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HIGHWAY CROSSING PROTECTION SYSTEMS

Filed Aug. 4, 1959

2 Sheets-Sheet 1

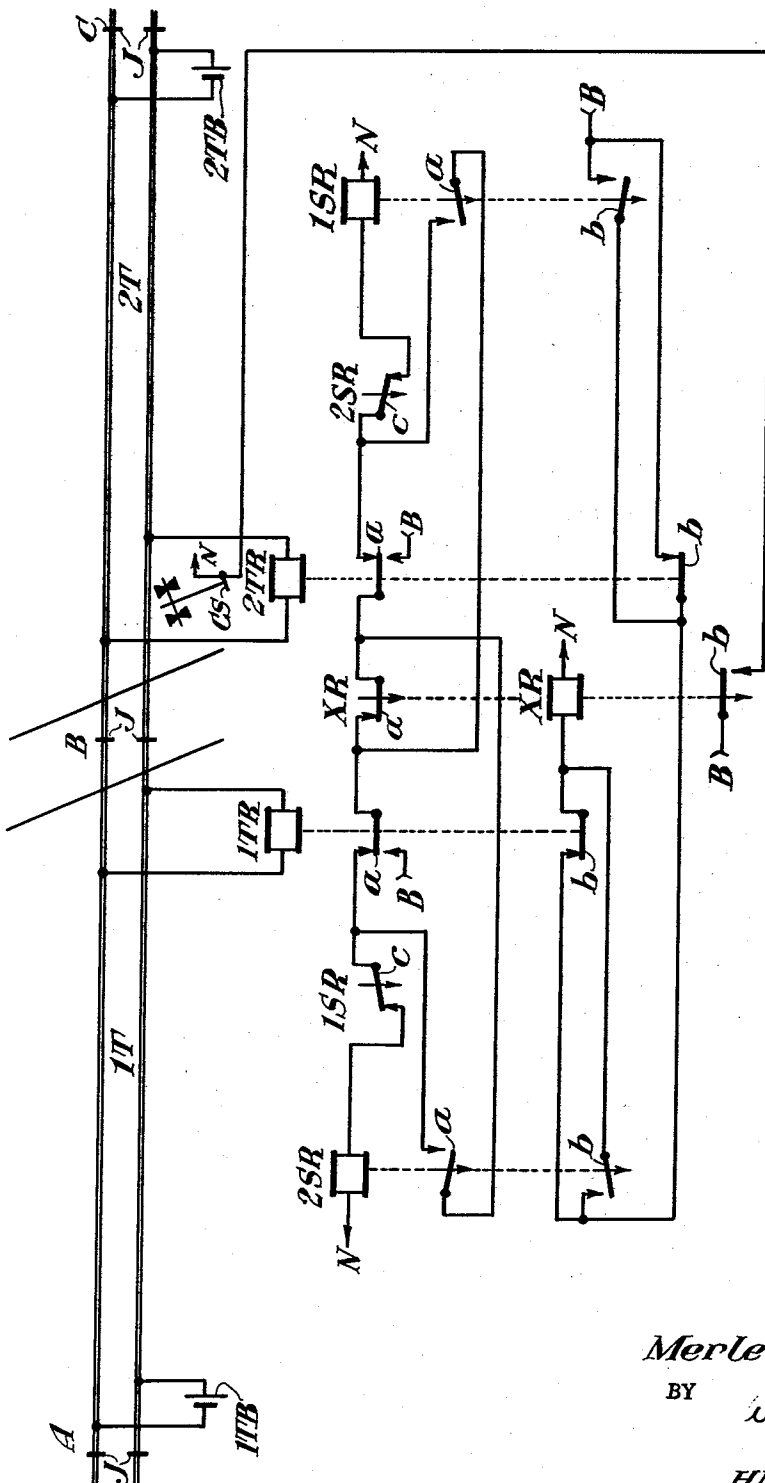


Fig. 1.

