the track relay B11TR supplies steady energy to section A11T and the signal 11S is conditioned to display its stop indication.

On movement of a train through the track stretch, the relay B11TR is shunted on entrance of the train into section B11T, and operation of the crossing signal XS1 is initiated in the normal manner as explained above. When the train enters section C11T the contacts of the track relay C11TR fail to release and relay C11FSC maintains the circuit of the winding 31 of interlocking relay XR2 so that the crossing signal XS2 does not start to operate when the train enters section C11T.

However, as pointed out above, the signal 11S will have been displaying its stop indication, so the train will be traveling at a slow speed when it approaches the highway intersection and will not present a serious hazard.

From the foregoing it will be seen that the system provided by this invention is arranged so that the maximum degree of safety is obtained in the event the contacts of a track relay fuse together so that they fail to separate when the relay winding is deenergized. The system is arranged so that the signals governing movement of trains in the track stretch are caused to display their most restrictive indication, and the only adverse effect of fusing of the contacts of a track relay is failure of a crossing signal to function in the intended manner. The effect of this failure is minimized because of the slow speed of the trains at the time.

The possibility of failure of the equipment to operate in the intended manner because of fusing together of the contacts of a track relay is extremely remote, but even this possibility can be eliminated by equipping the track relays with infusible contacts. For example, the track relays might be provided with silver to impregnated carbon contacts, instead of silver to silver contacts.

It will be seen that the system provided by this

invention is adapted for use in track stretches where there are a plurality of highway intersections within a single track or block section, and that the system makes it possible to employ back contact coding at the cut section nearest the exit end of the section. This is desirable to prevent code distortion in the remainder of the section.

The track relay for the cut section to which energy is supplied by the back contact coding apparatus has associated therewith means to detect code following operation of the track relay and to also detect the steadily energized condition of the track relay.

The relay C11FSB is controlled in such a manner that it is energized when and only when the track relay is responding to coded energy, while the relay C11FSC is energized when and only when the track relay C11TR is steadily energized.

Construction and operation of modification shown in Fig. 2 of the drawing

In Fig. 2 of the drawing there is shown a modified form of apparatus which may be employed with the track relay for section C11T. As shown the track relay C11TRA has associated therewith a decoding transformer C11DT, and auxiliary relays C11FSD and C11FSE. The decoding transformer C11DT has a primary winding 50 and a secondary winding 51. The track relay C11TRA has a contact 52 which when picked up establishes connection from terminal B of the local source of direct current to one end terminal of the winding 50 and when released establishes connection to the other end terminal of the winding 50, while the center terminal of the winding 50 is connected to terminal C of the source of current. The relay C11TRA has a contact 53 which when picked up establishes connection from one end terminal of the transformer secondary winding 51 to a terminal of the winding of the relay C11FSD, and when released establishes connection from the other end terminal of the winding 51 to the relay winding. The center terminal of the winding 51 is connected to the other terminal of the winding of the relay C11FSD. Accordingly when the track relay C11TRA is responding to coded energy, the end portions of the transformer primary winding 50 are alternately energized so that current is induced in the secondary winding 51, while contact 53 rectifies the current supplied from the secondary winding to the winding of relay C11FSD.

The relay C11TRA has a contact 25 which when picked up establishes a circuit to supply energy to the track transformer B11TT so that when the relay is supplied with coded energy, energy of the same code frequency is supplied to the adjacent section in the rear, and when the track relay contacts are constantly picked up steady energy is supplied to the adjacent section in the rear.

The track relay C11TRA has a contact 55 which when picked up establishes a circuit to supply energy to the winding of relay C11FSE, while contact 56 of relay C11FSD when picked up also establishes a circuit to supply energy to the winding of relay C11FSE.

The relay C11FSD has a contact 58 which when released establishes a circuit to supply steady energy to the track transformer B11TT, while relay C11FSE has a contact 60 which when picked up establishes circuits to supply energy to the windings 31 and 32 of the interlocking relays XR2 and XR1.

