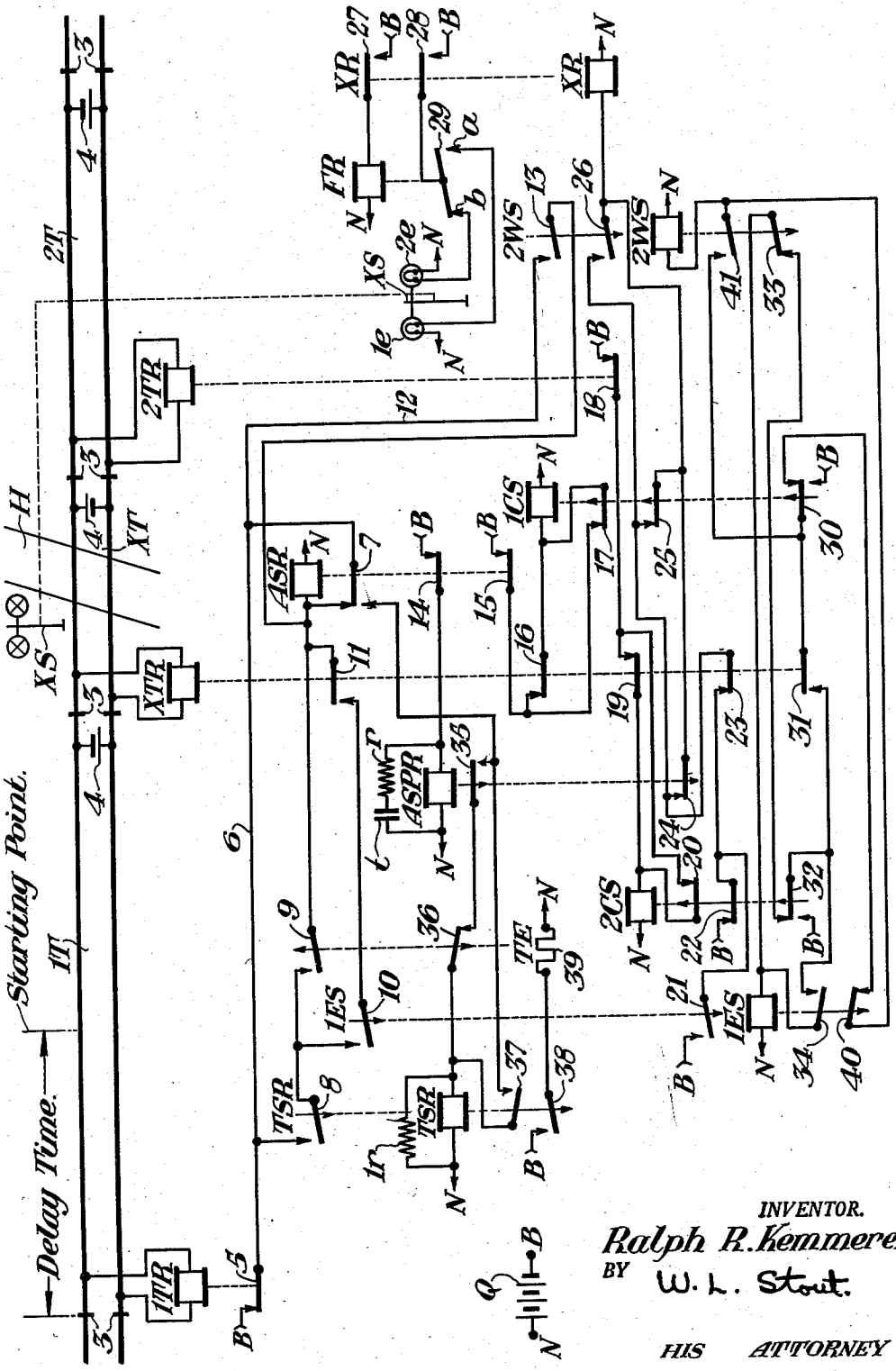
Aug. 21, 1956 R. R. KEMMERER 2,760,054

APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

Filed July 23, 1952



United States Patent Office 2,760,054 Patented Aug. 21, 1956

2,760,054

APPARATUS FOR CONTROLLING HIGHWAY CROSSING SIGNALS

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Application July 23, 1952, Serial No. 300,563

9 Claims. (Cl. 246—130)

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.

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.

