March 6, 1945. E. M. ALLEN 2,370,704

APPARATUS FOR THE CONTROL OF HIGHWAY CROSSING SIGNALS

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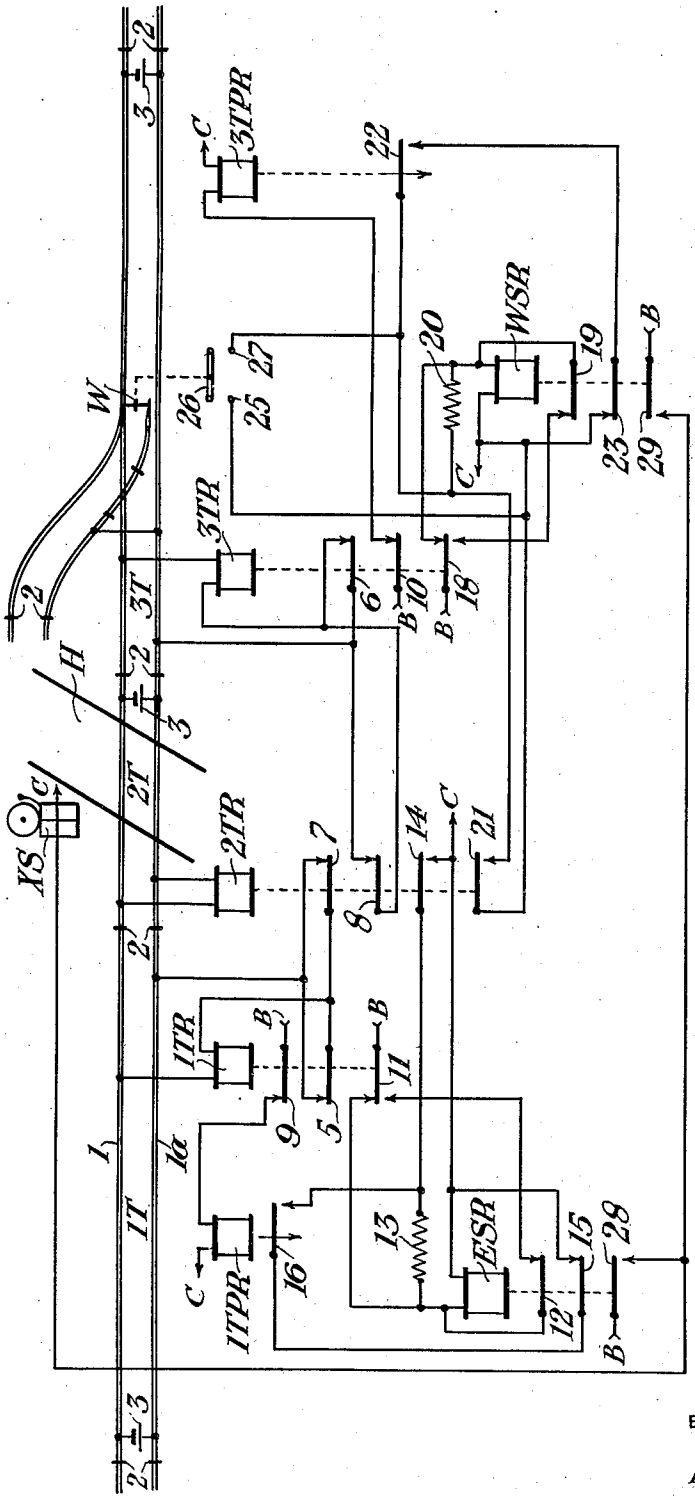


Fig. 1.