In operation, when the track stretch is vacant so that coded energy is supplied to the track relay C11TRA, energy is supplied through the decoding transformer C11DT to the winding of the relay C11FSD, and contact 56 of this relay is picked up to establish a circuit to supply energy to the winding of relay C11FSE so that contact 60 of relay C11FSE is picked up and establishes the circuits of the windings of the relays XR1 and XR2 so that these relays maintain the crossing signals inactive. In addition, contact 58 of relay C11FSD is picked up and interrupts the circuit which it controls for supplying energy to the track transformer B11TT so that the track transformer is supplied with coded energy over the circuit controlled by track relay contact 25.

When a train traveling in the normal direction of traffic enters section C11T, the track relay C11TR is shunted and the contacts of the relay remain in their released positions so that energy is no longer supplied through the transformer C11DT to the winding of relay C11FSD. Accordingly the contacts of relay C11FSD become released and contact 58 establishes the circuit to supply steady energy to the track transformer B11TT, and steady energy is supplied therefrom to the track relay for section B11T to discontinue operation of the crossing signal controlled by interlocking relay XR1 when the train vacates section B11T.

On release of contact 56 of relay C11FSD the circuit of the winding of relay C11FSE is interrupted, and the contact 60 of relay C11FSE becomes released to interrupt the circuits for supplying energy to the windings 31 and 32 of interlocking relays XR2 and XR1. Accordingly relay XR2 initiates operation of the crossing signal controlled thereby.

When the train advances far enough to vacate section C11T steady energy supplied to the rails of this section by the equipment associated with the adjacent section in advance feeds to the track relay C11TRA and picks up the contacts thereof. On picking up of contact 55 of relay C11TRA energy is supplied to the winding of relay C11FSE and contact 60 of this relay becomes picked up to establish the circuits for supplying energy to the windings of the interlocking relays XR1 and XR2. The relay XR2, therefore, operates to discontinue operation of the crossing signal controlled thereby.

When the train advances far enough in the track stretch to vacate the section in advance of section C11T coded energy is supplied to that section, while the supply of steady energy to the rails of section C11T is cut off and coded energy is supplied to the rails of section C11T and track relay C11TRA responds to coded energy.

On movement of contact 55 of the track relay C11TRA to the released position the circuit of the winding of relay C11FSE is interrupted, but the circuit is reestablished on picking up of the track relay contacts, and also on picking up of the contacts of relay C11FSD. When code following operation of the track relay contacts is initiated energy is supplied through the transformer C11DT to the relay C11FSD and the contacts of this relay become picked up so that contact 56 establishes a circuit to supply energy to the winding of relay C11FSE, while contact 58 interrupts the circuit which it controls for supplying steady energy to the track transformer B11TT. The supply of energy to the track transformer is thereafter controlled by contact 25 of

the track relay C11TRA so that coded energy is supplied to the transformer.

The contact 60 of the relay C11FSE is slow enough in releasing to remain picked up until the circuit for supplying energy to the relay winding is reestablished by picking up of the track relay contact 55 or of contact 56 of relay C11FSD. Accordingly on a change in the supply of energy to the track relay from steady to coded energy contact 60 of relay C11FSC remains picked up and maintains the circuits of the windings of the interlocking relays XR1 and XR2 so that these relays maintain the associated crossing signals inactive.

When a train traveling in the reverse direction of traffic enters the section in advance of section C11T, the equipment associated with that section operates as described in detail above to supply steady energy instead of coded energy to the rails of section C11T. On this change in the energy supplied to track relay C11TRA, the contacts of this relay remain picked up and energy is no longer supplied through the transformer C11DT to the relay C11FSD. Accordingly the contacts of this relay become released and contact 56 interrupts the circuit which it controls for supplying energy to the winding of relay C11FSE. However, since track relay contact 55 is picked up energy continues to be supplied to the winding of relay C11FSE so that its contact 60 is maintained picked up to maintain the supply of energy to the winding 32 of interlocking relay XR1 to thereby cause that relay to maintain the associated crossing signal inactive.

When contact 58 of relay C11FSD becomes released it establishes a circuit to supply steady energy to the track transformer B11TT, while steady energy is also supplied to this transformer over the circuit controlled by track relay contact 25.

When the train advances far enough to enter section C11T the track relay C11TRA is shunted and its contacts become released. On release of contact 25, the circuit which it controls is interrupted, but steady energy continues to be supplied to the track transformer B11TT over the circuit controlled by contact 58 of relay C11FSD.

