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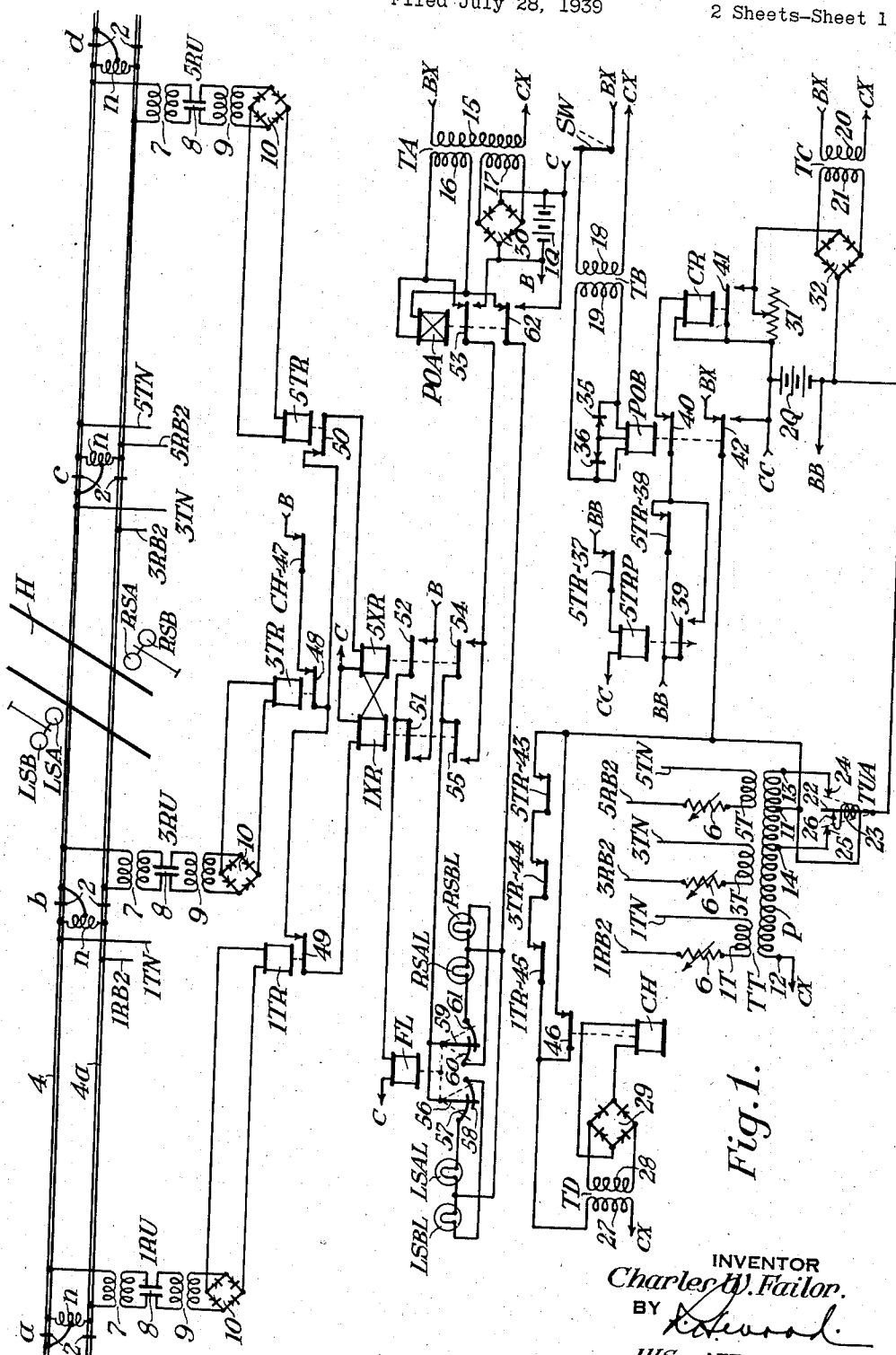
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2,268,193