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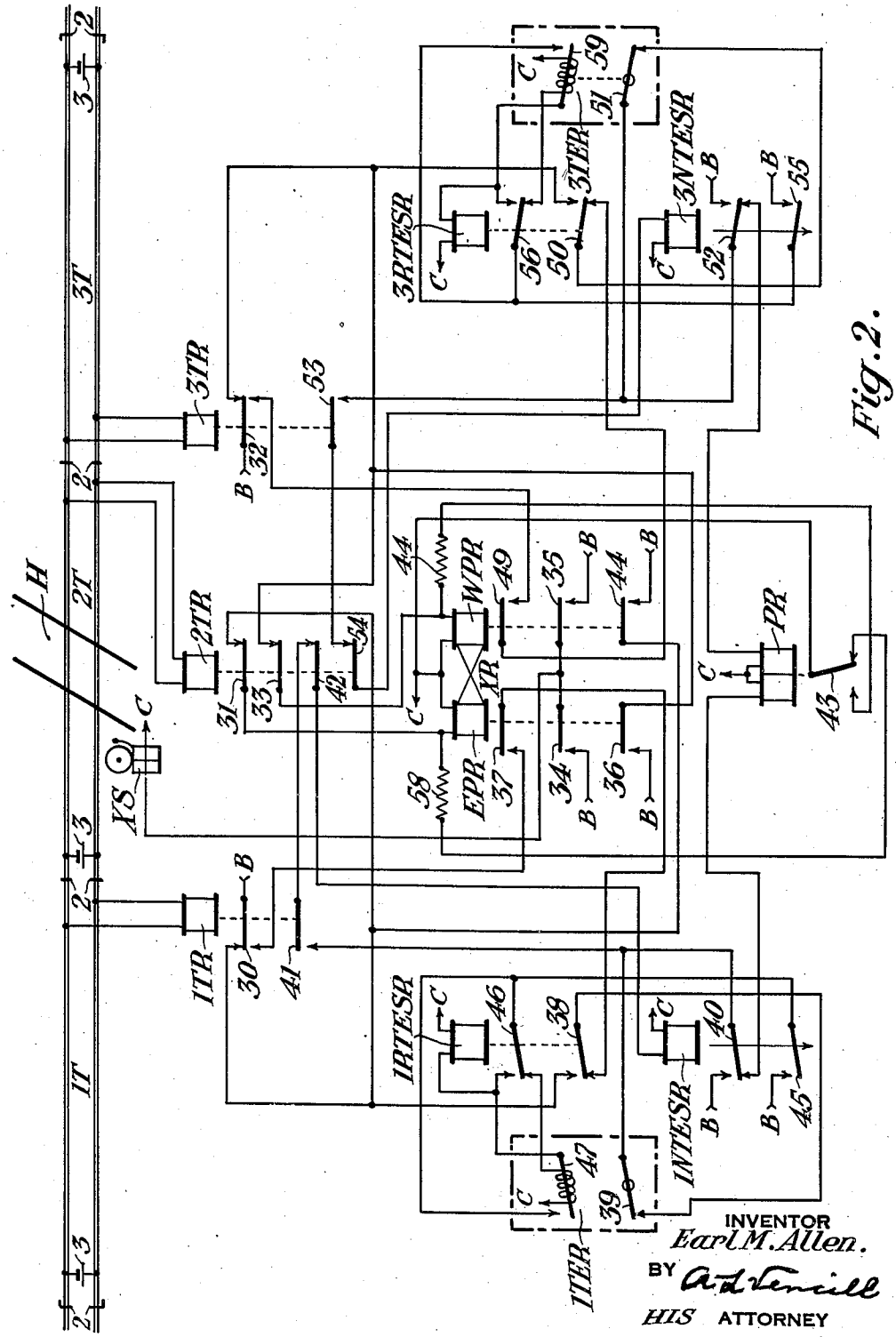


Fig. 2.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR THE CONTROL OF HIGHWAY CROSSING SIGNALS

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7 Claims. (Cl. 246—130)

My invention relates to apparatus for the control of highway crossing signals, and has particular reference to the organization of such apparatus into novel and improved systems controlled by railway traffic for operating highway crossing signals.

In highway crossing signal systems of the type employed for a stretch of track over which traffic operates in either direction, directional control means are employed to obtain operation of the crossing signal while a train approaches the crossing and to prevent operation when the train recedes from the crossing. In the ordinary forms of such systems, it is customary to employ two approach sections one on either side of the crossing and to arrange the directional control means to select the traffic direction whenever either approach section becomes occupied with the other approach section vacant. In other words, the directional control of the signal is usually established whenever either approach section is the first occupied and the apparatus then functions to prevent any train which occupies the other approach section during the time that the first is still occupied, from causing operation of the signal after the first section becomes vacant. These systems provide proper protection where only a single train is involved or where a plurality of trains operating in the same direction simultaneously occupy the two approach sections, that is, the systems function to cause operation of the signal while any train occupies the first-entered approach section and prevents operation after the first section becomes vacant either by the train in that section proceeding across the crossing and occupying the other approach section in receding from the crossing, or by the train reversing its direction of movement in the first section to recede from the crossing through the first section.

Where, however, trains operating in opposite directions concurrently occupy both approach sections and particularly where track switches are provided in or near the approach sections, then the usual forms of crossing signal control systems are subject to improper operation such as either or both preventing signal operation when a train approaches the crossing and permitting operation of the signal when a train is receding from a crossing after having passed that crossing. For example, if the first-entered approach section is occupied by a first train and a second train operating in the opposite direction enters the other section, then operation of the signal for the second train will be prevented or locked out if the first train vacates the first section either by being switched away from that section or by reversing its direction and receding from the crossing through the first section. In other words, operation of the signal will be terminated when the first train vacates the first section, even though the second train is approaching the crossing. Under the particular conditions assumed, operation of the signal will usually be effected by the second train after it reaches the crossing and enters the first approach section, but of course the operation of the signal when the second train recedes from the crossing through the first section has no useful function and is in fact improper.

I am aware that it has been proposed heretofore to provide crossing signal control systems of the class arranged to provide proper protection where trains operating in opposite directions concurrently occupy both approach sections, and an object of my present invention is to provide novel and improved highway crossing signal control systems of the class described.

Another object of my present invention is to provide novel and improved crossing signal control systems arranged to prevent switching or other irregular moves from interfering with the operation of a crossing signal.

