April 27, 1954 B. MISHELEVICH 2,677,047

APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

Filed Dec. 24, 1951 3 Sheets-Sheet 1

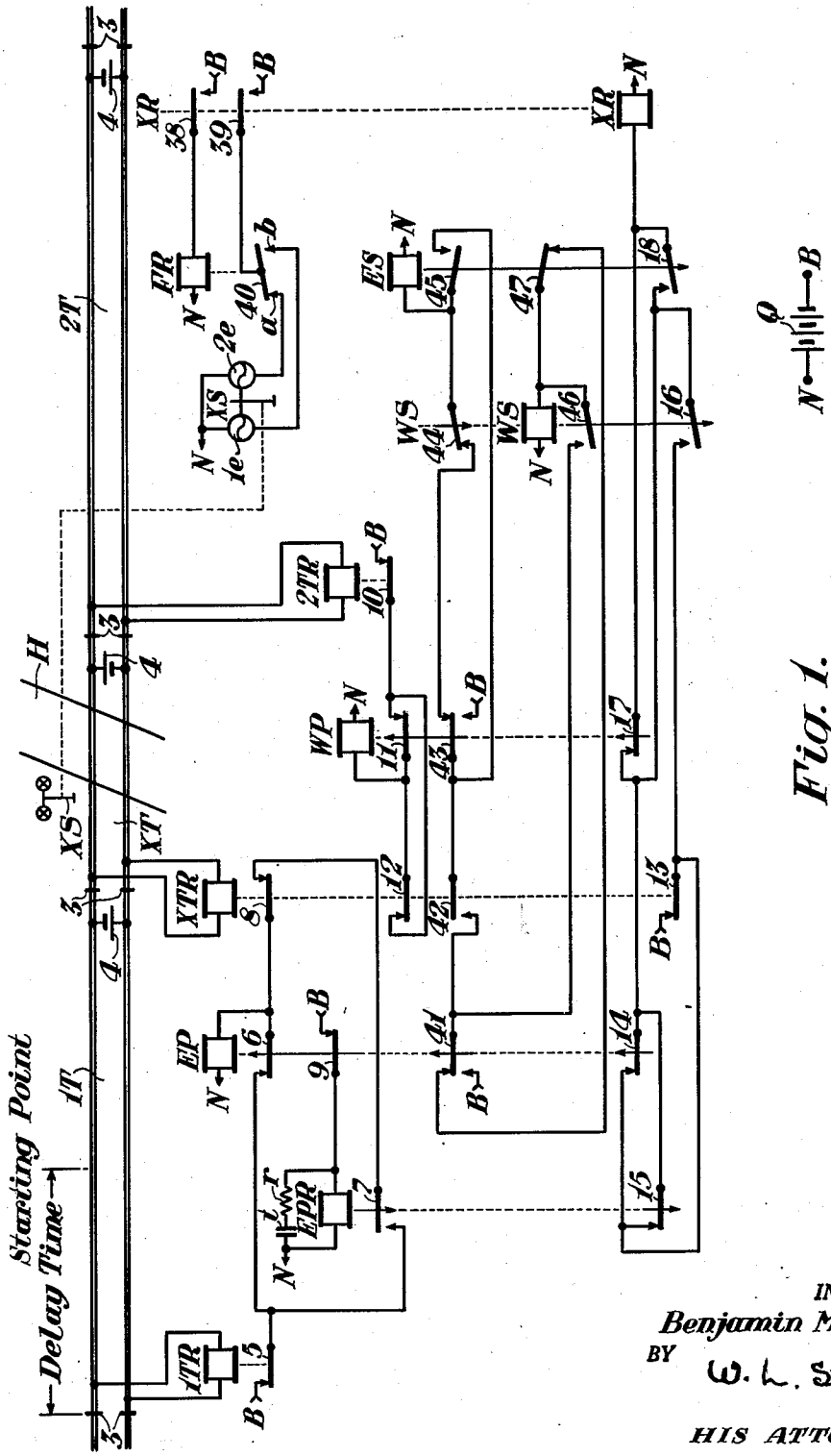


Fig. 1.