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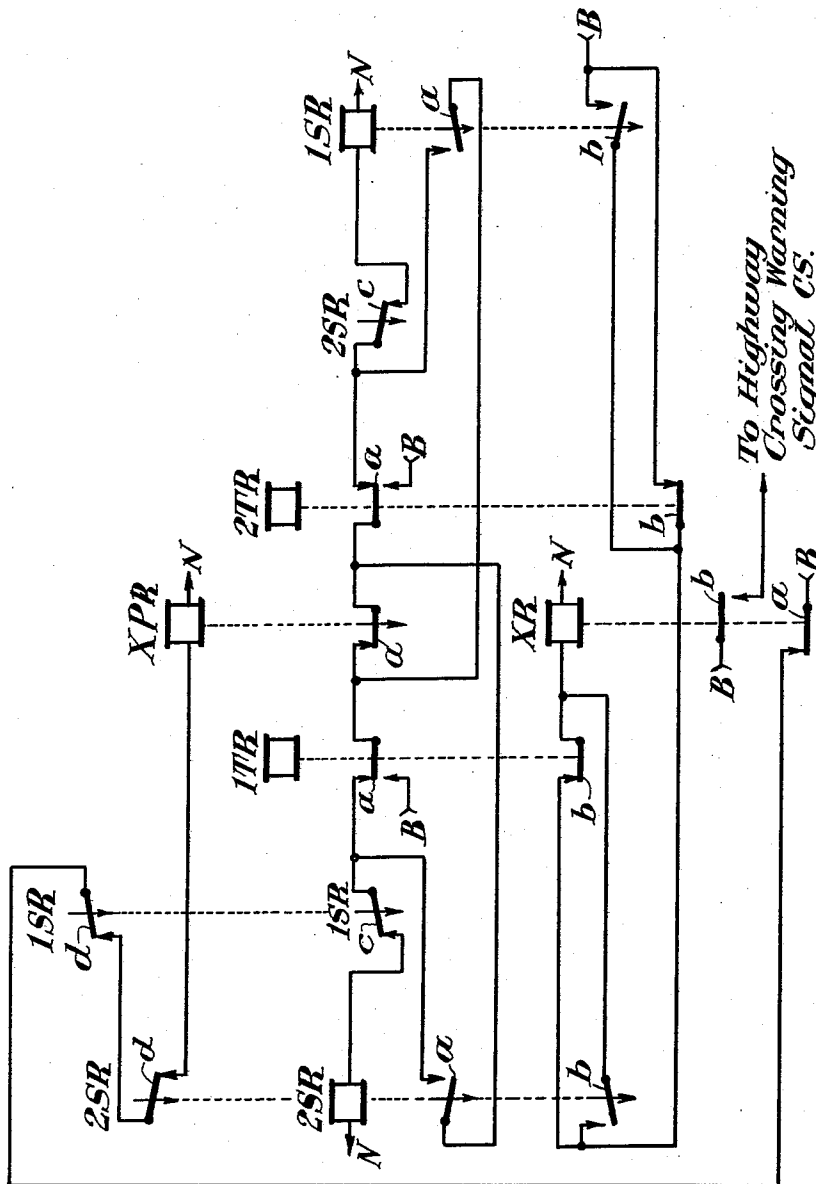
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HIGHWAY CROSSING PROTECTION SYSTEMS
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My invention relates to highway crossing protection systems, and particularly to systems of this type employing directional stick relays.

In double direction running single track railway territory highways crossing the track are often provided with crossing protection systems employing directional stick relays to prevent the operation of the crossing warning devices after a train has crossed the highway and is receding from the crossing. In such protection systems, where no separate track circuit is provided for the section of track spanning the highway, it is possible for the directional stick relay for the opposite direction of traffic to become picked up if the directional stick relay for a particular direction of traffic fails to become picked up when a train proceeds in said particular direction through the track stretch crossing the highway. Under some conditions such improper operation would merely cause the crossing warning devices to operate when the train is receding from the highway as well as when approaching and crossing the highway. However, if a second train is following sufficiently close behind the first train that it enters the approach warning track section for the highway before the first train has vacated the track section on the other side of the highway, the wrong directional stick relay which becomes picked up by the first train receding from the highway will be maintained picked up by the second train, and the crossing warning devices will not operate to warn users of the highway that the second train is approaching. It is accordingly the main object of my invention to minimize, insofar as possible, the danger of causing the wrong directional stick relay to become picked up in such crossing warning systems as described above. The conditions under which improper operation may result will become more apparent later in this description.

In accordance with my invention, which covers two arrangements for accomplishing the above object, in one arrangement the crossing warning control relay is made slow to release and a front contact thereof is employed in the pickup circuits for the directional stick relays. In the other arrangement a front contact of a slow release repeater relay is employed in said circuits which relay repeats a front contact of the usual crossing warning relay and a back contact of each of the directional stick relays. The advantages of both arrangements will be discussed hereinafter.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall describe two forms of highway crossing protection systems 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 a system embodying my invention.

