Feb. 10, 1953 J. E. McMAHON, JR 2,628,306

APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

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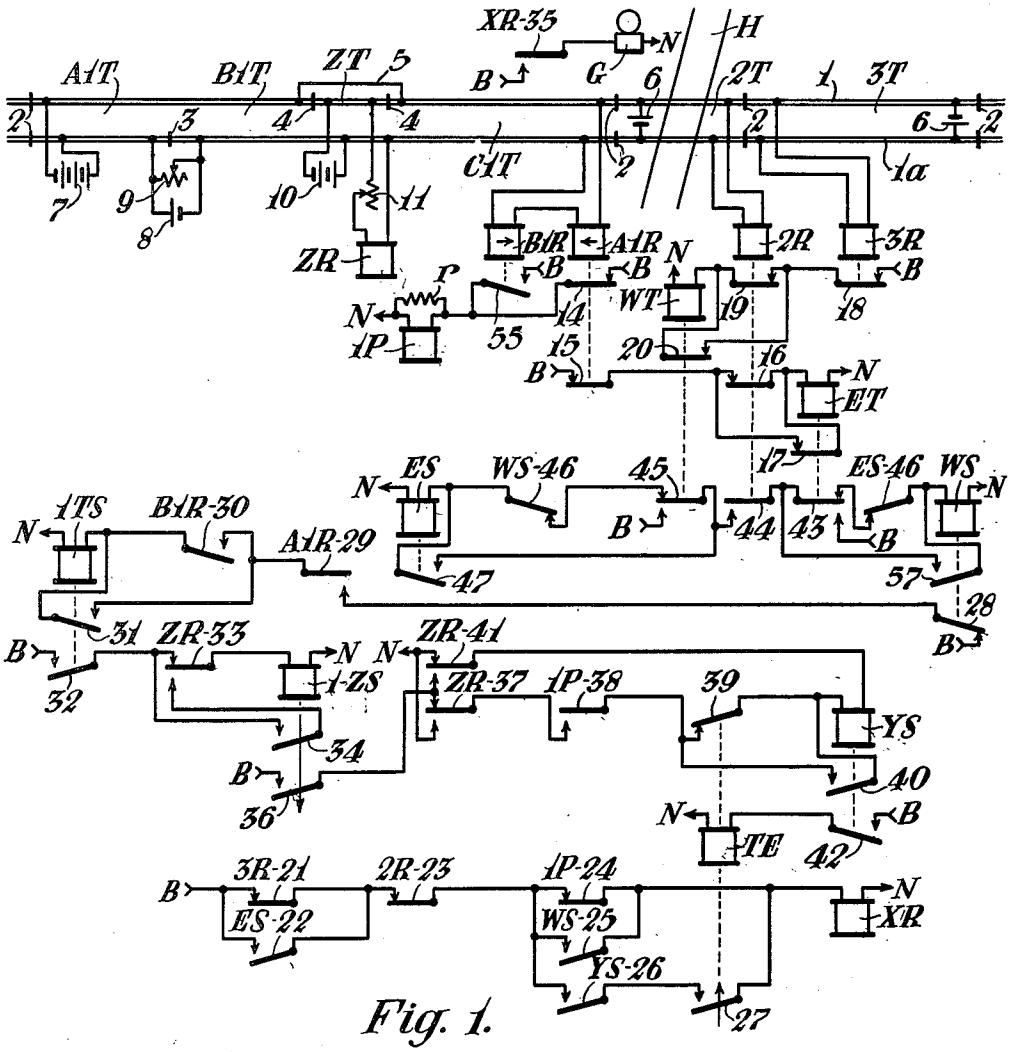


Fig. 1.

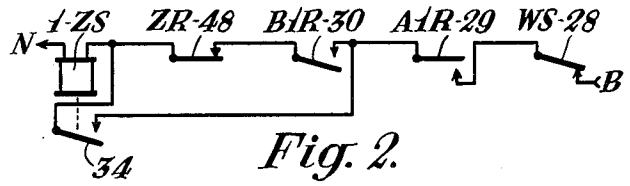


Fig. 2.

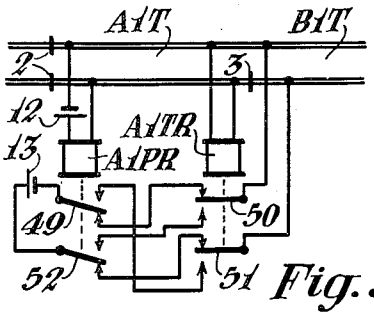


Fig. 3.

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APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

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10 Claims. (Cl. 246—130)

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My invention relates to apparatus for controlling highway crossing signals, and particularly to apparatus for interrupting the operation of a highway crossing signal when a train stops on a control track section for the highway crossing signal, and for then again starting operation of the highway crossing signal when the train resumes its movement toward the highway crossing.