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, and which includes means for protecting against a momentary los of shunt of the track circuit for the approach control section, it is desirable to also avoid excessive operation of a highway crossing signal when a second train approaching the crossing follows a first train closely.

An object of my invention in apparatus for controlling highway crossing signals, in which an energy storing device is employed for delaying the starting of operation of a highway crossing signal when a train enters an approach control track section, is therefore the provision of an arrangement for protecting against a momentary loss of shunt of a track circuit for an approach control section, which includes means for avoiding excessive operation of the highway crossing signal when a second train approaching the crossing follows a first train closely.

A feature of my invention, for accomplishing this object, is the provision of an approach stick relay ASR having pickup circuits controlled by a front contact of a track relay, designated by the reference character 1TR, for an approach control section, designated by the reference character 1T, and with a first one of the pickup circuits controlled to be closed only upon the lapse of a measured period of time in the event of a momentary loss of shunt of the approach control section 1T, and with a second pickup circuit controlled to be closed promptly when the approach control section 1T becomes vacated by a train which has moved over section 1T while approaching the crossing.

Another object of my invention is the provision of means for energizing the approach stick relay ASR promptly when a train moving away from the associated highway crossing vacates the approach control section 1T.

A feature of my invention for accomplishing this object is the provision of a third pickup circuit for the approach stick relay ASR controlled by a corresponding directional stick relay, designated by the reference character 2WS.

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

The accompanying drawing 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 an approach stick relay, designated by the reference character ASR, has three pickup circuits and a stick circuit; in which a repeater relay, designated by the reference character ASPR, is controlled by a front contact of relay ASR, and is made slow releasing 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 the repeater relay ASPR; in which a timing stick relay, designated by the reference character TSR, is controlled by a circuit including back contacts of relays ASR and ASPR, and of a time element

device TE; in which time element device TE is controlled by a front contact of relay TSR; in which a first and a second control stick relay, designated by the reference characters 1CS and 2CS, respectively, are of the slow pick-up type; in which a first and a second or eastbound and westbound directional stick relays, designated by the reference characters 1ES and 2WS, respectively, are of the slow release type; and in which a highway crossing signal control relay, designated by the reference character XR, is controlled by circuit means including contacts of the control stick relays, the directional stick relays, the repeater relay, and the track relay for the crossing track section.

Similar reference characters refer to similar parts in the drawing.

Referring further to the drawing, a highway crossing signal, designated by the reference character XS, which may be of any suitable design but which, as shown in the drawing, 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 approach stick relay ASR has three pickup circuits and a stick circuit, each of which includes a front contact 5 of track relay 1TR for the first or eastbound approach control track section 1T. A first one of the pickup circuits and a second one of the pickup circuits also includes a front contact 8 of relay TSR. The first one of the pickup circuits also includes a contact 9 of time element device TE. The second pickup circuit for relay ASR also includes front contact 10 of relay 1ES and back contact 11 of relay XTR. The third pickup circuit for relay ASR includes a front contact 13 of relay 2WS.

Relay TSR has a pickup and a stick circuit, each of which includes contact 5 of relay 1TR and the back point of contact 7 of relay ASR, and the pickup circuit also includes back contacts 35 and 36 of relay ASPR and the time element device TE, respectively.

Contact 9 of time element device TE becomes closed when the control element 39 of time element device TE has been energized for a measured period of time, and back contact 36 becomes closed upon the lapse of a further period of time after the control element 39 has become deenergized. An energizing circuit for time element device TE is at times completed through the front contact 38 of relay TSR. Time element device TE may be of the thermal type.

Each of the control stick relays 1CS and 2CS has a pickup and a stick circuit. Both the pickup and the stick circuit for relay 1CS includes a front contact 15 of relay ASR, and the pickup circuit also includes a contact 16 of relay XTR. Both the pickup and the stick circuit for relay 2CS includes a front contact 18 of relay 2TR, and the pickup circuit also includes a contact 19 of relay XTR.

Each of the directional stick relays 1ES and 2WS has a pickup and a first stick circuit which include a back contact 31 of relay XTR. The pickup circuit for relay 1ES also includes the back point of contact 30 of relay 1CS, the front point of contact 32 of relay 2CS, and back

contact 33 of relay 2WS. The pickup circuit for relay 2WS also similarly includes the back point of contact 32 of relay 2CS, the front point of contact 30 of relay 1CS, and the back contact 40 of relay 1ES. Each of the relays 1ES and 2WS is controlled by its pickup circuit to become energized when a train moving in the corresponding direction enters the crossing track section XT.