FIG. 2 is a view showing a modified form of the system illustrated in FIG. 1 and also embodying my invention.

Similar reference characters refer to similar parts in both views.

Referring first to FIG. 1, there is shown a stretch of railway track, extending from left to right on the drawing between two points A and C, respectively. A highway intersects the track stretch at a point B approximately midway between points A and C and the rails of the

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stretch are divided at point B by insulated rail joints J into left and right-hand track sections 1T and 2T, respectively. The rails of the railway track to the left and right of track sections 1T and 2T respectively are also insulated from the rails of the track sections 1T and 2T by insulated joints J.

Each of the track sections 1T and 2T is provided with a track circuit including a source of current, here shown as a primary battery, connected across the rails of the respective section at the end thereof remote from the highway crossing, and a track relay connected across the rails of each section at the end thereof adjacent the crossing, such that each track relay is normally in its picked up position, that is, is energized when its respective track section is unoccupied. These track batteries and relays are designated 1TB and 1TR, respectively, for track section 1T; and 2TB and 2TR, respectively, for track section 2T. Such track circuit arrangements are well known in the art.

A highway crossing signal or warning device CS is shown adjacent the highway on one side of the track stretch and it is to be understood that this crossing signal when actuated provides a warning for traffic moving in both directions on the highway. This crossing signal may be any of the types well known in the art, such as a wig-wag signal, bell, or flashing light signal, and is actuated to provide a crossing warning when energy is supplied thereto in the manner hereinafter described. For purposes of simplification the device for actuating the crossing signal is not shown in the drawings as it forms no part of my present invention, but such crossing signals and their operating devices are well known in the art.

Three additional relays 1SR, 2SR and XR are also shown in the drawings. Relays 1SR and 2SR are directional stick relays associated with track relays 1TR and 2TR, respectively, and are employed to reflect the direction in which a train is moving through the track stretch A—C as hereinafter described. Relay XR is a crossing control relay which repeats the operation of the track relays and the directional stick relays and controls the actuation of the crossing warning signal, as set forth hereinafter.

It is believed expedient to point out at this time that a suitable source of energy for operation of the apparatus other than the track circuits is provided, this source being preferably a battery of proper voltage and capacity. However, for the sake of simplicity the energy source is not shown in the drawings but its positive and negative terminals are identified in each of the figures of the drawings by the reference characters B and N, respectively.

Certain of the relays shown in the drawings are made slightly slow to release, as shown in the conventional manner by arrows drawn in the downward direction through the movable member of the contacts of these relays. The purpose of the slow release feature of these relays will become apparent as the description proceeds. Also contacts of several of the relays in the drawings are not disposed directly below the geometric rectangles representing the windings of their respective relays, but where the contacts are not so disposed the reference character designating the respective relay winding for each contact is disposed on the drawing directly above the movable member of the contact, as is believed apparent from an examination of the drawings.

Referring again to FIG. 1, directional stick relay 1SR has a pickup circuit extending from terminal B of the battery over the back point of contact *a* of track relay 1TR, front contact *a* of relay XR, the front point of contact *a* of track relay 2TR, back contact *c* of relay 2SR, and through the winding of relay 1SR to terminal N of the battery. Relay 1SR has a first stick circuit extending from terminal B of the battery over the back point of contact *a*

of relay 1TR, front contact *a* of relay 1SR, back contact *c* of relay 2SR, and through the winding of relay 1SR to terminal N of the battery. Relay 1SR has a second stick circuit extending from terminal B of the battery over the back point of contact *a* of relay 2TR, front contact *a* of relay XR, front contact *a* of relay 1SR, back contact *c* of relay 2SR, and through the winding of relay 1SR to terminal N of the battery. Relay 1SR is, therefore, picked up when track relay 1TR is released, relay XR is picked up, track relay 2TR is picked up, and relay 2SR is released; and is maintained picked up so long as track relay 1TR remains released, or track relay 2TR is released and relay XR is picked up. The operation of relay 1SR will become more apparent as the description proceeds.