CONTROLLING APPARATUS FOR HIGHWAY CROSSING SIGNALS

Filed July 28, 1939

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

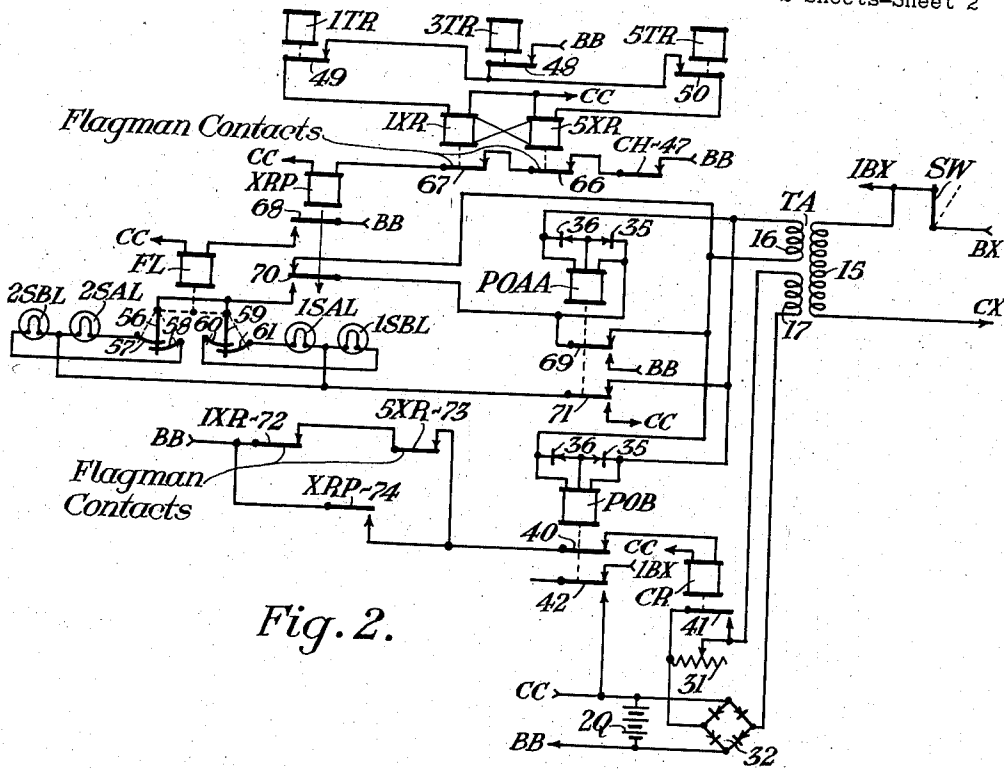


Fig. 2.

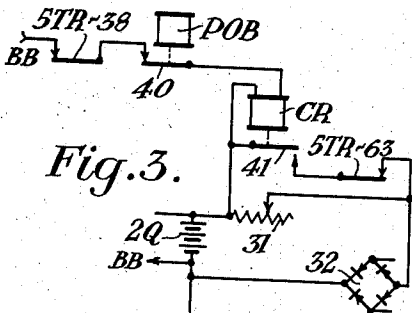


Fig. 3.

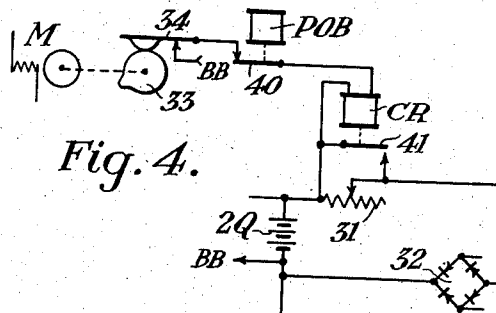


Fig. 4.

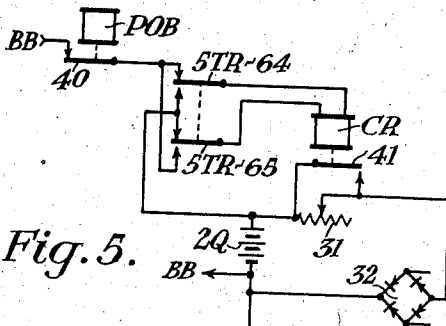


Fig. 5.

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CONTROLLING APPARATUS FOR HIGHWAY
CROSSING SIGNALSCharles W. Failor, Forest Hills, Pa., assignor to
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7 Claims. (Cl. 246—130)

My invention relates to controlling apparatus for highway crossing signals, that is, to apparatus for the control of signals which are placed at intersections of railways and highways for the purpose of warning users of a highway when a train is approaching a crossing, and particularly to such apparatus which is normally energized from a main source of power but which is energized from an auxiliary source of power if the main source fails.

One feature of my invention is the provision of means for preventing the displaying of a false indication by the highway crossing signals when the main source of power fails. Another feature of my invention is the provision of means for keeping a storage battery in properly charged condition when the storage battery is used as the auxiliary source of power.

I shall describe several 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 illustrating one form of apparatus embodying my invention as applied to highway crossing signals of the flashing light type. Fig. 2 is a diagrammatic view showing modifications of portions of the signal control and operating circuits shown in Fig. 1. Figs. 3, 4 and 5 are diagrammatic views showing modifications of the control of the charging apparatus for an auxiliary source of power comprising a storage battery shown in Figs. 1 and 2.

In each of the views, the contacts operated by the various relays or other devices are identified by numbers, such numbers having distinguishing prefixes from which they are separated by a dash when the contacts are shown apart from the relay or other device by which they are operated. The prefix for each of these contact numbers comprises the reference character for the respective relay or other device. For example, contact 5TR—37, shown in the control circuit for relay 5TRP, is identified by the number 37 separated by a dash from the prefix 5TR which is the reference character for relay 5TR by which this contact is operated.

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

Referring first to Fig. 1, the reference characters 4 and 4a designate the track rails of a stretch of railway track intersected by a highway H. Insulated joints 2 divide these track rails into three sections including sections a—b and c—d which extend in opposite directions from the intersection of the highway H with the railway

track, and including a short section b—c at the intersection.