The crossing signal control relay XR is controlled by front contacts of the control stick relays 1CS and 2CS, the directional stick relays 1ES and 2WS, repeater relay ASPR, and track relay XTR. Relay XR is normally energized.

A flasher control relay, designated by the reference character FR, is controlled by a back contact 27 of relay XR, and is normally deenergized. Relay FR is of the well-known type having a movable contact element 29 which, while relay FR is energized, oscillates between a first position, in which it engages a fixed contact element *b*, and a second position, in which engages a second fixed contact element *a*.

As shown in the drawing, highway crossing signal XS comprises two lamps 1*e* and 2*e*, the lighting circuits for which include contacts 29*a* and 29*b*, respectively, of relay FR, and a back contact 28 of relay XR. Lamps 1*e* and 2*e*, on account of being controlled by contact 28 of relay XR, are not lighted until relay XR becomes deenergized, causing its contact 27 to be closed in a circuit for energizing relay FR, and causing its contact 28 to become closed in the lighting circuits for signal XS. Lamps 1*e* and 2*e* of signal XS will then display a flashing indication, on account of being repeatedly lighted, alternately, through contacts 29*a* and 29*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 the drawing, having terminals B and N.

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

As shown in the drawing, 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 and 2TR are energized; relays ASR, ASPR, 1CS, 2CS and XR are also energized; and relays 1ES, 2WS, TSR and FR, time element device TE, and signal XS are deenergized.

The three pickup circuits for relay ASR are normally open, but relay ASR is energized by its stick circuit passing from terminal B, through contact 5 of relay 1TR, conductor 6, front point of contact 7 of relay ASR, and the winding of relay ASR to terminal N.

Relay ASPR is energized by its circuit passing from terminal B, through contact 14 of relay ASR, and a resistor *r* in series with a capacitor *t* in a path in multiple with the winding of relay ASPR, to terminal N.

Both the pickup circuit and the stick circuit for relay 1CS are closed. The pickup circuit for this relay passes from terminal B, through contacts 15 and 16 of relays ASR and XTR, respectively, and the winding of relay 1CS to terminal N. The stick circuit is the same as the pickup circuit except that it includes contact 17 of relay 1CS instead of contact 16 of relay XTR.

Both a pickup circuit and a stick circuit are also closed for relay 2CS, the pickup circuit for relay 2CS passing from terminal B, through contacts 18 and 19 of relays 2TR and XTR, respectively, and the winding of relay 2CS to terminal N. The stick circuit for relay 2CS is the same as the pickup circuit just traced except that it includes contact 20 of relay 2CS instead of contact 19 of relay XTR.

The circuit by which relay XR is energized passes from terminal B, through contacts 22 and 23 of relays 2CS and XTR, respectively, contact 24 of relay ASPR in multiple with contact 25 of relay 1CS, and the winding of relay XR to terminal N.

I shall assume that, with apparatus embodying my in-

vention arranged as shown in the drawing, an eastbound train enters section 1T, deenergizing relay 1TR. The stick circuit traced for relay ASR will therefore be opened at contact 5 of relay 1TR, causing relay ASR to be deenergized. Front contacts 14 and 15 of relay ASR will therefore in turn be opened and contact 7 of relay ASR will become opened at its front point and closed at its back point. With contact 15 of relay ASR open, the pickup and stick circuits traced for relay 1CS will become opened, and therefore relay 1CS will become deenergized. With contact 14 of relay ASR open, the energizing circuit for relay ASPR will be opened, but relay ASPR will be slow to release because of the path through resistor *r* and capacitor *t* in multiple with the winding of relay ASPR, and therefore, although contact 25 of relay 1CS is open, the circuit for relay XR will temporarily remain closed through contact 24 of relay ASPR, 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 24 of relay ASPR 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 24 of relay ASPR opens, relay XR will become deenergized, since contact 25 of relay 1CS is already open. With relay XR deenergized, relay FR will be energized by a circuit passing from terminal B, through contact 27 of relay XR, and the winding of relay FR to terminal N. Relay FR, upon thus becoming energized, will oscillate its movable contact element 29 to repeatedly engage alternately the fixed contact elements *a* and *b*. With relay XR deenergized, and with the movable contact element 29 engaging the fixed contact element *b*, lamp 2*e* of signal XS will be lighted by a circuit passing from terminal B, through contact 28 of relay XR, contact 29*b* of relay FR, and lamp 2*e* to terminal N. When movable contact element 29 engages the fixed contact element *a*, lamp 1*e* of signal XS will be lighted by a similar circuit passing from terminal B, through contact 28 of relay XR, contact 29*a* of relay FR, and lamp 1*e* to terminal N.