A further object is to provide novel and improved crossing signal systems, incorporating means arranged to lock out operation of the signals only when the train proceeds across the crossing.

An additional object is to provide novel and improved means in a signal system for effecting proper operation of a signal by at times varying the relative release periods of two control relays.

A further object is to provide novel and improved means for attaining proper operation of a crossing signal under various different conditions of movements of trains in the approach sections.

In practicing the invention, the above-mentioned and other important objects and characteristic features of my invention which will become readily apparent from the following description are attained by providing two approach track sections separated from each other by a detector track section, and by controlling two control relays by three track relays in such a manner that the relative release intervals of the two control relays are varied to establish a lock-out of one of the control relays only when the detector section is entered but not when either approach section is entered.

I shall describe two 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. Fig. 2 is a diagrammatic view showing a modified form of the apparatus represented in Fig. 1, and also embodying my invention. In each of the two views, similar reference characters have been employed to designate corresponding parts.

Referring to Fig. 1, the reference characters 1 and 1a designate the track rails of a stretch of railway track divided by insulated joints 2 into a plurality of successive adjoining track sections designated by the reference characters T with suitably distinguishing prefixes. Section 2T is intersected at grade by a highway H, and will be termed hereinafter a detector section. Section 1T through which an eastbound train, operating from left to right as viewed in the drawings, must travel in approaching the intersection will be termed the eastbound approach section, while the other section 3T through which westbound trains operate in approaching the intersection will be termed the westbound approach section. This latter section also includes a track switch W.

Each of the sections is provided with a track circuit comprising a suitable source of current, such as a battery 3, and a track relay designated by the reference character TR with a prefix corresponding to the prefix of the associated section. Relay 2TR is constantly connected in circuit with the rails of its associated section 2T; relay 1TR is normally connected with the rails of its associated section 1T over a circuit including its own front contact 5; and relay 3TR is normally connected with the rails of section 3T over a circuit including its own front contact 6. The relays 1TR and 3TR are provided with pick-up circuit paths controlled by relay 2TR and including front contacts 7 and 8, respectively, of relay 2TR so that when either relay 1TR or 3TR is released, it may be picked up only when its associated section is vacant and relay 2TR is picked up. Relay 1TR is provided with a slow releasing repeater relay 1TPR energized over a circuit which extends from one terminal B of a suitable source of current, such as a battery not shown, through front contact 9 of relay 1TR and the winding of relay 1TPR to the other terminal C of the same source of current. Relay 3TR is likewise provided with a slow releasing repeater relay 3TPR energized over an obvious circuit including front contact 10 of relay 3TR.

The reference characters ESR and WSR designate directional control relays, one for either direction of traffic movement on the stretch. The eastbound control relay ESR is normally energized over an obvious circuit including the front point of contact 11 of relay 1TR, and at times may be energized over a stick circuit which extends from terminal B through the back point of contact 11 of relay 1TR, front contact 12 of relay ESR and the winding of relay ESR to terminal C. Relay ESR is at times provided with a snubbing circuit which includes the winding of the relay, resistor 13 and back contact 14 of relay 2TR; and with another snubbing circuit including the winding of the relay, its own front contact 15, back contact 16 of relay 1TPR and resistor 13.

The other or westbound control relay WSR is normally energized over an obvious circuit including the front point of contact 18 of relay 3TR, and at times may be energized over a stick circuit including its own front contact 19 and winding and the back point of contact 18 of relay 3TR. Relay WSR is provided with a first snubbing circuit which connects resistor 20 across its terminals when back contact 21 of relay 2TR is closed; with a second or stick snub circuit which connects resistor 20 across its terminals through a circuit including its own front contact 23 and back contact 22 of relay 3TPR; and with a third snub circuit which connects resistor 20 across the relay terminals whenever contact 25—26—27 is closed due to the associated switch W being set for a movement thereover into or out of the turnout.

Located at the intersection is a highway crossing signal of any suitable form, such as, for example, an audible signal in the form of an electric bell XS. The bell is provided with an obvious energizing circuit completed whenever back contact 28 of relay ESR or back contact 29 of relay WSR is closed.

The apparatus of Fig. 1 is in its normal condition, as represented in the drawings, when sections 1T, 2T and 3T are vacant and switch W is set for a main line movement. In this condition of the apparatus, all relays shown in Fig. 1 are picked up, while signal XS is silent.

For a through train movement, that is, a movement through all three sections, the apparatus functions to initiate operation of signal XS when a train enters the approach section, maintains that operation when the train occupies the detector section, and prevents or locks out operation of the signal when the train clears the detector section and occupies the other approach section on the receding side of the intersection. For example, if an eastbound train enters section 1T, relay 1TR releases and opens the front point of its contact 11 to deenergize eastbound control relay ESR. That relay is quick acting and it in turn releases to open its front contact 12 before the back point of contact 11 of relay 1TR becomes closed. Relay ESR accordingly closes its back contact 28 to complete the energizing circuit for bell XS, thereby setting it into operation.