On release of contact 55 of the track relay C11TRA the circuit of the winding of relay C11FSE is interrupted and the contact 60 becomes released to interrupt the supply of energy to the winding 32 of interlocking relay XR1 so that this relay initiates operation of the associated crossing signal.

When the train advances far enough to clear section C11T, coded energy is again supplied to the track relay C11TRA and energy is again supplied to the windings of relays C11FSD and C11FSE so that contact 60 reestablishes the circuit for supplying energy to the windings of relays XR1 and XR2, and relay XR1 operates to discontinue operation of the associated crossing signal. On picking up of contact 58 of relay C11FSD the supply of steady energy to the section in the rear is cut off and thereafter coded energy is supplied to section B11T over the circuit controlled by track relay contact 25.

It will be seen, therefore, that the modification shown in Fig. 2 of the drawing incorporates means to detect both code following operation of the track relay contacts and to detect the steadily energized condition of the track relay. The decoding transformer C11DT and the relay C11FSD provide means to detect code following operation of the track relay, and if for any rea-

son the track relay contacts remain in either their released or picked-up positions the contacts of relay C11FSD become released and steady energy is supplied to the section in the rear with the result that the signal at the entrance to the section is conditioned to display its most restrictive indication.

When the track relay contacts are steadily picked up the relay C11FSE is energized and its contact 60 is picked up to establish the circuits to supply energy to the interlocking relays and condition these relays to prevent operation of the crossing signals. This makes it possible to employ steady energy to discontinue operation of crossing signals when a train clears a subsection, or to prevent their operation prior to entrance of a train into a section.

It will be seen that the modification shown in Fig. 2 may be incorporated in the system shown in Fig. 1 and provides means to distinguish between code following operation of the track relay, the steadily energized or the deenergized condition of the relay. In the system shown in Fig. 2 the relay C11FSD detects code following operation of the track relay and controls the circuit for supplying steady uncoded energy to the rails of the section in the rear, while the relay C11FSE detects the deenergized condition of the track relay and controls the circuits for supplying energy to the windings of the interlocking relays.

Although I have herein shown and described only one form of railway traffic controlling apparatus together with one modification thereof embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a stretch of railroad track having a pair of track rails having insulated joints therein to divide the track stretch into a plurality of successive track sections including a forward, an intermediate and a rearward track section, said track stretch including a first highway intersection located adjacent the rear of the forward section and a second highway intersection located adjacent the rear of the intermediate section, a first crossing signal protecting the first intersection and a second crossing signal protecting the second intersection, a first control relay operative when and only when energized to maintain the first crossing signal inactive, a second control relay operative when and only when energized to maintain the second crossing signal inactive, each of said track sections having a code following track relay having a winding receiving energy from the rails of said section, means governed by traffic conditions in advance of the forward section for supplying coded energy to the rails of said forward section, the track relays for the forward and intermediate sections each having associated therewith means operative when said relay is responding to coded energy to supply to the rails of the adjacent section in the rear energy of the same code frequency as is supplied to said track relay, means operative when the forward section track relay is not energized to supply uncoded energy to the rails of the intermediate section, means operative when and only when the intermediate section track relay is responding to coded or uncoded energy to supply energy to the first control re-

lay, a supply circuit for supplying uncoded energy to the rails of the rearward section, means responsive to code following operation of the intermediate section track relay for interrupting said supply circuit, and means operative when and only when the rearward section track relay is responding to coded or uncoded energy to supply energy to the second control relay.

2. In combination, a stretch of railroad track having a pair of track rails having insulated joints therein to divide the track stretch into a plurality of successive track sections including a forward, an intermediate and a rearward track section, said track stretch including a first highway intersection located adjacent the rear of the forward section and a second highway intersection located adjacent the rear of the intermediate section, a first crossing signal protecting the first intersection and a second crossing signal protecting the second intersection, a first control relay operative when and only when energized to maintain the first crossing signal inactive, a second control relay operative when and only when energized to maintain the second crossing signal inactive, each of said track sections having a code following track relay having a winding receiving energy from the rails of said section, means governed by traffic conditions in advance of the forward section for supplying coded energy to the rails of said forward section, a supply circuit through which energy is supplied to the rails of the intermediate section, the forward section track relay being operative when energized to interrupt said supply circuit, whereby on the supply of coded energy to said forward section track relay energy of the same code frequency is supplied to the rails of the intermediate section and when energy is not supplied to said forward section track relay uncoded energy is supplied to the rails of the intermediate section, means operative when and only when the intermediate section track relay is supplied with coded or uncoded energy to supply energy to the first control relay, a circuit for supplying uncoded energy to the rails of the rearward section, means operative when the intermediate section track relay is supplied with coded energy to interrupt said last-named circuit and to supply to the rails of the rearward section coded energy of the same code frequency as is supplied to said intermediate section track relay, and means operative when and only when the rearward section track relay is supplied with coded or uncoded energy for supplying energy to the second control relay.