When the train enters section XT, deenergizing relay XTR, contact 16 of relay XTR will become opened in the pickup circuit for relay 1CS, which is, however, already deenergized on account of contact 15 of relay ASR being open. Contact 23 of relay XTR will also be opened in the circuit traced for relay XR, which is, however, already deenergized on account of contacts 24 and 25 of relays ASPR and 1CS, respectively, being open. When back contact 31 of relay XTR becomes closed, the first, or eastbound, directional stick relay 1ES will become energized by a pickup circuit passing from terminal B, through the back point of contact 30 of relay 1CS, contact 31 of relay XTR, front point of contact 32 of relay 2CS, contact 33 of relay 2WS, and the winding of relay 1ES to terminal N. Relay 1ES, upon becoming energized by its pickup circuit, will complete a first stick circuit passing from terminal B, through the back point of contact 30 of relay 1CS, contact 31 of relay XTR, contact 34 of relay 1ES, and the winding of relay 1ES to terminal N.

When the train enters section 2T, contact 18 of relay 2TR will become opened in the pickup and stick circuits traced for relay 2CS, causing relay 2CS to be deenergized. A second stick circuit for relay 1ES will thereby be completed, passing from terminal B, through the back point of contact 32 of relay 2CS, contact 34 of relay 1ES, and the winding of relay 1ES to terminal N.

When the train leaves section 1T, relay TSR will become energized by its pickup circuit passing from terminal B, through contact 5 of relay 1TR, conductor 6, back point of contact 7 of relay ASR, contacts 35 and 36 of relay ASPR and time element device TE, respectively, and the winding of relay TSR in multiple with a resistor 1*r*, to terminal N. Relay TSR, upon becoming energized, will complete its stick circuit, which is the same as the pickup circuit just traced except that it includes contact 37 of relay TSR instead of contacts 35 and 36 of relay ASPR and time element device TE, respectively. With relay TSR energized, relay ASR will become energized promptly by its second pickup circuit, passing from terminal B, through contact 5 of relay 1TR, contacts 8, 10 and 11 of relays TSR, 1ES and XTR, respectively, and the winding of relay ASR to terminal N. Relay ASR, upon becoming energized, will then complete its stick circuit previously traced. With relay ASR energized, relay ASPR will become energized by its circuit previously traced. Contact 24 of relay ASPR will then again be closed in the circuit traced for relay XR, but relay XR will remain deenergized on account of contact 23 of relay XTR still being open.

Since relay ASR becomes energized promptly, by the closing of contact 8 of relay TSR, when the train leaves section 1T, relay TSR will in turn become deenergized quickly by the opening of contact 7 of relay ASR at its back point, and therefore time element device TE will not have time to close its contact 9. Relay ASR will then remain energized by its stick circuit.

When the train leaves section XT, the pickup and first stick circuits previously traced for relay 1ES will become opened at contact 31 of relay XTR, but relay 1ES will then remain energized by its second stick circuit, previously traced. With relays ASR and XTR again energized, relay 1CS will become energized by its pickup circuit previously traced. With relay XTR again energized, relay XR will now become energized by a circuit which is the same as the circuit previously traced for this relay except that it includes contact 21 of relay 1ES instead of contact 22 of relay 2CS which is now open. With relay XR again energized, contact 27 of relay XR will open the circuit for relay FR, causing relay FR to be deenergized, and contact 28 of relay XR will open the lighting circuits for signal XS, causing lamps 1*e* and 2*e* to be extinguished.

When the train leaves section 2T, relay 2CS will again become energized by its pickup circuit previously traced, and all parts of the apparatus will then again be in the normal condition.

I shall next assume that, again an eastbound train has moved over section 1T and occupies section XT after leaving section 1T, and that a second eastbound train then enters section 1T just before the first eastbound train leaves section XT. Relay ASR will then become deenergized in response to occupancy of section 1T by the second eastbound train, and relay ASPR will become deenergized as before, but will not release its front contacts until the lapse of a period of time determined by capacitor *t* and resistor *r* in multiple with the winding of relay ASPR. It follows that operation of the crossing signal XS in response to the second train will be delayed until the second train has arrived at some starting point on section 1T, after the lapse of the period of time determined by capacitor *t* and resistor *r*, and therefore there will not be excessive operation of the highway crossing signal when a second train follows a first train closely.