When the train enters section 2T, relay 2TR releases to open the pick-up circuit path of relay 1TR at front contact 7, and thereby functions to hold open the track circuit of section 1T after the train vacates that section so that relays 1TR and ESR remain released to maintain operation of the crossing signal XS until the train vacates section 2T and clears the crossing. Relay 2TR also closes its pack contact 21 to complete a previously mentioned snub circuit path which connects resistor 20 across the terminals of relay WSR with the result that when the train enters section 3T, and relay 3TR releases to open the normal energizing circuit of relay WSR at the front point of contact 18, the flux in the winding of relay WSR is provided with a closed circuit path through which it circulates to snub the release of the relay sufficiently to bridge the transfer time of relay 3TR, or in other words to hold up that relay until the back point of contact 18 of relay 3TR closes to complete the previously traced stick circuit of relay WSR. Relay WSR is therefore maintained energized when the eastbound train occupies section 3T. When the train vacates section 2T and relay 2TR picks up to complete the pick-up circuit path of relay 1TR, that relay picks up and in turn picks up relay ESR so that operation of signal XS is ter-

minated. Relay 2TR also opens its back contact 21 to open the snub circuit applied through that contact to the winding of relay WSR, but that relay is now provided with another snub circuit completed through its own front contact 23 and back contact 22 of relay 3TPR. This latter snub circuit is effective to provide a closed circuit path through which the flux in relay WSR circulates when relay 3TR picks up after the train vacates section 3T. This circulation of flux snubs or slows up the release of relay WSR sufficiently to bridge the transfer time of relay 3TR and hence maintains relay WSR in its picked-up position for the interval required for contact 18 of relay 3TR to pass from its back to its front point wherein the normal energizing circuit of relay WSR is completed.

From the foregoing description, it is readily apparent that the apparatus embodying my invention is so arranged that the eastbound directional control relay ESR is released when an eastbound train enters section 1T and is retained released to maintain operation of the crossing signal until the eastbound train clears the highway and vacates section 2T; and that when the eastbound train enters section 2T, the other or westbound directional control relay WSR is then made sufficiently slow to release to bridge the time required for the contacts of relay 3TR to travel from their front to their back points, so that as a result relay WSR is retained energized over a stick circuit including the back point of contact 18 of relay 3TR when the eastbound train occupies section 3T. With relay WSR held energized and repeater relay 3TPR released, relay WSR is snubbed and made slow releasing enough to bridge the transfer time of the contacts of relay 3TR from their back to their front points, thereby to avoid dropping relay WSR momentarily when the train vacates section 3T.

The apparatus operates in a correspondingly similar manner for through movements of westbound trains as can be seen from an inspection of the drawings and further detailed description is deemed unnecessary.

The apparatus also is arranged to take care of opposing and other irregular movements near the crossing. For example, if a first train operating in one direction first enters the one approach section for that one direction, and a second train operating in the opposite direction enters the other approach section while the first train still occupies the one section, operation of the signal for the second train will be attained after the first train vacates its section either by reversing its direction or by being switched away from the stretch before passing through section 2T. Thus if an eastbound train enters section 1T to release relays 1TR and ESR and set signal XS into operation, the apparatus will not be locked up when a westbound train enters section 3T with section 1T still occupied by the first train, but instead the westbound train will in turn release relays 3TR and WSR so that if the eastbound train reverses its direction and vacates section 1T at its left-hand end, as viewed in the drawing, relays 1TR and ESR will pick up but operation of the signal will be maintained by relay WSR until the westbound train vacates sections 2T and 3T. Also, the westbound train will apply a snub circuit on relay ESR through back contact 14 of relay 2TR when section 2T is entered, so that relay ESR will be maintained energized over its stick circuit and operation of signal XS will be prevented when the westbound train subsequently occupies section 1T. A similar operation will take place if a westbound train enters section 3T and then reverses its direction to vacate that section after an eastbound train enters section 1T, or if the westbound train makes a diverging movement over switch W and vacates the section after the eastbound train enters section 1T.

Should a train enter section 3T over switch W, the operation of the switch will close contact 25—26—27 to apply a previously traced snub circuit on relay WSR and that relay accordingly will not release when the train enters the section and proceeds to its right-hand end, as viewed in the drawings. It follows, therefore, that the apparatus embodying my invention makes use of two relays and locks one or the other of the relays out of control of a signal only when the train occupies the detector section, and that the lock-out of a relay is made dependent upon the relative release intervals of that relay. These relative release intervals are selectively controlled by the apparatus of the detector section to govern the closure of the back contacts of the relay and prevent establishing directional control whenever either approach section becomes occupied, and proper operation of the signal is attained for approaching trains even though opposing and switching movements might be involved.