In order to avoid unnecessarily delaying the users of a highway at the intersection of a railway track with a highway, it is important that the operation of a highway crossing signal shall be interrupted if a train stops on a control track section for the highway crossing signal. It is very desirable to prevent useless operation of a highway crossing signal in order to maintain the respect of users of a highway for the indications given by the highway crossing signal. If a highway crossing signal is unnecessarily operated when it should not be operated, users of a highway may become accustomed to disregarding the indications given by the highway crossing signal, and may sometimes disregard it when such action is dangerous. It is particularly important that means be provided for interrupting the operation of a highway crossing signal if it is so located that some trains stop regularly on a control section for the highway crossing signal, such as at passenger stations, or at points where trains receive fuel, or water, or where helper locomotives are coupled onto trains.

One feature of my invention, in apparatus embodying time element means for interrupting operation of a highway crossing signal when a train approaching the highway crossing signal in a given direction stops on a given control track section, is the provision of means to prevent energization of the time element means when a train moving in the opposite direction recedes from the highway crossing signal.

Another feature of my invention is the provision of means to insure the operation of a highway crossing signal in event of failure of given control apparatus for the signal.

The apparatus of my invention is an improvement over that which is disclosed in the copending application, Serial No. 33,980, filed June 19, 1948, by Kenneth L. Muse, for Apparatus for Controlling Highway Crossing Signals.

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

In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of apparatus

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embodying my invention, in which a railway track which intersects a highway is divided to form a crossing section at the highway, an approach control section adjacent one end of the crossing section, and also an approach control stretch adjacent the opposite end of the crossing section; in which one rail of the entering end of the approach control stretch of track is divided to form a preliminary control section and a main control section between the preliminary section and the intersection of the railway track with the highway; in which one rail of an intermediate portion of the main control section is divided to form an intermediate section; in which operation of a highway crossing signal adjacent the intersection of the railway track with the highway is started when a train on the preliminary section enters the adjacent portion of the main control section; in which operation of the crossing signal is interrupted if a train approaching the intersection stops on the main control section; and in which operation of the highway crossing signal is resumed when the train again proceeds over the intermediate section; Fig. 2 is a diagrammatic view showing a modification of a portion of the apparatus shown in Fig. 1; and Fig. 3 is a diagrammatic view showing a modification of the track circuit apparatus shown in Fig. 1.

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

In each of the drawings, the contacts operated by the various relays or by a time element device are identified by numbers, each such number having a distinguishing prefix from which it is separated by a dash when the associated contact is shown apart from the relay by which it is operated. The prefix for each of the contact numbers comprises the reference character for the respective relay by which the associated contact is operated. For example, contact WS–28, shown in Fig. 2 in the circuits for relay 1–ZS, is identified by the number **28** separated by a dash from the prefix WS which is the reference character for relay WS by which this contact is operated.

Referring further to Fig. 1 of the drawings, a stretch of railway track is shown intersected by a highway H. A highway crossing signal, which may be of the flashing light type or of any other suitable design, but which, in order to simplify the drawing, is shown as a bell G, is located adjacent the intersection of the railway track with highway H.

Rails 1 and 1*a* of the railway track are divided by insulated joints 2 to form a crossing section 2T at the intersection of the railway track with

the highway, an aprroach control section 3T adjacent the right-hand end of section 2T, as shown in the drawing, which I shall assume is the east end, and also an approach control stretch of track adjacent the opposite or west end of section 2T. The approach control stretch west of section 2T is divided by an insulated joint 3 in one of its rails, adjacent its entering or west end, to form a preliminary control section A!T, and a main control section which comprises two portions B!T and C!T An intermediate portion of the main control section is divided by insulated joints 4 in rail 1 to form an intermediate section ZT which is shorter than the distance between the trucks of a railway car, so that when a train moves over the intermediate section, this section is periodically shunted instead of being continuously shunted by the train. Portions B!T and C!T of the main control section are interconnected by a jumper 5 around section ZT.

Each of the track sections 2T and 3T is provided with a track circuit which includes a relay 2R or 3R, respectively, connected across the rails adjacent one end of the section, and a suitable source of current, such as a battery 6, connected across the rails adjacent the opposite end of the section.

Two biased neutral track relays, designated by the reference characters A!R and B!R, are connected in series opposition across the rails of portion C!T of the main control section of track west of section 2T. Each of the relays A!R and B!R is so constructed that, when current of a given polarity is supplied to its winding, it will open its back contacts and close its front contacts, whereas when current of the opposite polarity is supplied to its winding, its back contacts will remain closed and its front contacts will remain open. The direction of flow of current, to which each of these relays will respond by closing its front contacts, is indicated by an arrow within the symbol for the winding of the relay.