Directional stick relay 2SR in FIG. 1 has a pickup circuit which may be traced from terminal B of the battery over the back point of contact *a* of relay 2TR, front contact *a* of relay XR, the front point of contact *a* of relay 1TR, back contact *c* of relay 1SR and the winding of relay 2SR to terminal N of the battery. Relay 2SR has a first stick circuit which extends from terminal B of the battery over the back point of contact *a* of relay 2TR, front contact *a* of relay 2SR, back contact *c* of relay 1SR, and through the winding of relay 2SR to terminal N of the battery. Relay 2SR has a second stick circuit extending from terminal B of the battery over the back point of contact *a* of relay 1TR, front contact *a* of relay XR, front contact *a* of relay 2SR, back contact *c* of relay 1SR, and through the winding of relay 2SR to terminal N of the battery. Relay 2SR is, therefore, picked up when track relay 2TR is released, relay XR is picked up, track relay 1TR is picked up and relay 1SR is released, and is maintained picked up so long as track relay 2TR remains released, or track relay 1TR is released and relay XR is picked up. The operation of relay 2SR will become more apparent hereinafter in this description.

Relay XR in FIG. 1 has a series-multiple pickup circuit which may be traced from terminal B of the battery over front contact *b* of relay 2TR, or over front contact *b* of relay 1SR which is in multiple with front contact *b* of relay 2TR; and thence over front contact *b* of relay 1TR, or over front contact *b* of relay 2SR which is in multiple with front contact *b* of relay 1TR, and the winding of relay XR to terminal N of the battery. Relay XR, is, therefore, actuated to its picked up position when both track relays 1TR and 2TR are picked up, or when one of the track relays and its associated stick relay are both picked up. The operation of relay XR will be more fully described hereinafter.

There is also shown in FIG. 1 a circuit for causing actuation of the crossing warning signal CS. This circuit extends from terminal B of the battery over back contact *b* of relay XR and to the crossing warning signal and its control device to terminal N of the battery. Crossing signal CS is, therefore, actuated to provide a warning to traffic traversing the highway whenever relay XR is released.

I will now describe the operation of the apparatus of my invention when a train moves from west to east or, as shown in the drawing, from left to right through the track stretch A-C, and will then describe the manner in which the directional stick relay 2SR for the opposite direction of traffic is prevented from being picked up in the event the proper directional stick relay 1SR fails to become picked up for some reason.

When the eastbound train enters track section 1T, and the wheels and axles of the train shunt the track circuit for that track section track relay 1TR is released. The release of track relay 1TR closes at the back point of its contact *a* the previously described pickup circuit for directional stick relay 1SR, and relay 1SR therefore becomes picked up and completes its previously described first stick circuit including its own front contact *a* and the back point of contact *a* of relay 1TR. Relay 1SR will

be maintained picked up over this stick circuit so long as track section 1T is occupied by the train.

The release of relay 1TR when the train enters track section 1T also opens at front contact *b* of relay 1TR the previously described pickup circuit for relay XR. However, relay XR is made sufficiently slow to release that it will maintain its front contact *a* closed for a sufficient period of time to permit relay 1TR to close the back point of its contact *a* and complete the pickup circuit for relay 1SR, as described above. After the slow release period of relay XR expires that relay will release and close over its back contact *b* the actuating circuit for the crossing signal CS. Signal CS will then be actuated to give a warning to the highway traffic that a train is approaching the crossing.

When a train enters track section 2T, track relay 2TR is released and the previously described second stick circuit for relay 1SR is prepared at the closed back point of contact *a* of relay 2TR but remains open at the open front contact *a* of relay XR. The control circuit for relay XR is also now open at the open point of front contact *b* of relay 2TR, but relay 1SR having been previously picked up, the multiple circuit in shunt around front contact *b* of relay 2TR is closed at front contact *b* of relay 1SR.

Assuming that the train now vacates track section 1T, relay 1TR again becomes picked up opening at the back point of its contact *a* the described first stick circuit for relay 1SR and closing at its front contact *b* the pickup circuit for relay XR including front contact *b* of relay 1SR. Relay XR accordingly picks up completing at its front contact *a* the second stick circuit for relay 1SR. The slow release feature of relay 1SR prevents it from releasing when its stick circuit is open during the period from the opening of the back point of contact *a* of relay 1TR, the closing of the front point of contact *b* of relay 1TR and the subsequent pickup of relay XR. Relay 1SR is, therefore, maintained picked up over its second stick circuit when the train vacates track section 1T and occupies track section 2T only. It is to be noted that the open back point of contact *c* of relay 1SR prevents relay 2SR from becoming picked up when track relay 1TR and relay XR become picked up and while track relay 2TR is released in the movement of the train out of track section 1T and through track section 2T.