Impedance bonds n of a usual and well-known type are provided for transmitting train propulsion current past the insulated joints. The train propulsion current can be alternating current of any suitable frequency, or can be direct current.

A signal of the flashing light type comprising two units RSA and RSB is located adjacent the intersection for governing traffic movements in one direction on the highway H across the intersection, and a second signal of the same type comprising two units LSA and LSB is located adjacent the intersection for governing traffic movements in the opposite direction on highway H across the intersection.

Each track section is provided with a traffic responsive circuit, such for example as a track circuit in which current is supplied to one end of track section a—b, b—c or c—d through the usual resistor 6 by secondary windings 1T, 3T and 5T, respectively, of a track transformer TT. Resonant units 1RU, 3RU and 5RU are connected across the rails adjacent the opposite ends of track sections a—b, b—c and c—d, respectively. Each of these resonant units comprises a transformer 7, a condenser unit 8 and a transformer 9. The purpose of the resonant units is to permit current of only the frequency supplied by transformer TT to pass to the full wave rectifiers 19 for energizing direct current track relays 1TR, 3TR and 5TR for sections a—b, b—c and c—d, respectively. In addition, if one of the condenser units 8 should become short-circuited, an unbalanced condition of the train propulsion current could not cause the associated track relay TR to become falsely energized.

Track transformer TT is normally energized by current from a main source of power having terminals BX and CX connected with terminals 11 and 12, respectively, of primary winding P. Other transformers designated by the reference characters TA, TB, TC and TD are also normally energized by current from the main source supplied to their primary windings 15, 18, 20 and 27, respectively.

Power-off relays POA and POB are normally energized by current from secondary windings 16 and 19 of transformers TA and TB, respectively, and hence these relays become deenergized when the main source of power fails. When relay POB becomes deenergized, primary winding P of track transformer TT is energized from an auxiliary source of power comprising a storage battery 2Q, through a tuned alternator TUA.

Tuned alternator TUA comprises a movable contact element 22, a control winding 23, fixed contact elements 24 and 25, and a control contact element 26. Movable contact element 22, in the normal or deenergized position in which it is shown in the drawings, connects with the control contact element 26.

Upon the deenergization of relay POB, a control circuit for tuned alternator TUA becomes closed, passing from terminal BB of battery 2Q, through contact 22—26 of tuned alternator TUA, control winding 23, and the back point of contact 42 of relay POB to terminal CC of battery 2Q. This causes contact element 22 to move to the right as shown in the drawings, where it engages fixed contact element 24 and disengages control contact element 26, thereby deenergizing control winding 23. Contact element 22 then swings to the left, engaging contact element 25 and again engaging control contact element 26, thereby again closing the control circuit including winding 23. The cycle of operation just described is then consecutively repeated, causing movable contact element 22 to continue to engage fixed contact elements 24 and 25 alternately as long as relay POB remains deenergized.

When contact element 22 engages contact element 24, current from battery 2Q passes from terminal 13 of primary winding P of transformer TT through a portion of primary winding P to terminal 11, and when contact element 22 engages contact element 25, current from battery 2Q passes from terminal 14 of primary winding P through a portion of primary winding P in the opposite direction to terminal 11, causing alternating current to be induced in the secondary or track windings 1T, 3T and 5T of transformer TT.

When transformer TT is thus energized from battery 2Q through contacts 22—24 and 22—25 of tuned alternator TUA, transformer TD is energized from terminals 11 and 12 of primary winding P which then acts as an autotransformer. A checking relay CH is energized from secondary winding 28 of transformer TD through a rectifier 29.

Directional control means comprising a relay of the well-known interlocking type, having windings 1XR and 5XR, is controlled by checking relay CH and by track relays 1TR, 3TR and 5TR.

A flasher relay FL is controlled by back contacts associated with windings 1XR and 5XR of the interlocking relay. As shown in the drawings, relay FL is equipped with two movable contact elements 56 and 59 which, when relay FL is energized, swing back and forth between left-hand and right-hand positions. In the left-hand position, contact element 56 engages a fixed contact element 57, and in the right-hand position, contact element 56 engages a fixed contact element 58. Similarly, in the left-hand position, contact element 59 engages a fixed contact element 60, and in the right-hand position engages a fixed contact element 61.

When a train approaches the intersection, the signal lights RSAL, RSBL, LSAL and LSBL of signal units RSA, RSB, LSA and LSB, respectively, are lighted by circuits energized from the main source of power and including a back contact of winding 1XR or 5XR and the contacts of flasher relay FL. The operation of the contact elements 56 and 59 of relay FL causes the signal lights to flash, so that the lights for each signal are alternately lighted.

In the event of failure of the main source of

power, relay POA transfers the energization of the signal lighting circuits to an auxiliary source comprising a storage battery 1Q. Battery 1Q is charged from secondary winding 17 of transformer TA through a rectifier 30.

A track relay repeater 5TRP is controlled through a front contact of relay 5TR, and is of a slow releasing type.

A charging control relay CR is energized by current from battery 2Q in a circuit controlled by power-off relay POB and by a contact of track relay 5TR in multiple with a contact of track repeater relay 5TRP. The parts of the apparatus are so proportioned that relay CR, upon becoming energized, will open its back contact 41 only when battery 2Q is, or becomes, fully charged.