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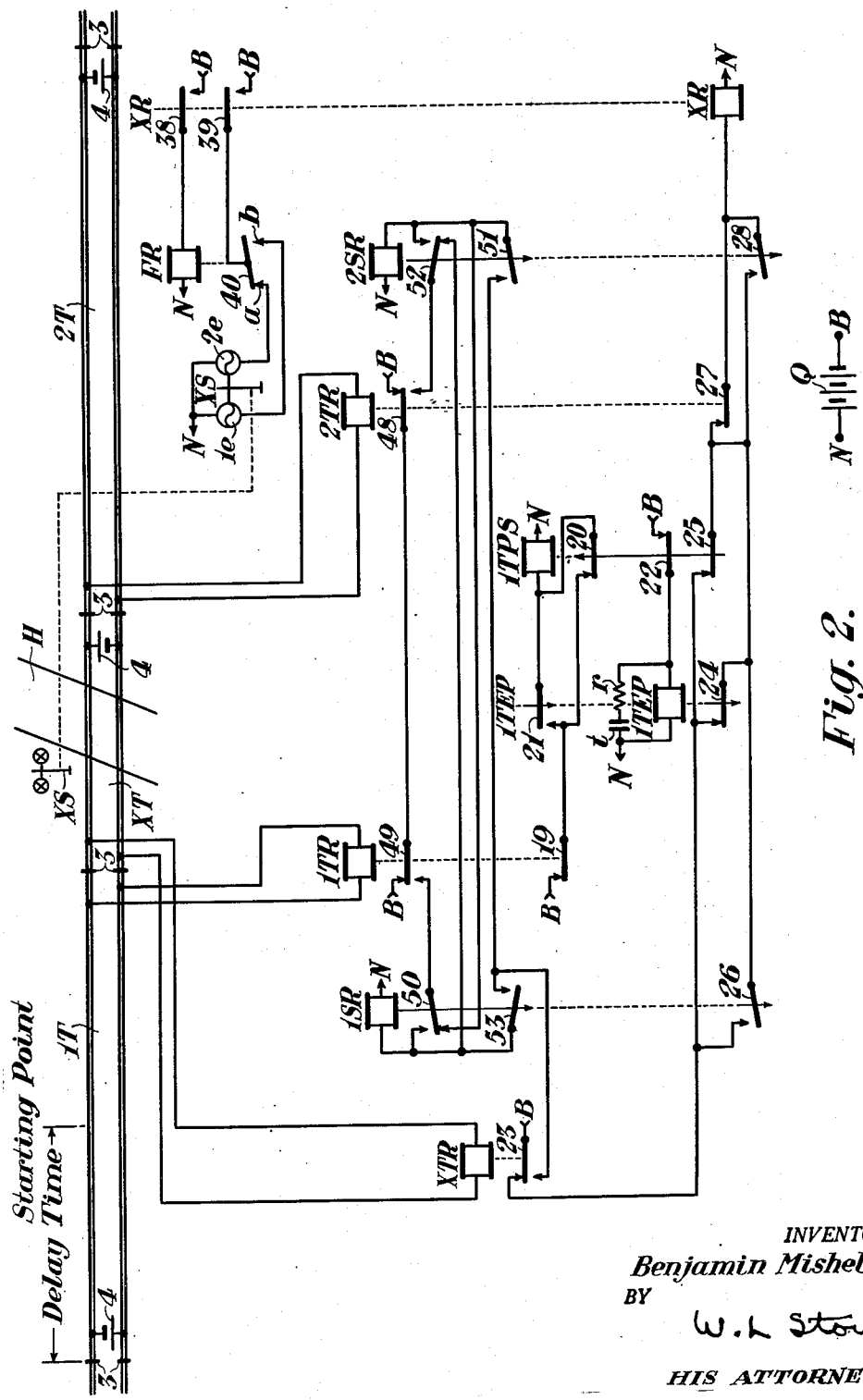


Fig. 2.

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Filed Dec. 24, 1951 3 Sheets-Sheet 3

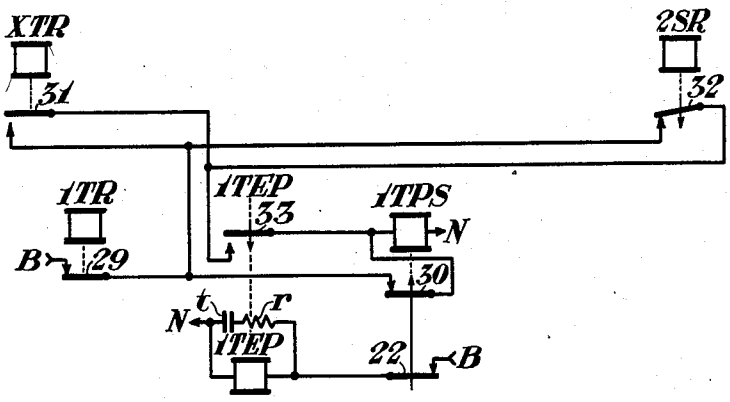


Fig. 3.

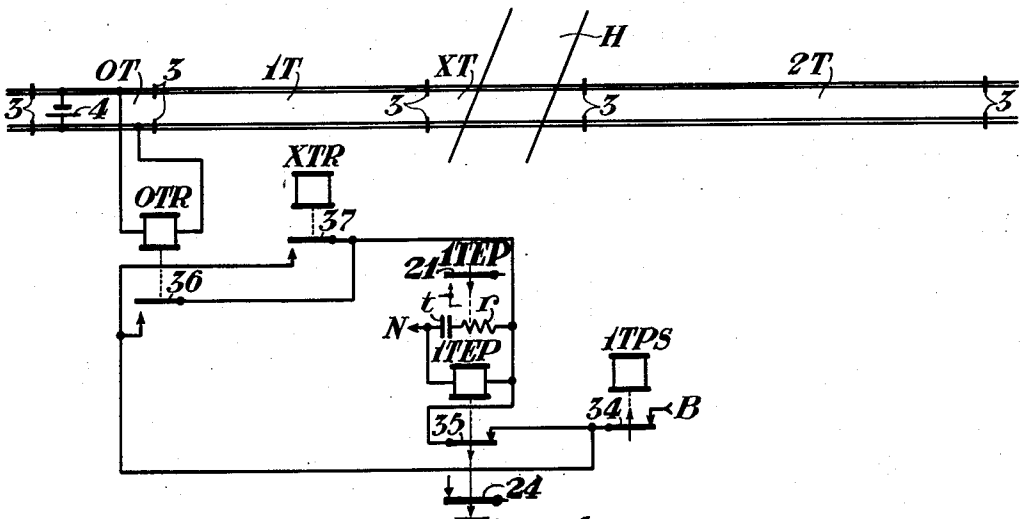


Fig. 4.