When relay XR becomes picked up subsequent to the picking up of relay 1TR as described above, the actuating circuit for the crossing signal is open at back contact *b* of relay XR and the signal gives no warning when the train is receding from the crossing through track section 2T.

Since the operation of the apparatus for a westbound train moving through the track stretch is similar to that described for an eastbound train, no description of the operation for the westbound train is considered necessary except to say that the directional stick relay 2SR would be energized rather than relay 1SR.

I will now describe the manner in which the apparatus embodying my invention prevents the pickup of the westbound directional stick relay 2SR if the eastbound directional stick relay 1SR fails to become picked up due to a broken or loose wire in its pickup circuit, or having been picked up failed to be maintained picked up due to a broken or loose wire in its stick circuits.

Assuming that the eastbound train entering track section 1T fails to pick up directional stick relay 1SR when the train first enters track section 1T, due to a broken wire in the pickup circuit for relay 1SR, the back contact *c* of relay 1SR in the pickup and stick circuits for relay 2SR would remain closed. However, front contact *b* of relay 1SR in the pickup circuit for relay XR would also remain open under these conditions. Therefore, when the eastbound train vacates track section 1T and track relay 1TR becomes picked up, relay XR will not become picked up since its pickup circuit remains open at front contacts *b* of relays 1SR and 2TR. Since relay

XR remains released at this time the pickup circuit for relay 2SR including the back point of contact *a* of relay 2TR, the front point of contact *a* of relay 1TR, back contact *c* of relay 1SR, and front contact *a* of relay XR, remains open at this last-mentioned contact and relay 2SR, which is the wrong directional stick relay for an eastbound train, will not become picked up. The crossing signal will continue to operate while the train is receding from the crossing through track section 2T, but this is not considered a dangerous condition similar to the failure of the crossing warning signal to operate when a train is approaching the crossing as described below.

Assuming, that as in previous similar crossing warning systems the front contact *a* of relay XR is not included in the pickup circuits for relays 1SR and 2SR, when a first eastbound train enters track section 1T and, due to a broken wire in the pickup circuit for relay 1SR that relay fails to become picked up, when the train enters track section 2T and vacates track section 1T, the pickup circuit for relay 2SR would be closed at the back point of contact *a* of relay 2TR. As a result, stick relay 2SR would become picked up at this time. The crossing warning system would continue to operate when the first train is receding from the crossing so no dangerous condition would result at this time. However, further assuming that a second train is following the first train at such a distance that the second train enters track section 1T just prior to the exit of the first train from track section 2T, a dangerous condition would result. The release of track relay 1TR by the entrance of the second train into track section 1T would close the stick circuit for relay 2SR and, when the first train vacates track section 2T, relay XR would become picked up over the circuit including front contact *b* of relay 2TR and front contact *b* of relay 2SR. Relay 2SR and consequently relay XR would be maintained picked up while the second train is approaching the highway and, therefore, no crossing warning would be given for the approach of the second train. It is therefore apparent that the inclusion of the front contact *a* of relay XR in the pickup circuits for relays 1SR and 2SR in accordance with my invention prevents a dangerous condition that might otherwise result if such contact were not included in these pickup circuits. As previously stated the apparatus of FIG. 1 of my invention also prevents the wrong directional stick relay from becoming picked up if the proper stick relay becomes picked up and then, due to a loose or broken wire, releases when a train is approaching the crossing. This operation of the apparatus is similar to that described when the proper directional stick relay failed to pick up and no further description of this operation is believed necessary.

Referring now to FIG. 2 of the drawings, the pickup and stick circuits for the directional stick relays are similar to those of FIG. 1 except that a front contact *a* of a repeater relay XPR, to be described, is employed in FIG. 2 in place of front contact *a* of relay XR as in FIG. 1, and no detailed tracing of these circuits is believed necessary. The control circuits for relay XR and for the highway crossing warning signal CS in FIG. 2 are identical to the corresponding circuits of FIG. 1 and a detailed description thereof is not believed necessary. However, it should be pointed out that in the arrangement of FIG. 2, relay XR is not a slow release relay, but the previously mentioned repeater relay XPR, which is a slow release relay, repeats, among other contacts as described below, a front contact of relay XR.