The charging circuit for auxiliary source battery 2Q is normally closed through a resistor 31 which is at times shunted by back contact 41 of charging control relay CR. Charging current for battery 2Q is supplied from secondary winding 21 of transformer TC through a rectifier 32. A manually controllable switch SW is shown in the primary control circuit for transformer TB for at times opening this circuit by hand.

Referring now to Fig. 2, the circuits for controlling the checking relay CH, track transformer TT, and tuned alternator TUA for the modified form here shown are the same as in Fig. 1, and have therefore been omitted from Fig. 2.

In Fig. 2, the interlocking relay windings 1XR and 5XR are controlled only by the track relays. The interlocking relay is here shown provided with the well-known type of contact referred to as a flagman contact, which is a front contact which opens if the associated winding is first deenergized, but which remains closed if the associated winding becomes deenergized after the other winding for the interlocking relay has become deenergized. Flagman contacts 67 and 1XR—72 are associated with winding 1XR, and flagman contacts 66 and 5XR—73 are associated with winding 5XR.

A slow releasing signal relay XRP is controlled by a contact of checking relay CH and by flagman contacts of windings 1XR and 5XR. Flasher relay FL is here controlled by a back contact of relay XRP. The signal lights are here controlled by a back contact of relay XRP instead of by back contacts of the interlocking relay. Power-off relay POAA has a pick-up circuit including a front contact of relay XRP, and a stick circuit including one of its own front contacts. Charging control relay CR is here controlled by flagman contacts of the interlocking relay in multiple with a back contact of relay XRP, which are in series with a front contact of relay POB.

Transformers TB and TC, battery 1Q, and rectifier 30 are omitted from the modified form of apparatus shown in Fig. 2. Power-off relay POB is here controlled from secondary winding 16 of transformer TA instead of from transformer TB shown in Fig. 1. The contact 41 of relay CR, and resistor 31, are here placed between rectifier 32 and secondary winding 17 of transformer TA instead of between rectifier 32 and battery 2Q as in Fig. 1. Switch SW is here shown in the primary control circuit for transformer TA instead of in the primary control circuit for transformer TB shown in Fig. 1.

In the modification shown in Fig. 3, repeater relay 5TRP is not used. A contact of track relay 5TR is here included in series with back contact 41 of relay CR. The apparatus shown in Fig. 3 is otherwise the same as in Fig. 1.

In the modification shown in Fig. 4, the control circuit for charging control relay CR includes a contact 34 which is periodically opened by a cam 33 operated by a synchronous motor M. Contact 34 of motor M is used instead of the contacts of track relay 5TR and repeater relay 5TRP shown in Fig. 1, and therefore relay 5TRP is eliminated from the modification shown in Fig. 4.

In Fig. 5, charging control relay CR is controlled by pole changing contacts of track relay 5TR instead of by the contacts of relays 5TR and 5TRP as shown in Fig. 1. Relay 5TRP is therefore not used in the modification shown in Fig. 5.

Having thus described, in general, the arrangement and operation of the several forms of apparatus shown embodying my invention, I shall now describe in detail the operation of the apparatus.

As shown in the drawings, all parts are in the normal condition, that is, relays 1TR, 3TR, 5TR, 1XR—5XR, POA, POB, 5TRP, CR and CH are energized; also relays POAA and XRP of Fig. 2 are energized; motor M of Fig. 4 is constantly operating cam 33; relay FL and tuned alternator TUA are deenergized; switch SW is closed; and the lamps of the signals are unlighted.

In the form of apparatus shown in Fig. 1, relay POA is shown energized from secondary winding 16 of transformer TA, and direct current relay POB is shown energized from secondary winding 19 of transformer TB, one half-wave of the current from secondary 19 passing through the left-hand portion of the winding of relay POB and through an asymmetric unit 35 such, for example, as a half-wave copper oxide rectifier, and the other half-wave of the current from winding 19 passing through the right-hand portion of the winding of relay POB through asymmetric unit 36.

The storage battery 1Q is here shown being charged from secondary winding 17 of transformer TA through full-wave rectifier 30.

With track relay 5TR energized, track repeater relay 5TRP is energized by its circuit passing from terminal BB of battery 2Q, through contact 5TR—37, and the winding of relay 5TRP to terminal CC of battery 2Q.

Charging control relay CR is shown energized by its circuit passing from terminal BB of battery 2Q, through contact 5TR—38, contact 40 of relay POB, and the winding of relay CR to terminal CC of battery 2Q. The charging circuit for battery 2Q is shown closed through resistor 31, and includes rectifier 32.

With the track relays energized and relay POB energized, the primary winding 27 of transformer TD is energized by a circuit passing from terminal BX of the main source of power, through the front point of contact 42 of relay POB, contacts 5TR—43, 3TR—44, and 1TR—45 in series with each other and in multiple with contact 46 of relay CH and primary winding 27 of transformer TD to terminal CX of the main source of power. With primary winding 27 of transformer TD energized, checking relay CH is energized from secondary winding 28 of transformer TD through rectifier 29.