3. In combination, a stretch of railroad track having a pair of track rails having insulated joints therein to divide the track stretch into a plurality of successive track sections including a forward, an intermediate and a rearward section, said track stretch including a first highway intersection located adjacent the rear of the intermediate section and a second highway intersection located adjacent the rear of the forward section, a first crossing signal protecting the first intersection and a second crossing signal protecting the second intersection, a first control relay controlling the first crossing signal, a second control relay controlling the second crossing signal, each of said control relays being operative when and only when energized to maintain the associated crossing signal inactive, each of said track sections having a code following track relay having a winding receiving energy from the rails of the said section, means governed by traffic con-

ditions in advance of the forward section for supplying coded energy to the rails of said forward section, the track relays for the forward and intermediate sections each having associated therewith means responsive to code following operation of such relay to supply to the rails of the adjacent section in the rear energy of the same code frequency as is supplied to such track relay, whereby when the track stretch is vacant energy of the same code frequency is supplied to the rails of the rearward section as is supplied to the rails of the forward section, the forward section track relay having associated therewith means operative when said relay is not energized to supply uncoded energy to the rails of the intermediate section, a supply circuit for supplying uncoded energy to the rails of the rearward section, means responsive to code following operation of the intermediate section track relay for interrupting said supply circuit, whereby when either the forward or intermediate section is occupied uncoded energy is supplied to the rails of the sections in the rear, means responsive to the supply of coded or uncoded energy to the track relay of the rearward section for supplying energy to the second control relay, and means responsive to the supply of coded or uncoded energy to the track relay of the intermediate section for supplying energy to the first control relay.

4. In combination, a stretch of railroad track having a pair of track rails having insulated joints therein to divide the track stretch into a plurality of successive track sections including a forward, an intermediate and a rearward section, said track stretch including a first highway intersection located adjacent the rear of the forward section and a second highway intersection located adjacent the rear of the intermediate section, a first crossing signal protecting the first intersection, a second crossing signal protecting the second intersection, a first interlocking relay controlling the first crossing signal and a second interlocking relay controlling the second crossing signal, each of said interlocking relays having a pair of windings and being operative on deenergization of either of said windings to initiate operation of the associated crossing signal, means governed by traffic conditions in advance of said forward section for selectively supplying to the rails of the forward section energy coded at one of a plurality of different frequencies, each of said track sections having a code following track relay having a winding receiving energy from the rails of the said section, means associated with the rearward section track relay and operative when said relay is supplied with coded or uncoded energy to supply energy to one winding of the second interlocking relay, means associated with the intermediate section track relay and operative when said relay is supplied with coded or uncoded energy to supply energy to the other winding of the second interlocking relay and to one winding of the first interlocking relay, and means associated with the forward section track relay and operative when said relay is supplied with coded energy to supply energy to the other winding of the first interlocking relay, the track relays of the forward and intermediate sections each having associated therewith means operative when said relay is supplied with coded energy to supply energy of the same code frequency to the rails of the adjacent section in the rear, the track relay of the forward section being operative when deenergized to establish a circuit to

supply uncoded energy to the rails of the intermediate section, the track relay of the intermediate section being operative when deenergized or when supplied with uncoded energy to establish a circuit to supply uncoded energy to the rails of the rearward section.