It follows that, with relays A!R and B!R connected in series opposition across the rails of portion C!T as shown in the drawing, when current of a given or normal polarity is supplied to these relays from track section portion C!T, relay A!R will close its front contacts 14 and 15, and the front contacts 55 and B!R–30 of relay B!R will remain open, and when current of the opposite or reverse polarity is supplied to these relays from portion C!T, relay B!R will close its front contacts 55 and B!R–30 and the front contacts 14 and 15 of relay A!R will be open. Current of the given polarity is normally supplied from a suitable source having a given potential, such as a battery 7, connected across the rails of section A!T, and thence through portion B!T of the main control section in opposition to a battery 8, of less than the given potential, which is connected in multiple with a resistor 9 around insulated joint 3. With relays A!R and B!R thus energized, the front contacts 14 and 15 of relay A!R are closed, and the front contacts 55 and B!R–30 of relay B!R are open.

When an eastbound train enters preliminary section A!T, battery 7 is shunted, and battery 8 is connected through the wheels and axles of the train with rail 1 of section A!T for supplying current of reverse polarity to portions B!T and C!T of the main control section. Relays A!R and B!R thus become energized by current of reverse polarity, so that the front contacts 14 and 15 of relay A!R are opened, and the front contacts 55 and B!R–30 of relay B!R become closed. When the train enters section portion B!T, battery 8, as well as battery 7, is shunted, so that both relays A!R and B!R become deenergized, and their front contacts are opened.

Intermediate section ZT is provided with a track circuit which includes a suitable source of current, such as a battery 12, connected across the rails adjacent one end of the section, and a relay ZR connected through a resistor 11 across the rails adjacent the opposite end of the section. Relay ZR may preferably be of higher resistance than the windings of relays A!R and B!R.

A repeater relay 1P is controlled by front contacts 14 and 55 of relays A!R and B!R respectively, connected in multiple so that, when either relay A!R or B!R is energized by current, in response to which its front contacts are closed, relay 1P will be energized.

An eastbound control stick relay, designated by the reference character ET, has a pickup and a stick circuit, both of which are controlled by a front contact 15 of relay A!R, and the pickup circuit is also controlled by a front contact 15 of relay 2R. A westbound control stick relay, designated by the reference character WT, is similarly controlled by relays 3R and 2R.

An eastbound direction stick relay, designated by the reference character ES, has a pickup and a stick circuit, each of which is controlled by back contacts 43 and 44 of relays ET and 2R, respectively, and the pickup circuit is also controlled by a front contact 45 of relay WT and a back contact WS–43 of relay WS. Relay ES has also a second stick circuit, which is controlled by a back contact 45 of relay WT. A westbound direction stick relay WS is controlled similarly to relay ES.

A checking stick relay 1TS has a pickup and a stick circuit each of which is controlled by back contacts 28 and A!R–29 of relays WS and A!R, respectively, and the pickup circuit is also controlled by a front contact B!R–30 of relay B!R, so that, unless relay A!R becomes deenergized and relay B!R becomes energized when a train enters section A!T, relay 1TS will not become energized. A second checking stick relay, designated by the reference character 1–ZS, has a pickup and a stick circuit, each of which is controlled by a front contact 32 of relay 1TS, and the pickup circuit is also controlled by a front contact ZR–33 of relay ZR, and the stick circuit is also controlled by a back contact ZR–33 of relay ZR. It follows that, if relay ZR is deenergized for some reason such, for example, as on account of being disconnected from section ZT, relay 1–ZS will not pick up when relay 1TS becomes energized.

A timing stick relay, designated by the reference character YS, is controlled by relays 1–ZS, ZR, and 1P, and by time element device TE. When relay 1–ZS becomes energized, relay YS will become energized only if relay 1P is deenergized on account of both relays A!R and B!R being deenergized. If relay ZR becomes deenergized after relay YS is energized, relay YS will become deenergized because of the reversal of polarity through its winding, effected by the contacts ZR–41 and ZR–37 of relay ZR.

A time element device, designated by the reference character TE, is controlled by a front contact 42 of relay YS.

A highway crossing signal control relay XR is controlled to become deenergized when a westbound train enters section 3T, or when an east-

bound train enters portion BIT of the main control section. If a sufficient period of time then elapses for time element device TE to close its front contact 27 before the eastbound train enters section ZT, relay XR will again become energized and interrupt the operation of crossing signal G.

Referring next to Fig. 2, in the modification here shown, a single checking stick relay 1–ZS is provided instead of the two checking stick relays 1TS and 1–ZS shown in Fig. 1. All other parts of this form of apparatus are as shown in Fig. 1.

Referring now to Fig. 3, in the modification here shown, a separate track circuit is provided for preliminary section AIT, including a battery 12 connected in series with a track relay AIPR across the rails adjacent one end of section AIT, and a track relay AITR connected across the rails adjacent the opposite end of section AIT. The parts of this track circuit are so proportioned that, with section AIT unoccupied, the front contacts 49 and 52 of relay AIPR will be open and its back contacts 49 and 52 will be closed, whereas the front contacts 50 and 51 of relay AITR will be closed and its back contacts 50 and 51 will be open.