A modification of the apparatus represented in Fig. 1 is illustrated in Fig. 2. Referring now to Fig. 2, the track relays 1TR and 3TR are constantly connected with the track rails and hence are not controlled in any manner by detector track relay 2TR. Each approach track relay has associated therewith a time element relay TER, two time element stick relays RTESR and NTESR, and the winding of a control relay of an interlocking relay XR. Relay XR may for example be of the type shown in Letters Patent of the United States No. 1,799,629 granted April 7, 1931, to W. K. Lockhart and T. J. O'Meara and it comprises two control relays EPR and WPR and an interlocking mechanism actuated by the armatures of the relays and arranged so that when either armature is the first to be released, the interlocking mechanism is actuated to a position wherein it engages the other armature to prevent it from dropping to a full down position if the other armature is released when the first is still released. A two-winding polar relay PR of the magnetic stick type also is provided for connecting a snub circuit path across the terminals of relay EPR or WPR, as will be made clear presently.

In the normal condition of the apparatus, sections 1T, 2T and 3T are vacant so that relays 1TR, 2TR and 3TR are picked up; relay EPR is energized over a circuit which may be traced from terminal B through the front point of contact 30 of relay 1TR, front contact 31 of relay 2TR and the winding of relay EPR to terminal C; and relay WPR also is energized over a circuit which extends from terminal B through the front point of contact 32 of relay 3TR, front contact 33 of relay 2TR and the winding of relay WPR to terminal C. Signal XS is provided with an energizing circuit completed at either back contact 34 of relay EPR or back contact 35 of relay WPR, and under normal conditions the signal is of course deenergized.

For a train movement through all three sections, the apparatus operates in accordance with the usual custom to initiate operation of the signal when the train enters an approach section,

maintains that operation when the train occupies the detector section, and prevents or locks out operation of the signal when the train clears the detector section and occupies the other approach section in receding from the intersection. For example, if an eastbound train enters section 1T, relay 1TR releases to interrupt at the front point of contact 30 the previously traced energizing circuit of relay EPR, whereupon that relay in turn releases to close its back contact 34 and energize signal XS. Relay EPR also completes an alternate circuit for the other relay WPR, which circuit extends from terminal B through back contact 36 of relay EPR, front contact 33 of relay 2TR and the winding of relay WPR to terminal C. Relay 1TR also energizes one winding of polar relay PR and relay 1NTESR over a circuit extending from terminal B through the back point of contact 30 of relay 1TR, back contact 37 of relay EPR, back contact 38 of relay 1RTESR, back or checking contact 39 of relay 1TER, and then through two alternate paths one comprising back contact 40 of relay 1NTESR and the left-hand winding (as viewed in the drawings) of relay PR to terminal C, and the other circuit path comprising back contact 41 of relay 1TR, front contact 42 of relay 2TR and the winding of relay 1NTESR to terminal C. The energization of the left-hand winding of relay PR at this time causes it to operate its polar contact 43 to its left-hand position (as viewed in the drawings) wherein an obvious snub circuit is completed for connecting resistor 44 across the terminals of relay WPR, while relay 1NTESR picks up to complete a circuit extending from terminal B through front contact 45 of relay 1NTESR, back contact 46 of relay 1RTESR and the operating element of relay 1TER to terminal C. The time element relay 1TER accordingly becomes energized and opens its checking or back contact 39. When this happens, the previously traced circuits for relays PR and 1NTESR are interrupted but relay PR remains in its left-hand position because of its magnetic stick features while relay 1NTESR is held energized over a stick circuit which extends from terminal B through the front point of contact 40 of relay 1NTESR, back contact 41 of relay 1TR, front contact 42 of relay 2TR and the winding of relay 1NTESR to terminal C. The time contact 47 of relay 1TER is adjusted to close after a time interval substantially longer than that required for a train under ordinary conditions of operation to traverse section 1T and enter section 2T. If, as has been assumed heretofore, the train makes a through move without pausing in section 1T, then section 2T will be entered by the train before relay 1TER closes its contact 47, and when relay 2TR drops it interrupts the energizing stick circuit of relay 1NTESR at front contact 42, whereupon relay 1NTESR releases to deenergize relay 1TER at front contact 45. In addition, front contact 33 of relay 2TR interrupts the previously traced energizing circuits for relay WPR and that relay accordingly releases its armature which is engaged by the interlocking mechanism and prevented from closing its back contacts.

When the train enters section 3T, relay 3TR releases but this action has no useful function at this time. When, however, the train vacates section 2T and relay 2TR picks up, relay EPR becomes energized over its previously traced circuit to terminate operation of signal XS, while relay 3TR retains relay WPR deenergized and as a result the armature of the latter relay remains latched up until the train vacates section 3T. When this happens, relay 3TR picks up in turn to pick up relay WPR, and the apparatus is restored to its normal position.