The repeater relay XPR is provided with a control circuit extending from terminal B of the battery over front contact *a* of relay XR, back contact *d* of relay 1SR, back contact *d* of relay 2SR, and through the winding of relay XPR to terminal N of the battery. Relay XPR is thus in its picked-up position when the crossing control relay XR occupies its picked-up position and both stick relays occupy their released positions.

The arrangement of FIG. 2 operates in a manner similar to that of FIG. 1 to prevent the wrong directional

stick relay from becoming picked up but provides an amount of additional protection under certain conditions which will now be described.

It will be assumed, in the example previously set forth describing the operation of the apparatus of FIG. 1 of my invention when a first train and a second closely following train move through the track stretch shown in FIG. 1, that after the first train clears track section 1T and is receding from the crossing on track section 2T, relay 1SR, which was previously picked up by the proper operation of the circuits, releases due to a broken or loose wire in its second described stick circuit. Such release of relay 1SR when the first train occupies track section 2T in the arrangement of FIG. 1, will permit directional stick relay 2SR to become picked up over its previously described pickup circuit including back contact *c* of relay 1SR, front contact *a* of relay XR, and the back point of contact *a* of relay 2TR. The front point of contact *a* of relay XR, due to the slow release feature of that relay, does not open immediately when front contact *b* of relay 1SR opens in the control circuit for relay XR and, therefore, relay 2SR becomes picked up under these conditions. Therefore, if the second train enters track section 1T causing track relay 1TR to close the back point of its contact *a* before the first train vacates track section 2T, or within a period of time less than the release time of relay 2SR after relay 2TR opens the back point of its contact *a* upon the first train vacating track section 2T, relay 2SR will be maintained picked up by its second described stick circuit including the back point of contact *a* of relay 1TR and front contact *a* of relay XR. Relay XR is held up at this time over the front point of contact *b* of relay 2SR and no crossing warning will be provided for the second train under these conditions.

Assuming now that the apparatus arrangement of FIG. 2 is employed under the above-described conditions, when the stick circuit for relay 1SR fails, the control circuit for relay XR will be opened at front contact *b* of relay 1SR. At this time relay XPR is in its released position due to its control circuit having previously been opened at the open back contact *d* of relay 1SR. The release of relay 1SR will close back contact *d* of relay 1SR in the control circuit for relay XPR but before such contact closes relay XR will open its front contact *a* in the control circuit for relay XPR and, therefore, relay XPR will remain released. In other words, the period of time between the opening of front contact *b* of relay 1SR and the consequential opening of front contact *a* of relay XR is less than the period of time between the opening of front contact *b* of relay 1SR and the closing of back contact *d* of relay 1SR, it being remembered that in the arrangement of FIG. 2 relay XR is not provided with a slow release feature. The pickup circuit for relay 2SR cannot, therefore, be closed when a train is receding from the crossing over track section 2T and the stick circuit for relay 1SR fails, thereby releasing relay 1SR from its picked-up position. Consequently, the following train occupying track section 1T cannot operate to close the stick circuit for the wrong directional stick relay 2SR and a crossing warning for the second train will be provided.

The apparatus arrangement of FIG. 2 of my invention will operate in a manner similar to that just described when two closely following trains move through the track stretch A-C in a westward direction and the stick circuit for the directional stick relay 2SR fails as the first train is receding from the crossing over track section 1T.

In view of the above description it is apparent that with the apparatus of FIG. 1 of my invention I have provided an economical arrangement providing a considerable degree of protection against the possibility of the wrong directional stick relay becoming picked up in a highway crossing protection system. Also with the modification of my invention as shown in FIG. 2 an arrangement is provided which prevents, insofar as pos-

sible, the wrong directional stick relay from becoming picked up in such protection systems. The additional protection provided by FIG. 2 is effected through the use of but one additional relay and an additional contact on each of the stick relays.

Although I have herein shown only two forms of highway crossing protection systems embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a stretch of railway track intersected by a highway; two track circuits for said stretch, one on each side of said highway and each including a normally energized track relay; a normally deenergized slow release stick relay associated with each track relay, a normally energized slow release relay; a pickup circuit for each stick relay including a back contact of the associated track relay, a front contact of the other track relay, a back contact of the other stick relay, and a front contact of the normally energized slow release relay; a first stick circuit for each stick relay including its own front contact, said back contact of the other stick relay, and said back contact of the associated track relay; a second stick circuit for each stick relay including its said own front contact, said back contact of the other stick relay, said front contact of said normally energized slow release relay, and said back contact of the other track relay; a crossing warning device for said highway, means controlled by said track relays and said stick relays for deenergizing said normally energized slow release relay when one of said track relays and the stick relay associated with the other track relay are deenergized, and means controlled by said normally energized slow release relay when released for actuating said crossing warning device.