With relay POB energized, primary winding P of track transformer TT is energized by a circuit passing from terminal BX, through the front point of contact 42 of relay POB, terminal 11 of primary winding P, primary winding P to

the left of terminal 11, and terminal 12 of primary winding P to terminal CX.

With checking relay CH and the track relays energized, winding 1XR of the interlocking relay is energized by a circuit passing from terminal B of battery 1Q, through contact CH—47, contact 48 of relay 3TR, contact 49 of relay 1TR, and winding 1XR to terminal C of battery 1Q. Winding 5XR is also energized by a circuit passing from terminal B, through contact CH—47, contact 48 of relay 3TR, contact 50 of relay 5TR, and winding 5XR to terminal C.

I shall assume that a train moves over the stretch of track from left to right as shown in the drawings, which I shall assume is the east-bound direction. When the train enters section a—b, relay 1TR becomes deenergized, thereby releasing contact 49 which opens the circuit previously traced for winding 1XR. Relay FL then becomes energized by a circuit passing from terminal B, through contact 51 of winding 1XR, and winding of relay FL to terminal C. Contact element 56 of relay FL thereupon moves to one of its extreme positions, which I shall assume is to the left, in which it engages contact element 57. Lamp LSAL of signal unit LSA is now lighted by a circuit passing from secondary winding 16 of transformer TA, through the front point of contact 53 of relay POA, contact 55 of relay winding 1XR, contact 56—57 of relay FL, lamp LSAL, and the front point of contact 62 of relay POA back to secondary winding 16 of transformer TA. At the same time, lamp RSBL of signal unit RSB is lighted by a similar circuit which includes contact 59—60 of relay FL instead of contact 56—57 of this relay. Contact elements 59 and 60 then swing to the right-hand position, and lamps LSBL and RSAL are lighted by similar circuits. The lamps of the units of each of the signals are therefore alternately lighted or flashed. The portion of the circuit for primary winding 27 of transformer TD including contact 1TR—45 is now open, but the portion including contact 46 of relay CH is still closed, and therefore primary winding 27 remains energized, and also continues to remain energized after contacts 3TR—44 and 5TR—43 become opened when relays 3TR and 5TR become deenergized.

When the train enters section b—c, relay 3TR becomes deenergized, thereby deenergizing winding 5XR. On account of winding 1XR being already deenergized, contact 52 of winding 5XR is kept from closing.

Relay 5TR, upon becoming deenergized, opens its contacts 5TR—37 and 5TR—38 in the circuits previously traced for relays 5TRP and CR, respectively. Relay CR is therefore deenergized, causing its contact 41 to form a shunt path around resistor 31 in the charging circuit for battery 2Q. Relay 5TRP being of a slow releasing type, its contact 39 does not at once close, but closes after the lapse of a brief period of time, thereby completing a second circuit for energizing relay CR, this circuit passing from terminal BB, through contact 39 of relay 5TRP, contact 40 of relay POB, and the winding of relay CR to terminal CC of battery 2Q. If battery 2Q is fully charged, relay CR will at once open its contact 41, but if battery 2Q is not fully charged, contact 41 of relay CR will remain closed until battery 2Q becomes fully charged.

When the train leaves section b—c, winding 1XR again becomes energized by its circuit previously traced. Contact 51 of winding 1XR

thereupon opens the circuit for flasher relay FL, and contact elements 56 and 59 of relay FL then come to rest in the position shown. At the same time, contact 55 of winding 1XR opens the circuits previously traced for the signal lights controlled by flasher relay FL, causing the lights to be extinguished. Winding 5XR remains deenergized as long as the train occupies section c—d, but its contact 52 will still remain open due to the interlocking feature.

The apparatus embodying my invention is so designed and proportioned that normally in the event of failure of the main source of power, tuned alternator TUA will start operating, and through its contacts, the auxiliary source of power, battery 2Q, will energize transformer TT before track relays 1TR, 3TR, and 5TR have had time to release their front contacts, and hence the front contacts of these relays will remain closed. If, however, due to a loose connection or to some other cause, the tuned alternator TUA fails to start immediately, causing the track relays to become deenergized and open their front contacts, checking relay CH will ensure safe control of the highway crossing signals by the interlocking relay.

I shall now assume that the main source of power fails, and that for some reason the tuned alternator fails to start operating immediately, and that hence the track relays become deenergized. I shall further assume that track relay 5TR opens its front contacts before relays 1TR and 3TR open theirs. The interlocking relay armature associated with winding 5XR will therefore drop before the armature associated with winding 1XR drops. In the well-known interlocking relay operation, the armature of winding 5XR will therefore close its back contacts 52 and 54, but the armature of winding 1XR will be prevented from closing its back contacts 51 and 55. Relay FL then becomes energized by a circuit which is the same as the circuit previously traced except that it includes contact 52 of winding 5XR instead of contact 51 of winding 1XR. The signal lights will then be flashed as previously described.