The apparatus will function in a correspondingly similar manner for a through movement of a westbound train, as will be apparent from an inspection of the drawings and further detailed explanation is deemed unnecessary except to point out that when the westbound train enters section 3T and releases relay 3TR, the front point of contact 32 of relay 3TR opens to release relay WPR whereupon back contact 35 of relay WPR closes to energize signal XS while back contact 44 of relay WPR closes to complete a circuit extending from terminal B through back contact 44 of relay WPR, front contact 31 of relay 2TR and the winding of relay EPR to terminal C. The back point of contact 32 of relay 3TR also closes to energize relays PR and 3NTESR over a circuit extending from terminal B through the back point of contact 32 of relay 3TR, back contact 49 of relay WPR, back contact 50 of relay 3RTESR, back contact 51 of relay 3TER, and then through back contact 52 of relay 3NTESR and the right-hand winding of relay PR to terminal C or through back contact 53 of relay 3TR, front contact 54 of relay 2TR, and the winding of relay 3NTESR to terminal C. Relay 3NTESR accordingly picks up and closes its front contact 55 to complete a circuit extending from terminal B through that contact, back contact 56 of relay 3RTESR and the winding of relay 3TER to terminal C; while relay PR shifts its polar contact 43 to its right-hand position wherein an obvious circuit is completed for connecting resistor 58 across the terminals of relay EPR. Assuming that the westbound train enters section 2T before front contact 59 of relay 3TER closes, winding WPR is retained deenergized as long as the train occupies section 3T or 2T, while the armature of relay EPR is released to its latched up position when front contact 31 of relay 2TR opens when the train occupies section 2T. The armature of relay EPR is maintained latched up by relay 1TR being released until the train vacates section 1T, whereupon relays 1TR and EPR pick up and the apparatus is restored to its normal condition.

The snub circuits applied to the windings of relays EPR and WPR function to provide correct operation of signal XS for opposing or switching movements on the stretch. For example, if a train enters an approach section and pauses for a time therein, it is undesirable to continue operation of signal XS for the entire interval and hence the apparatus is arranged to terminate operation of the signal after a predetermined interval, and to restart such operation if the train enters detector section 2T or if another train enters the other approach section. Thus, if an eastbound train enters section 1T and pauses therein, relay 1TR releases to deenergize relay EPR so that operation of signal XS is initiated and the previously traced auxiliary energizing circuit of relay WPR is completed through back contact 36 of relay EPR and front contact 33 of relay 2TR. In addition, the left-hand winding of polar relay PR is energized over its previously traced circuit to shift its polar contact 43 to its left-hand position wherein it connects resistor 44 across the terminals of relay WPR, while relay 1NTESR picks up over its previously

traced circuit and energizes relay 1TER over its circuit including front contact 45 of relay INTESR and the back point of contact 46 of relay IRTESR.

With the apparatus of Fig. 2 in the condition just described, further operation of the apparatus will be described in connection with different train movements.

(1) If the train reverses its direction and vacates section 1T prior to relay 1TER closing its front contact 47, then relay 1TR picks up to energize relay EPR and that relay picks up to terminate operation of signal XS. Relay 1TR also opens its back contact 41 to deenergize relay INTESR, whereupon that relay releases to deenergize relay 1TER. Relay 1TER is slow in closing its checking or back contact 39, and the apparatus will not restore to its normal condition until that back contact closes so that if the train reenters section 1T before back contact 39 of relay 1TER closes, then relay EPR is released to initiate operation of signal XS, but relays PR and INTESR remain deenergized at back contact 39 of relay 1TER. After that back contact closes, relays PR and INTESR become energized and relay INTESR in turn energizes relay 1TER. This arrangement insures that the full timing action of relay 1TER must elapse for each train entering the section, and prevents a train from utilizing a portion of the time measured by relay 1TER for a previous train. In other words, relay 1TER must go through its entire pick-up cycle for each train, and to insure this the relay must be restored to its normal condition before its pick-up cycle can be commenced.

(2) If the train occupies section 1T for the full interval required for relay 1TER to close its front contact 47, relay IRTESR picks up over a circuit which extends from terminal B through front contact 45 of relay INTESR, front contact 47 of relay 1TER and the winding of relay IRTESR to terminal C. Relay IRTESR accordingly picks up and closes the front point of its contact 46 to complete its own stick circuit which is connected to terminal B at front contact 45 of relay INTESR, and also opens the back point of contact 46 to deenergize relay 1TER, which relay accordingly opens its front contact 47. When back contact 39 of relay 1TER closes at the end of its slow release interval, relay EPR becomes energized over a circuit extending from terminal B through front contact 40 of relay INTESR, back contact 39 of relay 1TER, front contact 38 of relay IRTESR, front contact 31 of relay 2TR and the winding of relay EPR to terminal C. Relay EPR accordingly picks up to open its back contact 34 and thus terminate operation of signal XS, to open its back contact 36 and thus open the alternate circuit of relay WPR, and also to release the interlocking mechanism of relay XR to cause it to assume its normal condition.

(3) If, after operation of signal XS has been terminated by the time element apparatus in the foregoing manner, the train vacates section 1T at its remote or left-hand end, as viewed in the drawings, then relay 1TR picks up to close its front contact 30 and complete the normal energizing circuit for relay EPR, and back contact 41 also opens to interrupt the stick circuit for relay INTESR whereupon that relay releases to release relay IRTESR, and the apparatus is restored to its normal condition.