2. In combination, a stretch of railway track intersected by a highway; two track circuits for said stretch, one on each side of said highway and each including a track relay; a slow release stick relay associated with each track relay, a third slow release relay normally energized; a pickup circuit for each stick relay including a back contact of the associated track relay, a front contact of the other track relay, a back contact of the other stick relay, and a front contact of said third relay; a first stick circuit for each stick relay including its own front contact, said back contact of the other stick relay, and said back contact of the associated track relay; a second stick circuit for each stick relay including its said own front contact, said back contact of the other stick relay, said front contact of said third relay, and a back contact of the other track relay; a crossing warning device for said highway, means controlled by said track relays and said stick relays for deenergizing said third relay when one of said track relays and the stick relay associated with the other track relay are deenergized, and means controlled by said third relay when released for actuating said crossing warning device.

3. In combination, a stretch of railway track provided with two adjacent track circuits each including a track relay energized when its respective track circuit is unoccupied, a slow release stick relay associated with each track relay, a third slow release relay normally energized, a pickup circuit for each stick relay including a back contact of the associated track relay, a front contact of the other track relay, a front contact of said third relay, and a back contact of the other stick relay; a first stick circuit for each stick relay including a back contact of the associated track relay; a second stick circuit for each stick relay including a back contact of the other stick relay, a front contact of said third relay, and a back contact of the other track relay; and means controlled by a front contact of each track relay and a front contact of each stick relay for deenergizing said third relay when one of said track relays and the stick relay associated with the other track relay are deenergized.

4. In combination, a stretch of railway track provided with two adjacent track circuits each including a track relay, a stick relay associated with each track relay, a third slow release relay; means controlled by each stick relay when deenergized, by the track relay associated with the other stick relay when that track relay is deenergized, and by said third relay when energized for energizing said other stick relay; means controlled by each track relay for maintaining its associated stick relay energized when once energized so long as the track relay is deenergized, means controlled by said third relay and by the track relay associated with each stick relay for maintaining the associated stick relay energized once it becomes energized so long as the associated track relay is deenergized and said third relay is energized; and means controlled by said track relays and said stick relays for energizing said third relay when the track relays are energized.

5. In combination, a stretch of railway track intersected by a highway; two track circuits for said stretch, one on each side of said highway and each including a track relay energized when its respective track circuit is unoccupied; a slow release stick relay associated with each track relay, a third slow release relay; a pickup circuit for each stick relay, each including a back contact of the associated track relay, a front contact of the other track relay, a front contact of said third relay, and a back contact of the other stick relay; a first stick circuit for each stick relay, each including a front contact of the respective stick relay, said back contact of the associated track relay, and said back contact of the other stick relay; a second stick circuit for each said stick relay, each including a back contact of the other track relay, said front contact of said third relay, said front contact of the respective stick relay, and said back contact of the other stick relay; a crossing warning device for said highway, an actuating circuit for said crossing warning device including a back contact of said third relay; and means controlled by front contacts of said track relays and said stick relays for energizing said third relay when both track relays are energized, or when one track relay and its associated stick relay are energized.

6. In combination, a stretch of railway track intersected by a highway; two track circuits for said stretch, one on each side of said highway and each including a track relay energized when its respective track circuit is unoccupied; a slow release stick relay associated with each track relay, a control relay, a slow release repeater relay; a pickup circuit for each stick relay each including a back contact of the associated track relay, a front contact of the other track relay, a front contact of said repeater relay, and a back contact of the other stick relay; a first stick circuit for each stick relay, each including a front contact of the respective stick relay, and said back contact of the other stick relay; a second stick circuit for each stick relay, each including a back contact of the other track relay, said front contact of said repeater relay, said front contact of the respective stick relay, and said back contact of the other stick relay; a crossing warning device for said highway, an actuating circuit for said crossing warning device including a back contact of said control relay; means controlled by front contacts of said track relays and said stick relays for energizing said control relay when both of the track relays are energized, or when one of the track relays and its associated stick relay are energized; and an energizing circuit for said repeater relay including a front contact of said control relay and a back contact of each of the stick relays.