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2,677,047

UNITED STATES PATENT OFFICE

2,677,047

APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

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Application December 24, 1951, Serial No. 263,037

13 Claims. (Cl. 246—130)

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My invention relates to apparatus for controlling highway crossing signals, and particularly to apparatus for protecting against momentary losses of track circuit shunt in highway crossing signal control systems which embody an energy storing device, such for example as a capacitor, for delaying the starting of the operation of a highway crossing signal when a train approaches within a given distance of the intersection of a highway with a railway track.

It is important that a highway crossing signal be operated long enough before the arrival of a train at the intersection of a highway with a railway track, to provide ample warning to users of the highway that a train is approaching, so that users of the highway will have sufficient time to get into the clear. It is, however, desirable that a highway crossing signal be not operated so long before the arrival of a train at the intersection as to unduly delay users of the highway and thereby cause them to become careless about obeying the indications given by highway crossing signals.

It is well-known practice to install insulated joints for dividing a railway track into approach and crossing track sections adjacent an intersection of a highway with a railway track, for starting the operation of a highway crossing signal in response to the arrival of a train within a given distance of the highway crossing, and for continuing the operation of the highway crossing signal while the train is moving over the crossing. If train movements are in both directions over the track, an approach control section is provided in each direction from the intersection. Operation of a highway crossing signal is started when a train approaching an intersection enters the corresponding approach control section, and is continued until the train vacates the crossing track section.

From the standpoint of maintenance costs of insulated track joints, as well as of the original cost of installing them, it is desirable to keep from dividing a railway track into any more sections than can be avoided. If, for some other purpose, such, for example, as the control of a railway signal, insulated joints are already installed in a railway track in the vicinity of an intersection of a highway with the railway track, but at a location which is farther from the intersection or crossing than is necessary for providing ample warning to users of the highway when a train is approaching the intersection, a capacitor-resistor arrangement can be used for delaying the starting of the operation of a highway crossing signal for a desired period of time after the leading end of a train approaching the intersection has passed over these insulated joints.

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It has been found, however, that in a highway crossing signal control system in which a capacitor-resistor arrangement is employed for delaying the starting of operation of a highway crossing signal when a train enters an approach control track section, there may be a dangerous condition if there should be a momentary loss of track circuit shunt of the approach control track section. This is because the capacitor in the capacitor-resistor arrangement may become recharged because of a momentary loss of track circuit shunt, and delay still further the starting of the operation of the highway crossing signal. If the momentary loss of shunt of the track circuit for an approach track section should occur near the end of the delay period normally provided by the capacitor-resistor arrangement, the resulting delay period might be almost double the normal delay period intended, so that the highway crossing signal would provide very little, if any, warning of the approach of a train before the train arrived on the crossing track section.

An object of my invention is therefore the provision of means for protecting against a momentary loss of shunt of the track circuit for an approach control section in a highway crossing signal control system in which a capacitor-resistor arrangement is used for delaying the starting of operation of a highway crossing signal after a train enters the approach control section.

A feature of my invention, for accomplishing this object, is the provision of means to prevent the capacitor from becoming recharged, in the event of a momentary loss of shunt of a corresponding approach control track section, until the lapse of a period of time which is longer than the duration of any momentary loss of track circuit shunt which might be expected to occur.

I shall describe four 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 embodying my invention, in which a railway track which is intersected by a highway designated by the reference character H, is divided to form a crossing track section, designated by the reference character XT, at the highway, and a first and a second approach control track section, designated by the reference characters 1T and 2T, respectively, adjacent the opposite ends of the

crossing track section XT; in which a first and a second control stick relay, designated by the reference characters EP and WP, respectively, are of the slow pickup type; in which a repeater relay, designated by the reference character EPR, is controlled by a front contact of the first control stick relay EP, and is made slow releasing by a capacitor and a resistor connected in series with each other in a path which is in multiple with the winding of the repeater relay EPR; in which relay EP is controlled by means including a back contact of the repeater relay EPR; and in which a crossing signal control relay, designated by the reference character XR, is controlled by a circuit which includes contacts of the repeater relay EPR and the first control stick relay EP; Fig. 2 is a diagrammatic view showing a modified form of apparatus, also embodying my invention, in which a control stick relay of the track repeater stick relay type, designated by the reference character 1TPS, is also of the slow pickup type; in which a second repeater relay, designated by the reference character 1TEP, is controlled by a front contact of relay 1TPS, and is made slow releasing by a capacitor and a resistor connected in series with each other in a path which is in multiple with the winding of the second repeater relay 1TEP; and in which a crossing signal control relay XR is controlled by a circuit which includes contacts of the relay 1TPS and the second repeater relay 1TEP; Fig. 3 is a diagrammatic view showing a modification of the control circuits for relay 1TPS shown in Fig. 2; and Fig. 4 is a diagrammatic view showing a modification of the control circuits for relay 1TEP shown in Fig. 2.

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

Referring further to Fig. 1 of the drawings, a highway crossing signal, designated by the reference character XS, which may be of any suitable design, but which, as shown in the drawings, is of the flashing light type, is located adjacent the intersection of the highway H with the railway track. I shall assume that train movements over the stretch of track from left to right, as shown in the drawing, are in the eastbound direction, and that therefore train movements in the opposite direction, from right to left, are in the westbound direction.

The rails of the railway track are divided by insulated joints 3 to form the crossing section XT at the intersection of the highway with the railway track, the first or eastbound approach control section 1T adjacent the west end of section XT, and the second or westbound approach control section 2T adjacent the opposite or east end of section XT.