When a train enters section AIT, relay AITR becomes shunted, so that its front contacts 50 and 51 become open and its back contacts 50 and 51 become closed. With a train on section AIT, sufficient current will be supplied through the winding of relay AIPR and the wheels and axles of the train for causing relay AIPR to close its front contacts 49 and 52 and open its back contacts 49 and 52. Current of normal or reverse polarity is supplied to portion BIT of the main control section, from battery 13, according as the contacts 49 and 52 of relay AIPR are closed at their back points while the contacts 50 and 51 of relay AITR are closed at their front points, or the contacts 49 and 52 of relay AIPR are closed at their front points while the contacts 50 and 51 of relay AITR are closed at their back points.

All other parts of this form of apparatus are as shown in either Fig. 1, or in Fig. 1 modified as shown in Fig. 2.

Having described, in general, the arrangement and control of the apparatus shown by the accompanying drawings, I shall now describe, in detail, its operation.

As shown in the drawings, all parts of the apparatus are in their normal condition, that is, each of the track sections is unoccupied, and therefore track relays 2R, 3R and ZR are energized, and relays AIR and BIR are energized by current of normal polarity, so that the front contacts 14 and 15 of relay AIR are closed, and the front contacts 55 and BIR–30 of relay BIR are open; relays IP, ET, WT, and XR are energized; relays ES, WS, 1TS, 1–ZS, and YS, time element device TE, and crossing signal G are deenergized; and relay AITR in Fig. 3 is energized, but relay AIPR is energized by insufficient current to close its front contacts.

The circuit by which relays AIR and BIR in Fig. 1 are energized by current of the given or normal polarity passes from battery 7, through rail 1 of section AIT and portion BIT of the main control section, jumper 5, rail 1 of portion CIT, windings of relays AIR and BIR, rail 1*a* of the main control section, battery 8 in multiple with resistor 9, and rail 1*a* of section AIT, back to battery 7.

Relay IP is energized by a circuit passing from terminal B of a suitable source of current, through contact 14 of relay AIR, and the winding of relay IP in multiple with a resistor *r*, to terminal N of the same source of current.

Both a pickup and a stick circuit are closed for relay ET, the pickup circuit passing from terminal B, through contact 15 of relay AIR, contact 16 of relay 2R, and the winding of relay ET to terminal N. The stick circuit for this relay is the same as the pickup circuit just traced except that it includes contact 17 of relay ET instead of contact 16 of relay 2R. Pickup and stick circuits are also closed for relay WT which are similar to the circuits just described for relay ET.

Relay XR is energized by a circuit passing from terminal B, through contacts 3R–21, 2R–23, and IP–24, and the winding of relay XR to terminal N.

I shall assume that, with apparatus embodying my invention as shown in Fig. 1, an eastbound train enters preliminary section AIT, shunting battery 7 and completing a circuit for now energizing relays AIR and BIR by current of reverse polarity, this circuit passing from battery 8, through rail 1*a* of the main control section, windings of relays BIR and AIR, rail 1 of section portion CIT, jumper 5, rail 1 of section portion BIT, and through the wheels and axles of the train, back to battery 8. The front contacts 14 and 15 of relay AIR therefore become open, whereas the front contacts 55 and BIR–30 of relay BIR become closed.

Although contact 14 of relay AIR is now open, relay IP remains energized by a second circuit, passing from terminal B, through contact 55 of relay BIR, and the winding of relay IP in multiple with resistor *r*, to terminal N.

Relay ET is now deenergized because contact 15 of relay AIR is opened.

With the back contact AIR–29 of relay AIR closed, and the front contact BIR–30 of relay BIR closed, a pickup circuit is completed for relay 1TS, passing from terminal B, through contact 28 of relay WS, contacts AIR–29 and BIR–30, and the winding of relay 1TS to terminal N. Relay 1TS, upon becoming energized, completes its own stick circuit which is the same as the pickup circuit just traced except that it includes contact 31 of relay 1TS instead of contact BIR–30.

Relay 1TS, upon becoming energized, completes a pickup circuit for relay 1–ZS, this circuit passing from terminal B, through contact 32 of relay 1TS, front point of contact ZR–33, and the winding of relay 1–ZS to terminal N.

When the train enters section portion BIT, battery 8, as well as battery 7, will be shunted, so that relays AIR and BIR will both be deenergized, causing relay IP to also be deenergized. With relay BIR deenergized, the pickup circuit traced for relay 1TS becomes opened at contact BIR–30, but relay 1TS remains energized by its stick circuit previously described. With relay IP deenergized, the circuit traced for relay XR is opened at contact IP–24 so that relay XR is deenergized, and starts the operation of bell G by closing its operating circuit passing from terminal B, through contact XR–35, and the mechanism of bell G to terminal N.