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 ASR. I shall assume further that, just before relay ASPR releases its contacts, a momentary loss of shunt of the track circuit for section 1T occurs, so that contact 5 of relay 1TR becomes closed for a brief period of time. Since the

train has not yet entered section XT, relay 1ES has not yet become energized. Relay ASR will therefore not become energized by its second pickup circuit, previously traced. When relay ASPR releases its contacts, operation of the crossing signal XS will be started, as previously described. With relays ASR and ASPR deenergized, the pickup circuit for relay TSR will become closed as previously traced. Relay TSR, upon becoming energized, will complete its stick circuit which includes contact 37 of relay TSR instead of contacts 35 and 36 of relay ASPR and time element device TE, respectively. Time element device TE will then become energized by its circuit passing from terminal B, through contact 38 of relay TSR, and the control element 39 of time element device TE to terminal N. The momentary loss of shunt will have ended before time element device TE has had time to close its contact 9, and therefore relay ASR will not become energized during the period of the momentary loss of shunt. With contact 5 of relay 1TR again open at the end of the period of the momentary loss of shunt, relay TSR will again be deenergized, causing the time element device TE to in turn also be deenergized. Since relay ASR remains deenergized, relays 1CS and ASPR will also remain deenergized, and so relay XR will not become energized during the period of the momentary loss of shunt. Signal XS will therefore continue to provide a warning indication to users of the highway, without interruption because of a momentary loss of shunt of track section 1T.

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 ASR to be deenergized. I shall assume further that a momentary loss of shunt for the track circuit of section 1T occurs after relay ASPR has released its contacts. Therefore, with the second pickup circuit for relay ASR open at contact 10 of relay 1ES, as previously described, so that relay ASR is maintained deenergized, relay TSR will become energized, as previously described, by its pickup and stick circuits, and time element device TE will then also become energized, but before time element device TE has had time to close its front contact 9, any momentary loss of shunt will have ended, so that again contact 5 of relay 1TR will open the circuits for relay TSR, and time element device TE will then again be deenergized. Relays ASR, ASPR, and 1CS therefore remain deenergized, and relay XR in turn also remains deenergized, so that signal XS will be operated without interruption because of the momentary loss of shunt.

I shall assume still further that a second momentary loss of shunt occurs a brief period of time after the first momentary loss of shunt has ended, while the eastbound train is still on section 1T and before it has entered section XT. If contact 36 of time element device TE has been opened because of the energization of device TE during the first momentary loss of shunt, and if the second momentary loss of shunt has occurred before contact 36 of device TE has had time to close after device TE became deenergized, relay TSR will not become closed at once when the second momentary loss of shunt occurs. As soon, however, as contact 36 of device TE becomes closed, relay TSR will become energized by its pickup and stick circuits previously traced.

It follows that, since contact 36 of time element device TE is included in the pickup circuit for relay TSR, apparatus embodying my invention, as shown in the accompanying drawing, provides full protection against repeated momentary losses of shunt of the track circuit for section 1T, by insuring that time element device TE has been restored to its normal condition after each such momentary loss of shunt, before the pickup time for contact 9 of device TE can begin during the next succeeding momentary loss of shunt.

I shall now assume that all parts of the apparatus are again in the normal condition, and that a westbound train enters section 2T, deenergizing relay 2TR. Relay 2CS will then become deenergized because of the opening of

contact 18 of relay 2TR in the pickup and stick circuits for relay 2CS. Relay 2CS, upon becoming deenergized, will open, at its contact 22, the energizing circuit for relay XR, causing relay XR to be deenergized, which in turn causes signal XS to display a warning indication to users of the highway.

When the train enters section XT, deenergizing relay XTR, the circuit for relay XR will again be opened at contact 23 of relay XTR for retaining relay XR deenergized until the train has left section XT. With relay 2CS deenergized, and relay XTR deenergized, relay 2WS will become energized by its pickup circuit passing from terminal B, through the back point of contact 32 of relay 2CS, contact 31 of relay XTR, front point of contact 30 of relay 1CS, contact 40 of relay 1ES, and the winding of relay 2WS to terminal N. Relay 2WS, upon becoming energized, will complete a first stick circuit which is the same as the pickup circuit just traced except that it includes contact 41 of relay 2WS instead of contacts 30 and 40 of relays 1CS and 1ES, respectively.