Each of the track sections 1T, XT and 2T is provided with a track circuit which includes a suitable source of current, such as a battery 4, connected across the rails adjacent one end of the section, and a track relay, designated by the reference character R preceded by the reference character for the corresponding section, connected across the rails adjacent the opposite end of the section.

The first slow pickup control stick relay EP, which may also be referred to as an eastbound control stick relay, has a pickup and a stick circuit, both of which are controlled by a front contact 5 of the first approach track relay 1TR, and the pickup circuit is also controlled by a front contact 8 of the crossing track relay XTR and by a back contact 7 of the repeater relay EPR.

Repeater relay EPR is controlled by front contact 9 of relay EP. An energy storing device, such for example as a capacitor, designated by the reference character *t*, and a resistor, designated by the reference character *r*, are connected in series with each other in a path which is in multiple with the winding of relay EPR, and therefore relay EPR is rendered slow to release when its control circuit becomes opened by contact 9 of relay EP.

A first or eastbound direction stick relay, designated by the reference character ES, has a pickup circuit controlled by back contacts 41, 42 and 44 of relays EP, XTR and WS, respectively, and by the front point of a contact 43 of relay WP. Relay ES has two stick circuits, one of which is controlled by back contacts 41 and 42 of relays EP and XTR, respectively, and the other of which is controlled by the back point of contact 43 of relay WP.

A second or westbound direction stick relay, designated by the reference character WS, has pickup and stick circuits which are similar to the pickup and stick circuits just described for relay ES.

A crossing signal control relay, designated by the reference character XR, is controlled by front contacts of relays XTR, EP, EPR, WP, WS and ES, and is normally energized.

A flasher control relay, designated by the reference character FR, is controlled by a back contact 38 of relay XR, and is normally deenergized. Relay FR is of the well-known type having a movable contact element 40 which, while relay FR is energized, oscillates between a first position in which it engages a first fixed contact element *a*, and a second position in which it engages a second fixed contact element *b*.

As shown in the drawing, highway crossing signal XS comprises two lamps 1*e* and 2*e*, the lighting circuits for which include contacts 40*a* and 40*b* of relay FR, respectively, and a back contact 39 of relay XR. Lamps 1*e* and 2*e*, on account of being controlled by contact 39 of relay XR, are not lighted until relay XR becomes deenergized, causing its contact 38 to be closed in the circuit for energizing relay FR, and causing its contact 39 to become closed in the lighting circuits for signal XS. Lamps 1*e* and 2*e* of signals XS will then display a flashing indication, on account of being repeatedly lighted, alternately, through contacts 40*a* and 40*b* respectively, of relay FR.

The various control and lighting circuits may be energized by current from any suitable source such, for example, as a battery Q, shown in Fig. 1, having terminals B and N.

In the modified form of apparatus shown in Fig. 2, first and second, or eastbound and westbound direction stick relays, designated by the reference characters 2SR and 1SR, respectively, are controlled to become energized when eastbound and westbound trains enter the approach control sections 1T and 2T, respectively, whereas the direction stick relays ES and WS, shown in Fig. 1, do not become energized until an eastbound or a westbound train, respectively, enters the crossing track section XT. The direction stick relays ES and WS in Fig. 1, and the direction stick relays 1SR and 2SR in Fig. 2 are all of the slow release type.

The slow pickup control stick relay 1TPS of the track repeater stick type, in Fig. 2, has a pickup and a stick circuit, both of which are controlled by a front contact 19 of the first approach track relay 1TR. The pickup circuit

for relay 1TPS includes also a back contact 21 of the second repeater relay 1TEP.

The second repeater relay 1TEP is controlled by a front contact 22 of relay 1TPS, and is made slow releasing, similarly to relay EPR in Fig. 1, by a capacitor t and a resistor r connected in series with each other in a path which is in multiple with the winding of relay 1TEP.

Figs. 3 and 4 show modifications of the control circuits for relays 1TPS and 1TEP, respectively, of Fig. 2. In Fig. 4, an additional approach control track section, designated by the reference character 0T, is provided, having a track relay, designated by the reference character 0TR.

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 the normal condition, that is, each of the track sections is unoccupied, and therefore track relays 1TR, XTR, 2TR and 0TR are energized; relays EP, WP and EPR, shown in Fig. 1, are energized; relays 1TPS and 1TEP, shown in Figs. 2, 3 and 4 are energized; relay XR is energized; relays ES and WS, shown in Fig. 1, and relays 1SR and 2SR, shown in Fig. 2, are deenergized; and relay FR and signal XS are deenergized.

As shown in Fig. 1, relay EP is energized by its stick circuit passing from terminal B, through contact 5 of relay 1TR, contact 6 of relay EP, and the winding of relay EP to terminal N. Both the pickup and the stick circuit for relay WP are closed, the pickup circuit passing from terminal B, through contacts 10 and 12 of relays 2TR and XTR, respectively, and the winding of relay WP to terminal N. The stick circuit for relay WP is the same as the pickup circuit just traced, except that it includes contact 11 of relay WP instead of contact 12 of relay XTR. Relay EPR is energized by its circuit passing from terminal B, through contact 9 of relay EP, and a resistor r in series with a capacitor t in a path in multiple with the winding of relay EPR, to terminal N. Relay XR is energized by a circuit passing from terminal B, through contact 13 of relay XTR, contact 14 of relay EP in multiple with contact 15 of relay EPR, contact 17 of relay WP, and the winding of relay XR to terminal N.