7. In combination, a stretch of railway track intersected by a highway; two track circuits for said stretch, one on each side of said highway and each including a track relay energized when its respective track circuit is unoccupied; a slow release stick relay associated with each track relay, a third slow release relay; means for energizing one of the stick relays controlled by the associated track relay, said third relay, the other track relay, and

the other stick relay, and effective when the associated track relay is deenergized, the third relay is energized, the other track relay is energized, and the other stick relay is deenergized; similar means for energizing the other stick relay, means for maintaining one of the stick relays energized when once energized controlled by the associated track relay and the other stick relay and effective when the associated track relay is deenergized and the other stick relay is deenergized, similar means for maintaining the other stick relay energized when once energized; means for maintaining one of the stick relays energized when once energized controlled by the other track relay, the third relay, and the other stick relay, and effective when the other track relay is deenergized, the third relay is energized and the other stick relay is deenergized; similar means for maintaining the other stick relay energized when once energized; means for energizing the third relay controlled by said track relays and said stick relays and effective when both track relays are energized, or when one of the track relays and its associated stick relay are energized; a crossing warning device for said highway, and means for actuating said warning device controlled by the third relay and effective when that relay is deenergized.

8. In combination, a stretch of railway track intersected by a highway; first and second track circuits for said stretch, one on each side of said highway and including respectively a first and a second track relay each energized when its respective track circuit is unoccupied; first and second slow release stick relays for the first and second track relays respectively, a repeater relay; means controlled by the track relays, the second stick relay, and said repeater relay, for energizing the first stick relay when the first track relay and the second stick relay are deenergized and the second track relay and the repeater relay are energized; means controlled by the track relays, the first stick relay, and said repeater relay, for energizing the second stick relay when the second track relay and the first stick relay are deenergized and the first track relay and the repeater relay are energized; means controlled by the first track relay and the first stick relay for maintaining the first stick relay energized when once energized, so long as the first track relay is deenergized; means controlled by the second track relay and the second stick relay for maintaining the second stick relay energized when once energized, so long as the second track relay is deenergized; means controlled by the second track relay, the repeater relay, and the first stick relay, for maintaining the first stick relay energized when once energized so long as the second track relay is deenergized and the repeater relay is energized; means controlled by the first track relay, the repeater relay and the second stick relay, for maintaining the second stick relay energized when once energized, so long as the first track relay is deenergized and the repeater relay is energized; a control relay; means controlled by the track relays and

the stick relays for energizing said control relay when both track relays are energized, or when one track relay and its associated stick relay are energized; means controlled by the control relay and the stick relays for energizing said repeater relay when the control relay is energized and the stick relays are deenergized, a warning signal for said highway, and means controlled by the control relay for energizing said warning signal when the control relay is deenergized.

9. In combination, a stretch of railway track over which trains may travel at different times in opposite directions, said stretch being provided with first and second adjacent track circuits including first and second normally energized track relays respectively, first and second directional stick relays associated with the first and second track relays respectively, a slow release relay, means controlled by the track relays and said stick relays for energizing said slow release relay when both of the track relays or one of the track relays and its associated stick relay are energized, means controlled by said slow release relay and the track relays for energizing the first directional stick relay when a train enters said first track circuit first and the slow release relay is in its picked-up position, and means controlled by said slow release relay and the track relays for energizing the second directional stick relay when a train enters said second track circuit first and the slow release relay is in its picked-up position.

10. In combination, two adjacent sections of railway track, a track circuit for each said section each including a normally energized track relay, a stick relay associated with each said section and its track relay, a slow release relay, means controlled by the track relays and the slow release relay for energizing each stick relay when a train enters the associated section moving toward the other section and the slow release relay is energized, means controlled by the track relay for the section so entered for maintaining the associated stick relay energized so long as such train occupies the associated track section, means controlled by the track relay for said other section for maintaining the stick relay associated with the other track relay energized until such train moves out of said other section, means controlled by the track relays for energizing said slow release relay when both track relays are energized, means controlled by the track relays and said stick relays for energizing said slow release relay when one of the track relays and the associated stick relay are both energized, a highway crossing signal, and means controlled by a contact of said slow release relay for actuating said signal.

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