(3a) If, on the other hand, after the operation of signal XS has been terminated by relay 1TER in the manner described in detail hereinbefore, and the train in section 1T enters section 2T, then relay 2TR is released and relays EPR and WPR are simultaneously deenergized at front contacts 31 and 33 of relay 2TR, respectively. Relay WPR is, however, provided with a snub circuit which includes polar contact 43 of relay PR in its left-hand position and which connects resistor 44 across the terminals of the winding of relay WPR and thus provides a closed circuit path wherein the flux in the winding of relay WPR circulates to hold up the armature of that relay for an interval of time sufficient to enable the armature of relay EPR to release to its full down position and actuate the mechanical locking mechanism into the path of the armature of relay WPR to latch up that armature when it finally releases. When the train enters section 3T, relay 3TR of course releases to hold the armature of relay WPR released in its latched-up position after the train vacates section 2T and relay 2TR picks up to reenergize the winding of relay EPR. The timing apparatus associated with relay 3TR is not active at this time because back contact 49 of relay WPR is open, and back contact 35 also is open so that operation of signal XS is prevented when the train recedes from the crossing. After the train vacates section 3T, relay 3TR picks up to reenergize relay WPR and the apparatus is restored to its normal condition.

It is to be noted that when the eastbound train enters section 2T after the timing apparatus has terminated operation of signal XS, relay INTESR becomes deenergized at front contact 42 of relay 2TR, and relay INTESR in turn deenergizes relay IRTESR at front contact 45. This operation restores the timing apparatus of section 1T to its normal condition and thus insures against a following eastbound train using the time period measured for the first train.

(4) If, with an eastbound train in section 2T, a second eastbound train enters section 1T, relay 1TR of course releases to maintain relay EPR deenergized after the first train vacates section 2T and relay 2TR picks up, but the timing apparatus is not rendered active when relay 1TR releases but is delayed until relay 2TR picks up and closes its front contact 42, whereupon relay INTESR then becomes energized to energize relay 1TER and start the timing period for the second train.

(5) If with an eastbound train occupying section 1T so that relays 1TR and EPR are released, polar relay PR is in its left-hand position to snub winding WPR, and the timing apparatus associated with relay 1TR is active, a westbound train enters section 3T, relay 3TR will release but relay WPR will be held up at this time over an auxiliary circuit that includes back contact 36 of relay EPR. (a) Should the train in section 1T reverse its direction of travel and vacate the section at its left-hand end before relay 1TER closes its front contact 47, then relay 1TR will pick up to open its front contact 41 and deenergize relay INTESR. Relay INTESR thereupon will release to open its front contact 45 and deenergize relay 1TER. Also, the front point of contact 30 of relay 1TR will close to complete the normal energizing circuit of relay EPR, and that relay in turn will pick up to open its back contact 36 and thereby open the previously mentioned auxiliary circuit for the winding of relay WPR. Relay WPR accordingly will become deenergized but since it is snubbed at this time it is slow to release and does not release until after the arma-

ture of relay EPR picks up and the locking mechanism assumes its normal position. When the armature of WPR does release, however, it will drop to its full down position wherein back contact 35 establishes the operating circuit for bell XS, and the mechanical locking arrangement is actuated into the path of the armature of relay EPR so that when the westbound train enters section 2T and relay 2TR releases, the resultant release of relay EPR will result in its armature being latched up. When the train enters section 1T, relay 1TR will release to hold the armature of relay EPR in its latched position after section 2T is vacated and relay 2TR picks up to energize relay WPR and thereby terminate operation of the signal. The apparatus is of course restored to its normal condition when the westbound train vacates section 1T and relay 1TR picks up to energize relay EPR.

(*b*) Should the first train in section 1T occupy that section (with section 3T also occupied by a second westbound train) for an interval sufficient to enable relay 1TER to close its front contact 47, then when relay 1RTESR picks up, relay 1TER will become deenergized and after it closes its back contact 39, relay EPR will become energized over its previously traced circuit including the front point of contact 40 of relay 1NTESR, back contact 39 of relay 1TER, the front point of contact 38 of relay 1RTESR, front contact 31 of relay 2TR and the winding of relay EPR. When relay EPR picks up it transfers the control of signal XS to the other relay WPR, in substantially the same manner as that hereinbefore described in detail in connection with the pick-up of relay 1TR when the eastbound train vacates section 1T at its left-hand end, and it follows that after the eastbound train vacates section 1T, the signal will be properly controlled for a movement of the westbound train over sections 1T, 2T and 3T.

The apparatus will function for the various possible movements of a westbound train either alone or in conjunction with the eastbound train in substantially the same manner as that pointed out in detail hereinbefore for the various movements of an eastbound train. That is to say, the timing apparatus associated with relay 3TR is arranged to become active when the section is entered, and it will terminate operation of signal XS if the westbound train occupies the section for an interval of time longer than the pick-up period of relay 3TER. Also, when a westbound train enters section 3T, relay PR is shifted to its right-hand position wherein the winding of relay EPR is snubbed so that operation of signal XS may be transferred to an eastbound train or be retained by the westbound train according as section 2T is entered by an eastbound or a westbound train, respectively.