As shown in Fig. 2, relay 1TPS is energized by its stick circuit passing from terminal B, through contact 19 of relay 1TR, contact 20 of relay 1TPS, and the winding of relay 1TPS to terminal N. Relay 1TEP is energized by its circuit which includes contact 22 of relay 1TPS, and is otherwise similar to the circuit traced for relay EPR in Fig. 1. Relay XR is here energized by a circuit passing from terminal B, through the front point of contact 23 of relay XTR, contact 24 of relay 1TEP in multiple with contact 25 of relay 1TPS, contact 27 of relay 2TR, and the winding of relay XR to terminal N.

As shown in Fig. 3, relay 1TEP is energized by a circuit which is the same as the circuit shown for relay 1TEP in Fig. 2. The stick circuit by which relay 1TPS is energized, as shown in Fig. 3, passes from terminal B, through contact 29 of relay 1TR, contact 30 of relay 1TPS, and the winding of relay 1TPS to terminal N.

As shown in Fig. 4, relay 1TEP is energized by a stick circuit passing from terminal B, through contact 34 of relay 1TPS, contact 35 of relay 1TEP, and a resistor r in series with a capacitor t in a path in multiple with the winding of relay 1TEP to terminal N.

I shall assume that, with apparatus embodying my invention arranged as shown in Fig. 1, an eastbound train enters section 1T, deenergizing relay 1TR. The stick circuit traced for relay EP will therefore be opened at contact 5 of relay 1TR, causing relay EP to be deenergized. Front contacts 6, 9, 14 and 41 of relay EP will therefore be opened. With contact 9 of relay EP opened, relay EPR will be disconnected from terminal B, but relay EPR is slow to release, because of the path through resistor r and capacitor t in multiple with the winding of relay EPR. Therefore, although contact 14 of relay EP is opened, the circuit for relay XR will temporarily remain closed through contact 15 of relay EPR, so that relay XR will remain energized for a brief period of time after the eastbound train enters section 1T.

By the time that contact 15 of relay EPR opens, the train will have arrived at a location designated on the drawing as the starting point. The distance of this starting point from the entering end of section 1T will of course vary for different trains, according to their speed, so that the higher the speed of the train the farther the starting point will be from the entering end of section 1T, and the nearer it will be to the intersection of the highway H with the railway track. The parts of the apparatus are so proportioned that, for a train traveling at highest speed, the starting point will be far enough from the intersection for signal XS to provide ample warning to users of the highway.

When contact 15 of relay EPR opens, relay XR will become deenergized, since contact 14 of relay EP is already open. With relay XR deenergized, relay FR will be energized by a circuit passing from terminal B, through contact 38 of relay XR, and the winding of relay FR to terminal N. Relay FR, upon thus becoming energized, will oscillate its movable contact element 40 to repeatedly engage alternately the fixed contact elements a and b. With relay XR deenergized, and with the movable element 40 engaging the fixed contact element a, lamp 2e of signal XS will be lighted by a circuit passing from terminal B, through contact 39 of relay XR, contact 40a of relay FR, and lamp 2e to terminal N. When movable contact element 40 engages the fixed contact element b, lamp 1e of signal XS will be lighted by a similar circuit passing from terminal B, through contact 39 of relay XR, contact 40b of relay FR, and lamp 1e to terminal N.

When the train enters section XT, deenergizing relay XTR, contact 8 of relay XTR will become opened in the pickup circuit for relay EP, which is, however, already deenergized on account of contact 5 of relay 1TR being open. Contact 12 of relay XTR will now be opened in the pickup circuit for relay WP which will, however, remain energized by its stick circuit previously traced. Contact 13 of relay XTR will now also be opened in the circuit traced for relay XR which is, however, already deenergized on account of contacts 14 and 15 of relays EP and EPR, respectively, being open.

With relays EP and XTR deenergized, relay ES will become energized by its pickup circuit passing from terminal B, through the back point of contact 41 of relay EP, contact 42 of relay XTR, front point of contact 43 of relay WP, contact 44 of relay WS, and the winding of relay ES to teminal N. Relay ES, upon becoming

energized, will complete a first stick circuit, passing from terminal B, through the back point of contact 41 of relay EP, contact 42 of relay XTR, contact 45 of relay ES, and the winding of relay ES to terminal N.

When the train enters section 2T, deenergizing relay 2TR, relay WP will become deenergized because of the opening of contact 10 of relay 2TR. With relay WP deenergized, a second stick circuit will be completed for relay ES, this circuit passing from terminal B, through the back point of contact 43 of relay WP, contact 45 of relay ES, and the winding of relay ES to terminal N.

When the train leaves section XT, relay EP will become energized by its pickup circuit passing from terminal B, through contact 5 of relay 1TR, contact 7 of relay EPR, contact 8 of relay XTR, and the winding of relay EP to terminal N. Relay EP is of the slow pickup type, and therefore its front contacts will not become closed until after the lapse of a brief period of time. Relay EP, upon closing its contact 6, will complete its stick circuit previously traced.

When contact 9 of relay EP becomes closed, relay EPR will become energized by its circuit previously traced. Contact 41 of relay EP, upon becoming opened at its back point, will open the first stick circuit traced for relay ES. Relay ES will, however, now remain energized by its second stick circuit, previously traced. When contact 14 of relay EP becomes closed, relay XR will become energized by a circuit passing from terminal B, through contact 13 of relay XTR, contact 14 of relay EP, contact 18 of relay ES, and the winding of relay XR to terminal N. Relay XR, upon becoming energized, will open its contacts 38 and 39, thereby deenergizing relay FR and signal XS.