I shall also further assume that before either the main source of power is restored or the track circuits are energized from the auxiliary source, an eastbound train enters section a—b, and that the main source of power is then restored or the auxiliary source becomes operative to energize relays 3TR and 5TR. On account of the failure of both the main and auxiliary sources of power, checking relay CH has become deenergized and its contact CH—47 has opened. Relay CH cannot again become energized while the train occupies section a—b, and hence the winding 5XR cannot become energized, although relays 3TR and 5TR are now energized. Winding 5XR will therefore remain deenergized, and its back contacts 52 and 54 will remain closed, causing the lamps of the signals to be flashed while the train is approaching the crossing.

If the back contacts of winding 5XR were opened while the back contacts of winding 1XR were still held open, the signal lights would be extinguished before the approaching train reached the intersection, which would, of course, be a dangerous condition.

On account of contact CH—47 in the circuits for windings 1XR and 5XR, neither of these windings of the interlocking relay can again become energized until relay CH has again become

energized after the train has cleared all three of the track sections a—b, b—c and c—d. Therefore, the flashing of the signal lamps will not be stopped while a train is approaching the crossing from either direction.

Although relay CH releases under the conditions referred to, it is, however, slow enough in releasing that it will not release during the normal transfer period from the main source of power to the auxiliary source while one of the track sections a—b, b—c and c—d is occupied.

The charging circuits for battery 2Q, including a back contact 41 of relay CR in multiple with resistor 31, provide one or the other of two different charging rates for battery 2Q according as back contact 41 of relay CR is open or closed. Relay CR, whenever it becomes deenergized due to deenergization of relay POB, or due to the deenergization of track relay 5TR as shown in Figs. 1, 3 and 5, or by other means shown in Figs. 1, 2 and 4, releases its armature which then closes its back contact 41. This contact, by shunting around resistor 31, permits a higher charging current to be supplied from rectifier 32 to battery 2Q. As already mentioned, relay CR, after becoming deenergized, will not open its back contact 41 when one of its control circuits is again closed, until battery 2Q is fully charged.

The characteristics of relay CR are also such that it will not release and close its back contact 41 upon a decrease in the voltage in battery 2Q while a control circuit for relay CR is closed, until the battery is completely discharged. Unless some means were provided for at times opening the control circuit for relay CR, other than the failure of the main source of power causing power-off relay POB to become deenergized, battery 2Q might, therefore, become under-charged if the voltage of the main source of power were to remain low for a prolonged period of time, but if it were not low enough to cause relay POB to release front contact 40. All that is necessary for this purpose is to open the energizing circuit for relay CR long enough to cause its armature to drop. As soon as battery 2Q becomes fully charged after contact 41 of relay CR is closed, relay CR will again open this contact.

The desired result can be accomplished by means of a switch SW shown in the primary circuit for transformer TB in Fig. 1 and in the primary circuit for transformer TA in Fig. 2, which can be periodically opened manually by some authorized person such, for example, as a signal maintainer. Another means, for accomplishing this result automatically, is also shown in Fig. 1 as contact 5TR—38, by which relay CR becomes deenergized whenever a train enters section c—d. Contact 39 of relay 5TRP protects against overcharge if the train should remain in section c—d too long.

In the modification of the apparatus shown in Fig. 2, contact CH—47 is omitted from the circuits for energizing interlocking relay 1XR—5XR, but is included in the circuit for slow releasing signal relay XRP, this circuit passing from terminal BB, through contact CH—47, flagman contacts 66 and 67 of interlocking relay windings 5XR and 1XR, respectively, and the winding of relay XRP to terminal CC. Flasher relay FL is here controlled by a back contact 68 of slow release signal relay XRP.

Relay POAA is provided with a pick-up circuit passing from the upper terminal of secondary winding 16 of transformer TA, through one or

the other of the rectifiers 35 and 36 and the corresponding portion of the winding of the relay POAA, and the front point of contact 70 of relay XRP to the lower terminal of the secondary winding 16 of transformer TA. Relay POAA, upon becoming energized, is retained energized by a stick circuit passing from the upper terminal of secondary winding 16 of transformer TA, through the asymmetric units 35 and 36 and the corresponding portions of the winding of relay POAA, and the front point of contact 69 of relay POAA, to the lower terminal of secondary winding 16 of transformer TA. Relay POAA, upon becoming deenergized, can therefore not again become energized until relay XRP is energized. It follows that if relay POAA should release its contacts due to low voltage while a train is approaching the crossing, relay POAA cannot then alternately pick up and release its contacts and thus cause interruptions in the energization of the signal lights from the auxiliary source of power while a train is approaching.

In Fig. 2, the operating circuits for the lights of the signals pass from the lower terminal of secondary winding 16 of transformer TA, through the front point of contact 69 of relay POAA, back point of contact 70 of relay XRP, contact elements 56 and 59 of relay FL in the left-hand or right-hand position, and the corresponding lamps of the crossing signals, and the front point of contact 71 of relay POAA to the upper terminal of secondary winding 16 of transformer TA. The lighting circuits for the highway crossing signals are here supplied with current from battery 2Q through the back points of contacts 69 and 71, when the main source of power fails.