5. In combination, a stretch of railroad track having a pair of track rails divided by insulated joints into successive track sections, the rails of one of said sections being divided by insulated joints into a plurality of subsections including a forward, an intermediate and a rearward subsection, said track section including a first highway intersection located adjacent the rear of the forward subsection and a second highway intersection located adjacent the rear of the intermediate subsection, a first crossing signal protecting the first intersection, a second crossing signal protecting the second intersection, a first control relay controlling the first crossing signal, a second control relay controlling the second crossing signal, each of said control relays being operative when energized to maintain the associated crossing signal inactive, means governed by traffic conditions in advance of said one section for selectively supplying to the track rails of the forward subsection coded energy periodically interrupted at either of a plurality of different code frequencies, each of said subsections having a code following track relay having a winding receiving energy from the rails of the associated subsection, the track relays of the forward and intermediate subsections each being operative when supplied with coded energy to effect the supply of coded energy of the same code frequency to the rails of the adjacent subsection in the rear, whereby when said section is vacant energy of the same code frequency is supplied to the rearward subsection track relay as is supplied to the rails of the forward subsection, a signal capable of displaying a plurality of different indications and governing traffic in said one track section, the rearward subsection track relay being adapted to have associated therewith means operative when said rearward subsection track relay is not supplied with energy or is supplied with uncoded energy to condition said signal to display its most restrictive indication, said means being selectively responsive to the supply of coded energy of different frequencies to said track relay to condition said signal to display one or another of its less restrictive indications, the track relay of the forward subsection being operative when deenergized to effect the supply of uncoded energy to the rails of the intermediate subsection, the track relay of the intermediate subsection being operative when deenergized or when steadily energized to effect the supply of uncoded energy to the rails of the rearward subsection, said intermediate section track relay being operative when supplied with either coded or uncoded energy to supply energy to the first control relay, the rearward subsection track relay being operative when supplied with either coded or uncoded energy to supply energy to the second control relay.

6. In a coded railway signaling system, in combination, a stretch of railroad track divided by insulated joints into successive track sections, the rails of one of said sections being divided by insulated joints into a plurality of subsections including a forward, an intermediate and a rearward subsection, said track section including a

highway intersection located adjacent the rear of the intermediate subsection, a crossing signal protecting said intersection, a control relay controlling said crossing signal, said relay being operative when energized to maintain said crossing signal inactive, means governed by traffic conditions in advance of said track section for supplying coded energy to the rails of said forward subsection, each of said subsections having a code following track relay having a winding receiving energy from the rails of the associated subsection, the track relays of the forward and intermediate subsections each being operative when supplied with coded energy to effect the supply of coded energy of the same code frequency to the rails of the adjacent subsection in the rear, whereby when the track section is vacant energy of the same code frequency is supplied to the rearward subsection track relay as is supplied to the rails of the forward subsection, means operative when the track relay of the forward subsection is not energized to supply uncoded energy to the rails of the intermediate subsection, means operative when the track relay of the intermediate subsection is deenergized or is steadily energized to effect the supply of uncoded energy to the rails of the rearward subsection, and means operative when the track relay of the rearward subsection is supplied with either coded or uncoded energy to supply energy to said control relay.

7. In a coded railway signaling system, in combination, a stretch of railroad track divided by insulated joints into successive track sections, the rails of one of said sections being divided by insulated joints into a plurality of subsections including a forward, an intermediate and a rearward subsection, said track section including a highway intersection located adjacent the rear of the intermediate subsection, a crossing signal protecting said intersection, a control relay controlling said crossing signal, said relay being operative when energized to maintain said crossing signal inactive, means governed by traffic conditions in advance of said track section for supplying coded energy to the rails of said forward subsection, each of said subsections having a code following track relay having a winding receiving energy from the rails of the associated subsection, the track relays of the forward and intermediate subsections each being operative when supplied with coded energy to effect the supply of coded energy of the same code frequency to the rails of the adjacent subsection in the rear, whereby when the track section is vacant energy of the same code frequency is supplied to the rearward subsection track relay as is supplied to the rails of the forward subsection, means operative when the track relay of the forward subsection is not energized to supply uncoded energy to the rails of the intermediate subsection, an auxiliary relay associated with the track relay for the intermediate subsection, said auxiliary relay being operative when deenergized to establish a circuit to supply uncoded energy to the rails of said rearward subsection, means responsive to code following operation of said intermediate subsection track relay for supplying energy to said auxiliary relay, and means operative on the supply of either coded or uncoded energy to the rearward subsection track relay for supplying energy to said control relay.

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