With relay IP deenergized and relay 1–ZS energized, a pickup circuit is closed for energizing relay YS, this circuit passing from terminal B, through contact 36 of relay 1–ZS, front point of contact ZR–37, contact IP–38, contact 39 of

time element device TE, winding of relay YS, and front point of contact ZR–41 to terminal N. Relay YS, upon becoming energized, completes its own stick circuit which is the same as the pick-up circuit just traced except that it includes contact 40 of relay YS instead of contact 39 of time element device TE.

Relay YS, upon becoming energized, completes a circuit for energizing time element device TE, this circuit passing from terminal B, through contact 42 of relay YS, and the winding of time element device TE to terminal N.

I shall assume further that the train proceeds at such speed that time element device TE does not close its contact 27 before the train enters section ZT, deenergizing relay ZR. With relay ZR deenergized, the pickup circuit previously traced for relay 1–ZS is opened at the front point of contact ZR–33, but relay 1–ZS is of the slow releasing type so that its front contacts 34 and 36 remain closed until its stick circuit becomes closed, passing from terminal B, through contact 32 of relay 1TS, contact 34 of relay 1–ZS, back point of contact ZR–33, and the winding of relay 1–ZS to terminal N. The front contacts 34 and 36 of relay 1–ZS are then retained closed by the stick circuit just traced for this relay.

When relay ZR becomes deenergized, the circuits previously described for relay YS are opened at the front points of contacts ZR–37 and ZR–41, and current of reverse polarity is then supplied to the winding of relay YS through the back points of contacts ZR–37 and ZR–41, causing the front contacts 40 and 42 of relay YS to be opened for a brief period of time. Time element device TE is of a type, which, upon becoming deenergized, returns quickly to its initial position, so that after contact 42 of relay YS again closes the energizing circuit for time element device TE, the timing period of device TE is started over. On account of section ZT being shorter than the distance between trucks of railway cars, relay ZR will be repeatedly deenergized and energized alternately while the train moves over section ZT, causing relay YS and, in turn, time element device TE, to be repeatedly deenergized.

As is well known, reversal of the polarity of the energizing current for a neutral relay insures that the electromagnetic flux in the relay will pass through zero, and that therefore the relay armature will be released, whereas if energizing current of a given polarity only is merely interrupted for a brief period of time, the electromagnetic flux in the relay may not go down all the way to zero, and therefore the relay armature may not be released. It is for this reason that the circuits for relay YS are arranged so that the direction of flow of energizing current through the winding of relay YS is reversed by relay ZR, instead of energizing current of a given polarity through the winding of relay YS being merely interrupted, for a brief period of time, by relay ZR.

I shall also assume further that the train enters section 2T before time element device TE closes its contact 27 after the train has left section ZT. Contact 2R–23 is therefore now open in the circuit previously traced for relay XR, so that relay XR remains deenergized, and the operation of bell G is continued.

Relay 2R, upon becoming deenergized when the train enters section 2T, completes a pickup circuit for relay ES, this circuit passing from terminal B, through the back point of contact 43 of relay ET, contact 44 of relay 2R, front point of contact 45 of relay WT, contact WS–46, and the winding of relay ES to terminal N. Relay ES, upon becoming energized, completes its own stick circuit, which is the same as the pickup circuit just traced except that it includes contact 47 of relay ES instead of contact 45 of relay WT and contact WS–46.

When the train enters section 3T, relay 3R becomes deenergized, and, by opening its contact 18, in turn deenergizes relay WT. Relay WT, upon becoming deenergized, opens the pickup circuit previously traced for relay ES, but completes a second stick circuit for relay ES, passing from terminal B, through the back point of contact 45 of relay WT, contact 47 of relay ES, and the winding of relay ES to terminal N.

When the train leaves the main control section west of section 2T, relay A1R again becomes operated by its circuit previously traced, causing relay 1P to again be energized by its circuit first traced. Relay A1R, upon opening its back contact A1R–29, deenergizes relay 1TS, which, in turn, deenergizes relay 1–ZS, and relay 1–ZS in turn deenergizes relay YS. Time element device TE then becomes deenergized on account of relay YS being deenergized.

When the train leaves section 2T, the stick circuit first traced for relay ES becomes opened at contact 44 of relay 2R, but relay ES then remains energized by its second stick circuit. Also, when the train leaves section 2T, relay ET becomes energized by its pickup and stick circuits previously traced. Relay 2R, upon becoming energized, completes a circuit for energizing relay XR, which is the same as the circuit first traced for this relay except that it includes contact ES–22 instead of contact 3R–21. Relay XR, upon thus becoming energized, opens the operating circuit for bell G at contact XR–35, thereby stopping operation of bell G.

When the train leaves section 3T, relay WT again becomes energized by its pickup and stick circuits previously described. Relay WT, upon becoming energized, opens the second stick circuit traced for relay ES, thereby deenergizing relay ES. With relay 3R again energized, the circuit first traced for relay XR is again closed, so that although relay ES is now deenergized, relay XR remains energized, and therefore signal G remains inoperative.