When the train leaves section 2T, permitting relay 2TR to again become energized, relay WP will become energized by its pickup circuit previously traced. Relay WP is, however, of the slow pickup type, and therefore will not close its front contacts until upon the lapse of a brief period of time after contact 10 of relay 2TR becomes closed. When contact 11 of relay WP becomes closed, the stick circuit previously traced for relay WP will be completed. Relay WP, upon opening its contact 43 at the back point, will open the second stick circuit traced for relay ES, causing relay ES to be deenergized. All parts of the apparatus will therefore now again be in the normal condition.

I shall now assume that, with all parts of the apparatus again in the normal condition, an eastbound train enters section 1T, effecting deenergization of relay EP, I shall assume further that, just before relay EPR releases its contacts, a momentary loss of shunt of the track circuit for section 1T occurs, so that relay 1TR closes its contact 5 for a brief period of time. Contact 7 of relay EPR, upon becoming closed at the end of its release period, will again complete the pickup circuit previously traced for relay EP. With contact 15 of relay EPR now open, relay XR will become deenergized, and therefore relay FR will be energized, and the lamps of signal XS will be displaying a flashing indication.

Relay EP, being of the slow pickup type, will not again close its front contacts before the end of the momentary loss of track circuit shunt, at which time, contact 5 of relay 1TR will again be opened, causing relay EP to again be deenergized without having closed its front contacts. Since contact 14 of relay EP therefore does not become closed during the momentary loss of shunt, relay XR will remain deenergized, and the operation of signal XS will be continued without interruption because of the momentary loss of track circuit shunt.

I shall next assume that all parts of the apparatus are again returned to the normal condition, and that again an eastbound train enters section 1T, causing relay EP to be deenergized. I shall assume further, that a loss of shunt of the track circuit for section 1T occurs after relay EPR has released its contacts. Therefore, the pickup circuit for relay EP will be completed as soon as relay 1TR closes its contact 5 because of the momentary loss of track circuit shunt. However, since relay EP is of the slow pickup type, it will not close its front contacts before the momentary loss of shunt has ended and relay 1TR has again opened its contact 5. Contacts 14 and 15 of relays EP and EPR, respectively, will therefore remain open, and relay XR will remain deenergized, so that the operation of signal XS will be continued without interruption during the momentary loss of track circuit shunt while a train is approaching the intersection.

I shall assume that, with the modified form of apparatus embodying my invention, as shown in Fig. 2, an eastbound train enters section 1T, deenergizing relay 1TR. With contact 19 of relay 1TR then open, relay 1TPS will become deenergized, so that its contact 25 will be opened in the control circuit for relay XR. With contact 22 of relay 1TPS open, the circuit for relay 1TEP will also be opened, but relay 1TEP will be slow to release because of the resistor r and the capacitor t connected in series with each other in a path in multiple with the winding of relay 1TEP, and therefore relay 1TEP will not at once release its contacts. With relay 1TR deenergized, relay 2SR is now energized by its pickup circuit passing from terminal B, through the front point of contact 48 of relay 2TR, back point of contact 49 of relay 1TR, back point of contact 50 of relay 1SR, and the winding of relay 2SR to terminal N.

Contact 24 of relay 1TEP, upon becoming opened at the end of the release period for relay 1TEP, will cause relay XR to be deenergized. With relay XR deenergized, relay FR will be energized, and signal XS will be controlled to display a flashing indication as previously described in connection with the operation of the apparatus shown in Fig. 1.

When the train enters section XT, deenergizing relay XTR, contact 23 of relay XTR will become opened at its front point in the circuit previously traced for relay XR which is now, however, already open at contacts 24 and 25 of relays 1TEP and 1TPS, respectively. Contact 23 of relay XTR, upon becoming closed at its back point, will complete a first stick circuit for relay 2SR, this circuit passing from terminal B, through the back point of contact 23 of relay XTR, contact 51 of relay 2SR, and the winding of relay 2SR to terminal N.

When the train enters section 2T, deenergizing relay 2TR, the pickup circuit traced for relay 2SR will become opened at the front point of contact 48 of relay 2TR. Relay 2SR will, however, remain energized by its stick circuit previously traced.

When the train leaves section 1T, a second stick circuit will be completed for relay 2SR, this circuit passing from terminal B, through the front point of contact 49 of relay 1TR, back point of contact 48 of relay 2TR, front point of contact 52 of relay 2SR, and the winding of relay

2SR to terminal N. Also, when the train leaves section 1T, relay 1TPS will become energized by a pickup circuit passing from terminal B, through contact 19 of relay 1TR, contact 21 of relay 1TEP, and the winding of relay 1TPS to terminal N. Relay 1TPS, on account of being slow to pick up, will not close its contact 25 in the circuit for relay XR until after the lapse of a brief period of time.

When the train leaves section XT, contact 23 of relay XTR will become closed at its front point in the circuit previously traced for relay XR. When contact 25 of relay 1TPS has become closed, relay XR will again be energized, causing relay FR and signal XS to be deenergized.

When the train leaves section 2T, contact 27 of relay 2TR will again be closed in the circuit for relay XR, and relay 2SR will again be deenergized because its second stick circuit will be opened at the back point of contact 48 of relay 2TR. All parts of the apparatus will therefore again be in the normal condition.