From the foregoing, it is readily apparent that the apparatus of Fig. 2 embodying my invention is arranged so as to employ two control relays and lock one or the other relay out of control of the signal only when the detector section becomes occupied. In addition, it is to be noted that the lock-out of a relay is dependent at times upon the relative release intervals of the relay and that these release intervals are selectively controlled so as to govern the closure of the back contacts and establish the correct directional control of the signal under the various conditions of train movements.

Although I have herein shown and described only a few forms of apparatus for the control of highway crossing signals 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 with a stretch of railway track intersected by a highway and provided with a highway crossing signal located adjacent to the intersection, two normally energized control relays one for each direction of traffic over said stretch, an energizing circuit for said signal including a back contact of either of said control relays, means controlled by a train on said stretch approaching said intersection for releasing the control relay associated with that train's direction of movement, means controlled by said train when adjacent said highway for increasing the release interval of the other control relay associated with the direction opposite that of the train's direction, and means controlled by said train and effective when the release interval of a control relay is increased for preventing the closure of the back contacts of that relay.

2. In combination with a stretch of railway track intersected by a highway and provided with a highway crossing signal adjacent to the intersection, two control relays one for each direction of traffic over said stretch and each normally energized in a pick-up circuit, an energizing circuit for said signal including a back contact of either of said control relays, means controlled by a train on said stretch approaching said intersection for interrupting the pick-up circuit of the control relay associated with that train's direction of movement, means controlled by said approaching train when adjacent said highway for increasing the release interval of the other control relay associated with the direction opposite to that of said train's direction, and means controlled by said train for interrupting the pick-up circuit of said other control relay and effective when the release interval of said other control relay is increased for completing a stick circuit for that relay including its own front contact.

3. In combination with a stretch of railway track divided into two successive adjoining track sections one of which is intersected by a highway, a highway crossing signal at the intersection, a track circuit including a track relay for each of said track sections, a control relay normally energized in a pick-up circuit including a front contact of the track relay of the other section, means including a back contact of the track relay of said one section for delaying the release of said control relay, a stick circuit for said control relay including its own front contact and a back contact of said other track relay and completed when said other track relay is released when said release delaying means is active to delay the release of said control relay, and an energizing circuit for said signal completed at a back contact of said control relay.

4. In combination with a stretch of railway track divided into two successive adjoining track sections one of which is intersected at grade by a highway, a highway crossing signal at said intersection, a track circuit for said one track section including a track relay constantly connected in circuit with the rails of said one section, a track circuit for the other of said sections including a track relay connected with the rails of said other section in a stick circuit including its own front contact and in a pick-up circuit including

a front contact of said one track relay, a control relay normally energized over a circuit including a front contact of said other track relay, means including a back contact of said one track relay for connecting a resistor across the terminals of said control relay for delaying its release, a stick circuit for said control relay including its own front contact and a back contact of said other track relay and completed only when said control relay is deenergized when its release is delayed by said release delaying means, and an energizing circuit for said signal completed at a back contact of said control relay.

5. In combination, a stretch of railway track divided into two approach track sections separated from each other by an intermediate section intersected at grade by a highway, a highway crossing signal at such intersection, a track circuit including a track relay for each of said sections, two control relays one for each approach track relay, means controlled by each approach track relay for normally energizing its associated control relay, an energizing circuit for said signal including a back contact of either of said control relays, means governed by the track relay of said intermediate section for increasing the release periods of each of said control relays, and means controlled by each of said approach track relays and effective when the release period of its associated control relay is increased for completing a stick circuit for that control relay including its own front contact.

6. In combination with a stretch of railway track divided into two approach track sections separated from each other by an intermediate section intersected by a highway, a track circuit for said intermediate section including a track relay constantly connected with the rails of said intermediate section, a track circuit for each of said approach track sections each including a track relay connected with the track rails of its associated section over a stick circuit path including its own front contact and a pick-up circuit path including a front contact of the track relay of said intermediate section, two control relays one for each approach track relay and each normally energized over a circuit including a front contact of its associated approach track relay, means governed by said intermediate section track relay for at times connecting a resistor across the terminals of each of said control relays for delaying the release of such relays, stick circuit means for each of said control relays comprising its own front contact and a back contact of the associated approach track relay and completed only when its associated approach track relay is deenergized when the release of the associated control relay is delayed by said release delaying means, and a highway crossing signal at said intersection energized over a circuit including a back contact of either of said control relays.

7. In a signal system provided for a stretch of railway track over which traffic operates in either direction, two normally energized control relays one for each direction of traffic over said stretch, a signal, a control circuit for said signal governed by either of said relays, means controlled by a train operating on said stretch for releasing the one of said control relays associated with that train's direction of traffic, means controlled by said train when adjacent said signal for varying the release interval of the other of said control relays associated with the direction of traffic opposite to that of said train's direction, and means controlled by said train and effective when the release interval of said other control relay is varied for rendering said other control relay ineffective to govern the control circuit of said signal.

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