I shall next assume that, with all parts of the apparatus again in the normal condition, an eastbound train moves over section A1T and enters portion B1T of the main control section, causing operation of the bell to start, as previously described, and effecting energization of relay YS and time element device TE. I shall assume further, that the train stops on portion B1T, or that it moves so slowly that time element device TE closes its contact 27 before the train enters section ZT. Contact 27, upon becoming closed, completes a circuit for energizing relay XR, this circuit passing from terminal B, through contacts 3R–21, 2R–23, YS–26, contact 27 of time element device TE, and winding of relay XR to terminal N. Relay XR, upon thus becoming energized, interrupts the operation of bell G.

When the train resumes its movement toward the intersection of the railway track and highway H, and enters section ZT, relay YS becomes deenergized for a brief period of time because of the deenergization of relay ZR. Time element device TE is in turn deenergized for a brief period of time and returned to its normal condition, so that its contact 27 opens the circuit

traced for relay XR, causing relay XR to be deenergized, which starts operation of bell G again. The operation of the apparatus as the train proceeds over the crossing will now be as previously described.

If, instead of stopping on section BIT before entering section ZT, the train stops with one pair of wheels on section ZT, causing relay ZR to remain deenergized, relay I–ZS will remain energized by its stick circuit previously traced. With relay ZR deenergized, relay YS will now be energized by a pickup circuit passing from terminal B, through contact 36 of relay I–ZS, back point of contact ZR–31, winding of relay YS, contact 39 of time element device TE, contact IP–38, and the back point of contact ZR–37 to terminal N. With relay YS energized, time element device TE will be energized by its circuit previously described. Upon the lapse of a measured period of time, device TE will close its contact 27, thereby energizing relay XR and interrupting the operation of bell G, as previously described.

When the train again resumes its movement toward highway H, relay ZR will first become energized, thereby momentarily deenergizing relay YS, and then reversing the polarity of energization of relay YS, so that time element device ST will be returned to its normal condition as previously described, and will thereby deenergize relay XR and start the operation of bell G over again.

From the foregoing description of operation of the apparatus shown in the accompanying drawings, it follows that my invention provides means for insuring operation of a highway crossing signal in event of failure of portions of the control apparatus.

If, for example, a connection should become broken between the rails of section portion CIT and the windings of relays AIR and BIR, relay ITS would not become energized because contact BIR–30 in its pickup circuit would remain open. Relays I–ZS and YS, and time element device TE would therefore also remain deenergized. With both relays AIR and BIR deenergized, relay IP would be deenergized, and therefore relay XR would be deenergized because contact IP–24 would be open. Operation of bell G would therefore be initiated, and would not be interrupted by time element device TE, so it would be continuous. That would indicate something was wrong, and so a signal maintainer would take the necessary action for correcting the condition.

It follows that the purpose of the arrangement embodying polarity responsive means, such for example as two biased neutral track relays AIR and BIR for the approach control stretch west of section 2T is to prevent energization of time element device TE in the event of a broken track circuit connection for this approach control stretch. If only one ordinary neutral track relay were used for starting the operation of time element device TE, deenergization of the one track relay because of a broken connection would effect operation of the time element device TE, and when an eastbound train subsequently arrived on this approach control stretch, the highway crossing signal would therefore not be operated.

The purpose of relay ITS is to check the correct operation of relays AIR and BIR. In order for relay ITS to become energized by its pickup circuit, relay AIR must become deenergized and relay BIR must become energized. If both relays AIR and BIR should become deenergized at the same time, due to a broken track circuit connection, relay ITS would not become energized, and therefore the time element device TE would not become energized.

The purpose of the directional relays ET, WT, ES and WS is to stop the operation of the highway crossing signal G as soon as a train has moved off of the crossing section 2T, and while it is moving away from the intersection over the approach control section 3T east of section 2T or over the approach control stretch west of section 2T.

If relay ZR would be falsely deenergized, its contact ZR–33 would be open in the pickup circuit for relay I–ZS. Relay YS and time element device TE would therefore remain deenergized. Relay XR would therefore also remain deenergized and cause bell G to be operated continuously, and not be interrupted while a train stands on the main control section, until the condition is corrected by a signal maintainer.

I shall now assume that all parts of the apparatus are again in the normal condition, and that a westbound train enters section 3T, deenergizing relay 3R, and thereby in turn deenergizing relay WT. With relay 3R deenergized, the circuit first traced for relay XR will be opened at contact 3R–21, causing relay XR to become deenergized, which, in turn causes bell G to be operated.

When the train enters section 2T, relay WS becomes energized by its pickup circuit passing from terminal B, through the back point of contact 45 of relay WT, contact 44 of relay 2R, front point of contact 43 of relay ET, contact ES–46, and the winding of relay WS to terminal N. Relay WS, upon becoming energized, completes its own stick circuit which is the same as the pickup circuit just traced except that it includes contact 57 of relay WS instead of the front point of contact 43 of relay ET and contact ES–46.