I shall now assume that, with apparatus arranged as shown in Fig. 2, again an eastbound train enters section 1T, and that, after relay 1TEP has released its contacts, a momentary loss of shunt of the track circuit for section 1T occurs, so that the pickup circuit for relay 1TPS previously traced will again be closed. Relay 1TPS, on account of being of the slow pickup type, will not close its front contacts before the period of the momentary loss of shunt has ended, and therefore relay 1TPS will again be deenergized because of the opening of contact 19 of relay 1TR. The front contacts of relay 1TPS will therefore remain open, and contact 24 of relay 1TEP will remain open after having become opened at the end of its release period. Relay XR therefore remains deenergized during the momentary loss of shunt, so that relay FR will remain energized, and signal XS will continue to display the flashing light indication during the period of the momentary loss of track circuit shunt.

I shall assume that, with apparatus shown in Fig. 2 modified as shown in Fig. 3, an eastbound train enters section 1T, deenergizing relay 1TPS, and effecting energization of relay 2SR, and that before relay 1TEP has released its contacts and deenergized relay XR, and therefore before operation of signal XS has started, there is a momentary loss of shunt of the track circuit for section 1T. With relay 1TR energized because of the momentary loss of track circuit shunt, relay 2SR will become deenergized because of the opening of its pickup circuit through the back point of contact 49 of relay 1TR. On account of relay 2SR being slow to release, the pickup circuit for relay 1TPS will not become closed for a brief period of time long enough for contact 32 of relay 2SR to become closed. Relay 1TPS, on account of being of the slow pickup type, can then not close its contacts before the lapse of a further brief period of time, during which the momentary loss of shunt will have ended. Contact 22 of relay 1TPS can therefore not become closed and complete the circuit for energizing relay 1TEP and charging the capacitor t during the period of the momentary loss of shunt of the track circuit. Relay 1TEP will therefore release its contacts, and so the operation of crossing signal XS will be started, regardless of the occurrence of a momentary loss of track circuit shunt.

It follows that, with the arrangement shown in Fig. 3, the slow release time of relay 2SR is added to the slow pickup time of relay 1TPS in the arrangement shown in Fig. 2 for protecting against a momentary loss of shunt of the track circuit for section 1T.

If the apparatus shown in Fig. 2 modified as shown in Fig. 4, relay 1TEP cannot become energized in response to energization of relay 1TPS, after having been deenergized by an eastbound train, while the train occupies section 1T after having vacated section 0T, until section XT becomes occupied by the eastbound train. The pickup circuit for relay 1TEP which becomes closed while the train occupies section XT passes from terminal B, through contact 34 of relay 1TPS, contact 37 of relay XTR, and the winding of relay 1TEP in multiple with a path which includes a resistor r and a capacitor t to terminal N.

If relay 1TEP becomes deenergized in response to a westbound train, it will again become energized while the westbound train occupies section 0T after leaving section 1T. The pickup circuit for relay 1TEP at that time passes from terminal B, through contact 34 of relay 1TPS, contact 35 of relay 0TR, and the winding of relay 1TEP in multiple with a path through resistor r and capacitor t to terminal N.

I have described the operation of the apparatus, shown in the accompanying drawings, under a few typical sets of conditions. It is believed that, in view of the foregoing description, the operation of the apparatus can be readily traced for any other possible sets of conditions.

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 highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a first and a second slow pickup control stick relay, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said first control stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said first control stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay and by a front contact of the track relay for said crossing section, a pickup and a stick circuit for said second control stick relay each controlled by a front contact of the track relay for said second approach control section and said pickup circuit also controlled by a front contact of the track relay for said crossing section, a first slow release direction stick relay controlled to become energized if a train enters said crossing section while said first control stick relay is deenergized

and to then remain energized while said train occupies said second approach control section, a second slow release direction stick relay controlled to become energized if a train enters said crossing section while said second control stick relay is deenergized and to then remain energized while the train occupies said first approach control section, and means including a front contact of said repeater relay in multiple with a front contact of said first control stick relay and with a front contact of said second direction stick relay and also including a front contact of said second control stick relay in multiple with a front contact of said first direction stick relay for controlling said highway crossing signal.

2. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a first and a second slow pickup control stick relay, a pickup and a stick circuit for said first control stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a front contact of the track relay for said crossing section, a pickup and a stick circuit for said second control stick relay each controlled by a front contact of the track relay for said second approach control section and said pickup circuit also controlled by a front contact of the track relay for said crossing section, a first slow release direction stick relay controlled to become energized if a train enters said crossing section while said first control stick relay is deenergized and to then remain energized while the train occupies said second approach control section, a second slow release direction stick relay controlled to become energized if a train enters said crossing section while said second control stick relay is deenergized and to then remain energized while the train occupies said first approach control section, and means including a front contact of said first control stick relay in multiple with a front contact of said second direction stick relay and including a front contact of said second control stick relay in multiple with a front contact of said first direction stick relay for controlling said highway crossing signal.

3. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and an approach control section adjacent one end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said slow pickup stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said approach control section and said pickup circuit also controlled by a back contact of said repeater relay and by a front contact of the track relay for said crossing section, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay for controlling said highway crossing signal.

4. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and an approach control section adjacent one end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said slow pickup stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said approach control section and said pickup circuit also controlled by a back contact of said repeater relay, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay for controlling said crossing signal.

5. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said slow pickup stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay, a first slow release direction stick relay controlled to become energized when a train occupies said first approach control section while a second slow release direction stick relay is deenergized, means for effecting energization of said second slow release direction stick relay when a train occupies said second approach control section while said first slow release direction stick relay is deenergized, and means including a front contact of said slow pickup stick relay in multiple with a front contact of said repeater relay and also in multiple with a front contact of said second slow release direction stick relay for controlling said highway crossing signal.

6. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first

approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a first and a second slow pickup control stick relay, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said first control stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said first control stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay and by a front contact of the track relay for said crossing section, a pickup and a stick circuit for said second control stick relay each controlled by a front contact of the track relay for said second approach control section and said pickup circuit also controlled by a front contact of the track relay for said crossing section, a first direction stick relay controlled to become energized if a train enters said crossing section while said first control stick relay is deenergized and to then remain energized while said train occupies said second approach control section, a second direction stick relay controlled to become energized if a train enters said crossing section while said second control stick relay is deenergized and to then remain energized while the train occupies said first approach control section, and means including a front contact of said repeater relay in multiple with a front contact of said first control stick relay and with a front contact of said second direction stick relay and also including a front contact of said second control stick relay in multiple with a front contact of said first direction stick relay for controlling said highway crossing signal.

7. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said slow pickup stick relay and including a capacitor and a resistor connected in series with each other in a path in multiple with the winding of said repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay, a first direction stick relay controlled to become energized when a train occupies said first approach control section while a second direction stick relay is deenergized, means for effecting energization of said second direction stick relay when a train occupies said second approach control section while said first direction stick relay is deenergized, and means including a front contact of said slow pickup stick relay in multiple with a front contact of said repeater relay and also in multiple with a front contact of said second direction stick relay for controlling said highway crossing signal.

8. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and an approach control section adjacent one end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a slow release repeater relay, means including a front contact of said slow pickup stick relay for controlling said slow release repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said approach control section and said pickup circuit also controlled by a back contact of said slow release repeater relay and by a front contact of the track relay for said crossing section, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay for controlling said highway crossing signal.

9. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and an approach control section adjacent one end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a slow release repeater relay, means including a front contact of said slow pickup stick relay for controlling said slow release repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said approach control section and said pickup circuit also controlled by a back contact of said slow release repeater relay, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay for controlling said highway crossing signal.

10. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a repeater relay, means including a front contact of said slow pickup stick relay for controlling energization of said repeater relay and for rendering said repeater relay slow to release, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also con-

trolled by a back contact of said repeater relay, a first and a second direction stick relay, pickup circuit means for effecting energization of said first direction stick relay while said first approach control section is occupied by a train and while said second direction stick relay is deenergized, stick circuit means for then retaining said first direction stick relay energized while said second approach control section is occupied, pickup circuit means for effecting energization of said second direction stick relay while said second approach control section is occupied by a train and while said first direction stick relay is deenergized, stick circuit means for then retaining said second direction stick relay energized while said first approach control section is occupied, and means including a front contact of said slow pickup and stick relay in multiple with a front contact of said repeater relay and also is multiple with a front contact of said second direction stick relay for controlling said highway crossing signal.

11. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a slow release repeater relay, means including a front contact of said slow pickup stick relay for controlling said repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay, a first direction control relay controlled to become energized while said first approach control section is occupied and a second direction control relay is deenergized, means for energizing said second direction control relay while said second approach control section is occupied and said first direction control relay is deenergized, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay and also in multiple with a front contact of said second direction stick relay for controlling said highway crossing signal.

12. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section adjacent one end of said crossing section and also a second approach control section adjacent the opposite end of said crossing section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a slow release repeater relay, means including a front contact of said slow pickup stick relay for controlling said repeater relay, a first direction control relay, a second direction control relay, means controlled by the track relay for said first approach control section and by said second direction stick relay for energizing said first direction stick relay while said first approach control section is occupied and said second direction stick relay is deenergized, control means including means controlled by the track relays for said crossing track section and said second approach control section for then retaining said first direction stick relay energized while either said crossing track section or said second approach control section is occupied, means controlled by the track relay for said second approach control section and by said first direction stick relay for energizing said second direction stick relay while said second approach control section is occupied and said first direction stick relay is deenergized, control means including means controlled by the track relays for said crossing track section and said first approach control section for then retaining said second direction stick relay energized while either said crossing track section or said first approach control section is occupied, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay and by a back contact of said first direction stick relay in multiple with a back contact of the track relay for said crossing section, and means including a front contact of said slow pickup stick relay in multiple with a front contact of said repeater relay and also in multiple with a front contact of said second direction stick relay for controlling said highway crossing signal.

13. In a control system for a highway crossing signal adjacent the intersection of a highway with a railway track which is divided into a crossing section including the intersection and a first approach control section one end of which is adjacent one end of said crossing track section and also a second approach control section adjacent the opposite end of said first approach control section, each of said sections being provided with a track circuit including a source of current and a track relay which is normally energized but which becomes deenergized in response to occupancy of the corresponding section by a train, the combination comprising, a slow pickup stick relay, a slow release repeater relay, a pickup and a stick circuit for said slow pickup stick relay each controlled by a front contact of the track relay for said first approach control section and said pickup circuit also controlled by a back contact of said repeater relay, a pickup and a stick circuit for said repeater relay each controlled by a front contact of said slow pickup stick relay and the pickup circuit also controlled by a back contact of the track relay for said crossing section in multiple with a back contact of the track relay for said second approach control section, and means including a front contact of said repeater relay in multiple with a front contact of said slow pickup stick relay for controlling said highway crossing signal.

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