In Fig. 2, the charging control relay CR is normally energized by a circuit passing from terminal BB, through flagman contacts 1XR—72 and 5XR—73, contact 40 of relay POB, and the winding of relay CR to terminal CC. When one or the other of the flagman contacts 1XR—72 and 5XR—73 becomes opened due to the approach of a train, the circuit just traced for relay CR will be opened and, after a brief period of time which is long enough for contact 41 of relay CR to close, a second circuit for relay CR will be closed, which is the same as the circuit just traced except including contact XRP—74 instead of the flagman contacts.

In Fig. 3, relay CR is controlled by a circuit including contact 5TR—38 as in Fig. 1, but relay 5TRP, and its contact 39 included in multiple with contact 5TR—38 in Fig. 1, are here omitted. A contact designated 5TR—63 is, however, here included in series with contact 41 of relay CR in the charging circuit for battery 2Q for preventing overcharging of battery 2Q in the event of the prolonged occupancy of track section c—d.

In the arrangement shown in Fig. 4, relay CR is controlled by a circuit which includes contact 34 which is periodically opened, such for example as once every twenty-four hours, by some suitable means such, for example, as a synchronous motor M through a cam 33.

In the arrangement shown in Fig. 5, relay CR is caused to momentarily release its armature and close its back contact 41, when a train enters section c—d, by including pole changing contacts of relay 5TR in the control circuit for relay CR. The reversal of polarity occasioned by the opening of contacts 5TR—64 and 5TR—65 at the front points and the closing of these contacts at their back points, or the opening of these contacts at their back points and the subsequent

closing at their front points, causes relay CR to momentarily release its armature and close its back contact 41.

Although I have described the operation of the apparatus shown in the accompanying drawings for only a few typical sets of conditions, it is believed that the operation of the apparatus can be readily traced, in view of this description and the accompanying drawings, for every other possible set of conditions, including westbound traffic movements. When an eastbound train occupies section a—b, and when a westbound train occupies section c—d, the highway crossing signals will be operated to warn users of the highway that a train is approaching. These signals continue to be operated when either an eastbound or a westbound train occupies section b—c.

From the foregoing description and the accompanying drawings, it follows that in apparatus embodying my invention, I have provided checking means which ensures that the operation of a highway crossing signal will not be falsely stopped, while a train is approaching a highway crossing, in event of failure of a main source of power for energizing the track circuits and the subsequent arrival of a train followed by energization of the track circuits by the main or an auxiliary source before the train reaches the crossing. The checking means could also be used to protect against momentary interruptions of a single main source of power if the auxiliary source were omitted. I have also provided means for controlling the charging rate for an auxiliary source of power comprising a storage battery, to prevent undercharging and overcharging of the battery.

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 combination, a stretch of railway track intersected by a highway and including two sections the first of which extends in one direction from said intersection and the second of which extends in the opposite direction from said intersection, a track circuit including a track relay for each of said sections, a main source of power for normally energizing said track circuits, an auxiliary source of power comprising a storage battery for energizing said track circuits if said main source fails, a charging control relay, a circuit for energizing said charging control relay by current from said storage battery, means controlled by said main source of power for opening said circuit for said charging control relay whenever said main source of power fails, a resistor, a circuit including said resistor in multiple with a back contact of said charging control relay for charging said storage battery from said main source of power, a checking stick relay, a pick-up circuit for said checking stick relay controlled by said track relays and a stick circuit for said checking stick relay controlled by a contact operated in response to current from said main source of power and both of said pick-up and stick circuits normally energized by current from said main source of power but energized from said storage battery if said main source fails and becoming deenergized if both said main and auxiliary sources fail, highway signal means adjacent said intersection, directional means controlled by

said track relays for normally effecting energization of said highway signal means while a train is approaching said intersection but for discontinuing such energization while a train is receding from said intersection in one of said track sections or the other, and means controlled by said checking relay for effecting energization of said highway signal means whenever said checking relay is deenergized and one of said sources of power is subsequently restored while either of said sections is occupied by a train.

2. In combination, a stretch of railway track intersected by a highway, a first circuit responsive to a train on said stretch of track adjacent and in a first direction from said intersection, a second circuit responsive to a train on said stretch of track adjacent and in the opposite direction from said intersection, a main source of power for normally energizing said first and second circuits, an auxiliary source of power comprising a storage battery for energizing said first and second circuits if said main source fails, a charging control relay, means for energizing said charging control relay by current from said storage battery, means controlled by said main source of power for deenergizing said charging control relay if said main source of power fails, means controlled in part by a back contact of said charging control relay for supplying charging current of greater magnitude to said storage battery when said back contact is closed than when said back contact is open, a checking relay, a pick-up circuit for said checking relay controlled by said first and second circuits and a stick circuit for said checking relay controlled by a contact which is responsive to current from said main source of power for normally energizing said checking relay by current from said main source of power and for energizing said checking relay from said storage battery if said main source fails and said checking relay becoming deenergized if both said main and auxiliary sources fail, highway signal means adjacent said intersection, directional means controlled by said first and second circuits for normally effecting energization of said highway signal means while a train is approaching adjacent said intersection but for discontinuing such energization while a train is receding from said intersection, and means controlled by said checking relay for effecting energization of said highway signal means if said checking relay is deenergized and if one of said sources of power is subsequently restored while either said first or said second circuit is deenergized in response to a train.