When the train enters portion CIT of the main control section, relay AIR becomes deenergized, and in turn deenergizes relay ET. Relay ET, upon becoming deenergized, opens the pickup circuit traced for relay WS, and completes a second stick circuit for this relay, passing from terminal B, through the back point of contact 43 of relay ET, contact 57 of relay WS, and the winding of relay WS to terminal N. Since relay WS is energized, its back contact 28 is open in the circuits previously traced for relay ITS. With relay ITS deenergized, relay I–ZS and, in turn, relay YS will remain deenergized. With relay YS deenergized, time element device TE remains deenergized. It follows that time element device TE does not become energized for westbound traffic movements.

When the train leaves section 3T, relay 3R becomes energized and, when the train leaves section 2T, relay 2R becomes energized, thereby completing the pickup circuit previously traced for relay WT. With relay 2R energized, relay XR is now energized by a circuit passing from terminal B, through contacts 3R–21, 2R–23, and WS–25, and the winding of relay XR to terminal N. Relay XR, upon thus becoming energized, opens the operating circuit for bell G, thereby stopping the operation of the bell.

I have described the operation of the apparatus for a few typical traffic movements. It is believed that, in view of the foregoing description, the operation of the apparatus as shown in Fig. 1, or as modified as shown in Fig. 2 or Fig. 3, can be readily followed for any other possible traffic movements by referring to the drawings.

Although I have herein shown and described

only a few forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, including a given control section of said railway track divided into a main portion and an intermediate portion, and including means controlled by a train approaching said intersection for starting operation of said highway crossing signal while said train occupies said given control section, the combination comprising, time element means energized for interrupting operation of said highway crossing signal if said train occupies said given control section longer than a given measured period of time, means responsive to said train upon moving over said intermediate portion of said given control section for then deenergizing said time element means and thereby rendering said time element means ineffective to interrupt further the operation of said highway crossing signal, and direction control means controlled by a train moving in the opposite direction over said given control section to prevent energization of said time element means.

2. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, including means controlled by a train approaching said intersection in a given direction for starting operation of said highway crossing signal, the combination comprising, time element means controlled by said train for repeatedly interrupting operation of said highway crossing signal if said train repeatedly stops approaching said intersection after starting operation of said highway crossing signal, means responsive to said train each time it resumes movement toward said intersection for deenergizing said time element means and thereby rendering said time element means ineffective to interrupt the operation of said highway crossing signal, and direction control means controlled by a train moving in the opposite direction to prevent operation of said time element means while said train moving in the opposite direction is receding from said intersection.

3. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided by an insulated joint in one rail of said stretch into a preliminary section and a main section between said preliminary section and said intersection, an intermediate portion of said main section divided into an intermediate section which is shorter than the distance between trucks of a railway car, a track circuit for said stretch including said preliminary section and the rails of said main section connected around said intermediate section and including a main source of current of a given potential connected across the rails of said preliminary section with an auxiliary source of current of opposite and lower potential connected around said insulated joint and also including two biased neutral relays connected in series opposition across the opposite end of said main section so that the front contacts of one of said relays are normally closed in response to current from said main source and the front contacts of the other of said relays become closed in response to current from said auxiliary source when a train enters said preliminary section, a checking stick relay controlled to become energized if said one relay is deenergized and said other relay is energized in response to a train approaching said intersection in a given direction only and said checking stick relay then controlled to remain energized after said other relay becomes deenergized, a repeater relay controlled by a front contact of each of said biased neutral relays connected in multiple with each other, a timing stick relay controlled by a front contact of said checking stick relay and by a back contact of said repeater relay and momentarily deenergized when said intermediate section becomes occupied, time element means controlled by said timing stick relay, means controlled by a train upon entering said main section for starting operation of said highway crossing signal, and means controlled by said timing stick relay and by said time element device for interrupting operation of said highway crossing signal if a train approaching said intersection in a given direction only stops on said main section and for again starting operation of said highway crossing signal when the train resumes movement toward said intersection.

4. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a crossing section at said intersection and an approach control stretch comprising a preliminary section and a main section between said preliminary section and said crossing section, polarity responsive means connected across the rails of said main section, means for normally supplying current of a given polarity to the rails of said main section but for supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said polarity responsive means when a train enters said main section for starting operation of said highway crossing signal, time element means controlled by said polarity responsive means for interrupting operation of said signal upon the lapse of a measured period of time after a train approaching said intersection in a given direction only enters said main section, traffic responsive means operable in response to said train moving over an intermediate portion of said main section, means controlled by said traffic responsive means upon becoming operated in response to said train moving over the intermediate portion of said main section for effecting deenergization of said time element means, operation of said highway crossing signal being then again started by said means controlled by said polarity responsive means while said train proceeds further on said main section, and means controlled by said train on said crossing section for then continuing the operation of said signal while said train is passing over said intersection.

5. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a crossing section at said intersection and an approach control stretch comprising a preliminary section and a main section between said preliminary section and said crossing section, polarity responsive means connected across the rails of said main section, means for nor-

mally supplying current of a given polarity to the rails of said main section but for supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said polarity responsive means when a train enters said main section for starting operation of said highway crossing signal, means controlled by said polarity responsive means for interrupting operation of said signal if said train stops on said main section while approaching said intersection in a given direction only, means controlled by said train for again starting operation of said signal when said train resumes its movement toward said intersection, and means controlled by said train on said crossing section for then continuing the operation of said signal while said train is passing over said intersection.

6. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a preliminary section and a main section between said preliminary section and said intersection, polarity responsive means connected across the rails of said main section, means for normally supplying current of a given polarity to the rails of said main section but for supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said polarity responsive means when a train enters said main section for starting operation of said highway crossing signal, time element means controlled by said polarity responsive means for interrupting operation of said signal upon the lapse of a measured period of time after a train approaching said intersection in a given direction only enters said main section, and means controlled by said train upon moving over a given portion of said main section for deenergizing said time element means for again starting operation of said signal.

7. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a preliminary section and a main section between said preliminary section and said intersection, polarity responsive means connected across the rails of said main section, means for normally supplying current of a given polarity to the rails of said main section but for supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said polarity responsive means upon becoming deenergized when a train enters said main section for starting operation of said highway crossing signal, time element means controlled by said polarity responsive means for interrupting operation of said signal upon the lapse of a measured period of time after a train approaching said intersection in a given direction only enters said main section, and traffic responsive means operated in response to said train moving over an intermediate portion of said main section for deenergizing said time element means for again starting operation of said signal.

8. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a preliminary section and a main section between said preliminary section and said intersection, two biased neutral relays connected in series opposition across the rails of said main section so that one of said relays closes its front contacts in response to current of a given polarity only and the other of said relays closes its front contacts in response to current of the opposite polarity only, means for normally supplying current of said given polarity to the rails of said main section but supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, a checking stick relay, a pickup and a stick circuit for said checking stick relay each controlled by a back contact of said one relay and said pickup circuit also controlled by a front contact of said other relay, means controlled by said biased neutral relays when a train enters said main section for starting operation of said highway crossing signal, time element means controlled by means including a front contact of said checking stick relay for interrupting operation of said signal upon the lapse of a measured period of time after a train approaching said intersection in a given direction only enters said main section, and means controlled by said train upon moving over a given portion of said main section for again deenergizing said time element means for again starting operation of said signal.

9. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a preliminary section and a main section between said preliminary section and said intersection, two biased neutral relays connected in series opposition across the rails of said main section so that one of said relays closes its front contacts in response to current of a given polarity only and the other of said relays closes its front contacts in response to current of the opposite polarity only, means for normally supplying current of said given polarity to the rails of said main section but supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said relays when a train enters said main section for starting operation of said highway crossing signal, an intermediate portion of said main section divided to form an intermediate section which is shorter than the distance between the trucks of a railway car, a track circuit for said intermediate section including a track relay, a checking stick relay, a pickup and a stick circuit for said checking stick relay each controlled by a contact which is controlled by said biased neutral relays to become closed when a train enters said preliminary section and to remain closed while the train occupies said main section and the pickup circuit also controlled by a front contact of said track relay for said intermediate section, time element means controlled by means including a front contact of said checking stick relay for interrupting operation of said signal upon the lapse of a measured period of time after a train approaching said intersection in a given direction only enters said main section, and said time element means also controlled by said track relay for said intermediate section for again starting operation of said signal when said train moves over said intermediate section.

10. In a control system for a highway crossing signal adjacent the intersection of a railway track with a highway, the combination comprising, a control stretch of said railway track divided into a preliminary section and a main sec-

tion between said preliminary section and said intersection, two biased neutral relays connected in series opposition across the rails of said main section so that one of said relays closes its front contacts in response to current of a given polarity only and the other of said relays closes its front contacts in response to current of the opposite polarity only, means for normally supplying current of said given polarity to the rails of said main section but for supplying current of the opposite polarity to the rails of said main section when a train enters said preliminary section, means controlled by said relays when a train enters said main section for starting operation of said highway crossing signal, a checking relay, means controlled by said biased neutral relays for energizing said checking relay only if said other relay is energized while said one relay is deenergized and for then retaining said checking relay energized while said one relay is deenergized, time element means, means controlled by a front contact of said checking relay and by said other relay upon becoming deenergized when a train approaching said intersection in a given direction only enters said main section for energizing said time element means, means controlled by said time element means for interrupting operation of said signal upon the lapse of a measured period of time after said train enters said main section, and means controlled by said train upon moving over a given portion of said main section for deenergizing said time element means to again start operation of said signal.

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