3. In combination, a stretch of railway track intersected by a highway and including two sections the first of which extends in one direction from said intersection and the second of which extends in the opposite direction from said intersection, a track circuit including a track relay for each of said sections, a main source of power for normally energizing said track circuits, an auxiliary source of power for energizing said track circuits if said main source fails, a checking stick relay, a pick-up circuit for said checking stick relay controlled by a front contact of each of said track relays and a stick circuit for said checking stick relay controlled by a contact operated in response to current from said main source of power and both of said pick-up and stick circuits normally energized by current from said main source of power but energized from said auxiliary source if said main source fails and becoming deenergized if both said main and

auxiliary sources fail, highway signal means adjacent said intersection, directional means controlled by said track relays for normally effecting energization of said highway signal means while a train is approaching said intersection but for discontinuing such energization while a train is receding from said intersection in one of said track sections or the other, and means controlled by said checking relay for effecting energization of said highway signal means if said checking relay is deenergized and one of said sources of power is subsequently restored while either of said sections is occupied by a train.

4. In combination, a stretch of railway track intersected by a highway, a first circuit responsive to a train on said stretch of track adjacent and in a first direction from said intersection, a second circuit responsive to a train on said stretch of track adjacent and in the opposite direction from said intersection, a main source of power for normally energizing said first and second circuits, an auxiliary source of power for energizing said first and second circuits if said main source fails, a checking relay, a pick-up circuit for said checking relay controlled by said first and second circuits and a stick circuit for said checking relay controlled by a contact which is responsive to current from said main source of power for normally energizing said checking relay by current from said main source of power and for energizing said checking relay from said auxiliary source if said main source fails and said checking relay becoming deenergized if both said main and auxiliary sources fail, highway signal means adjacent said intersection, directional means controlled by said first and second circuits for normally effecting energization of said highway signal means while a train is approaching adjacent said intersection but for discontinuing such energization while a train is receding from said intersection, and means controlled by said checking relay for effecting energization of said highway signal means if said checking relay is deenergized and if one of said sources of power is subsequently restored while either said first or said second circuit is deenergized in response to a train.

5. In combination, a stretch of railway track intersected by a highway, a first circuit responsive to a train on said stretch of track adjacent and in a first direction from said intersection, a second circuit responsive to a train on said stretch of track adjacent and in the opposite direction from said intersection, a main source of power for normally energizing said first and second circuits, a checking relay, a pick-up circuit for said checking relay controlled by said first and second circuits for energizing said checking relay by current from said main source of power, means controlled by a contact operated in response to current from said main source of power for retaining said checking relay energized by current from said main source of power when a train approaches said intersection and said checking relay becoming deenergized if said main source of power fails, highway signal means adjacent said intersection, directional means controlled by said first and second circuits for normally effecting energization of said highway signal means while a train is approaching adjacent said intersection but for discontinuing such energization while a train is receding from said intersection and means controlled by said checking relay for effecting energization of said highway signal means if said checking relay is de-

energized and if said main source of power is subsequently restored while either said first or said second circuit is deenergized in response to a train.

6. In combination, a stretch of railway track intersected by a highway, a first circuit responsive to a train on said stretch of track adjacent and in a first direction from said intersection, a second circuit responsive to a train on said stretch of track adjacent and in the opposite direction from said intersection, a main source of power for energizing said first and second circuits, a checking stick relay, a pick-up circuit for said checking stick relay closed by said first and second circuits when there is no train on said stretch of track adjacent said intersection and a stick circuit for said checking stick relay controlled by a contact operated in response to current from said main source of power and both of said pick-up and stick circuits energized by current from said main source of power and becoming deenergized if said main source of power fails, highway signal means for said intersection, directional means controlled by said first and second circuits for normally effecting energization of said highway signal means while a train is approaching said intersection but for discontinuing such energization while a train is receding from said intersection, and means controlled by said checking relay for effecting energization of said highway signal means if said main source

of power fails and if said main source of power is subsequently restored while either said first or said second circuit is deenergized in response to a train.

7. In combination, a stretch of railway track intersected by a highway, a first circuit responsive to a train on said stretch of track adjacent and in a first direction from said intersection, a second circuit responsive to a train on said stretch of track adjacent and in the opposite direction from said intersection, a main source of power normally energizing said first and second circuits, an auxiliary source of power comprising a storage battery for energizing said first and second circuits if said main source fails, a charging control relay, an interlocking relay one winding of which is controlled by said first circuit and the other winding of which is controlled by said second circuit and each of said windings controlling flagman contacts, a slow release relay, a circuit controlled by a flagman contact of each of said interlocking relay windings in series with each other for energizing said slow release relay, a control circuit for said charging control relay including a flagman contact of each of said interlocking relay windings in series with each other and in multiple with a back contact of said slow release relay, and means controlled by said charging control relay for charging said storage battery.

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