When the train enters section 1T, relay ASR will become deenergized because of the opening of contact 5 of relay 1TR. Relays ASPR and 1CS will then become deenergized on account of the opening of contacts 14 and 15, respectively, of relay ASR. With relay 1CS deenergized, a second stick circuit will now be completed for relay 2WS, passing from terminal B, through the back point of contact 30 of relay 1CS, contact 41 of relay 2WS, and the winding of relay 2WS to terminal N.

When the train leaves section XT, relay 2CS will again become energized by its pickup circuit previously traced. With relays 2CS and 2WS now energized, relay XR will become energized by a circuit passing from terminal B, through contact 22 of relay 2CS, contact 23 of relay XTR, contact 26 of relay 2WS, and the winding of relay XR to terminal N. With relay XR again energized, the operation of signal XS will be discontinued as previously described.

When the train leaves section 1T, relay ASR will become energized promptly by its third pickup circuit, passing from terminal B, through contact 5 of relay 1TR, conductors 6 and 12, contact 13 of relay 2WS, and the winding of relay ASR to terminal N. With relay ASR again energized promptly after the train leaves section 1T, relay TSR will become deenergized after a brief period of time, thereby avoiding unnecessary operation of time element device TE. With relay ASR again energized promptly when the train leaves section 1T, relay ASPR will in turn also be energized promptly so that if the train should now reverse its movement and again enter section 1T, the operation of the crossing signal will be delayed, as previously described, until the train has arrived at some starting point in section 1T as determined by resistor *r* and capacitor *t* in multiple with relay ASPR.

If, after all parts of the apparatus have again been restored to the normal condition, there should be a momentary shunting of the track circuit, or other momentary failure of the track circuit for section 1T, relay ASR will become deenergized because of the opening of contact 5 of relay 1TR, and then when contact 5 of relay 1TR again becomes closed, relay TSR would become energized as previously described, causing time element device TE to become energized. Upon the lapse of a measured period of time, the first pickup circuit traced for relay ASR would become closed by contact 9 of time element device TE, this circuit passing from terminal B, through contact 5 of relay 1TR, contact 8 of relay TSR, contact 9 of time element device TE, and the winding of relay ASR to terminal N. It follows that with apparatus embodying my invention, as shown in the accompanying drawing, if there should be a momentary failure of a track circuit for section 1T, the parts of the apparatus would be automatically restored to the normal condition when contact 5 of relay 1TR again becomes closed.

Although I have shown apparatus embodying my invention for a stretch of railway track over which traffic

movements are normally made in both directions, it is believed to be obvious to persons familiar with the railway signaling art that my invention could also be used for a stretch of railway track over which traffic movements are normally made in only one direction. It is also believed to be obvious to persons familiar with the railway signaling art that certain portions such, for example, as one of the directional stick relays 1ES and 2WS of the apparatus shown in the accompanying drawing could be omitted if my invention were used for a stretch of railway track over which traffic movements are normally made in only one direction. It is believed to be further obvious to persons skilled in railway signaling that various operable combinations such as recited in the attached claims could be provided if other portions of the apparatus shown in the accompanying drawing were omitted.

I have described the operation of the apparatus, shown in the accompanying drawing, 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 set of conditions.

Although I have herein shown and described only one form 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, an approach stick relay, a timing stick relay, a time element device having a front contact which is open while said device is deenergized but which becomes closed when said device has been energized a measured period of time, said time element device having also a back contact which becomes opened in response to energization of said time element device and which again becomes closed upon the lapse of a second measured period of time after said time element device becomes deenergized, means including a front contact of said timing stick relay for controlling energization of said time element device, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach 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 timing stick relay each controlled by a front contact of the track relay for said first approach control section and by a back contact of said approach stick relay and said pickup circuit also controlled by a back contact of said repeater relay and by said back contact of said time element device, a first and a second control stick relay each having a pickup circuit controlled by a front contact of the track relay for said crossing section, the pickup circuit and a stick circuit for said first control stick relay also controlled by a front contact of said approach stick relay, the pickup and a stick circuit for said second control stick relay also controlled by a front contact of the track relay for said second approach control section, a first directional relay controlled by back contacts of said first control stick relay and the track relay for said crossing section, a second directional relay controlled by back contacts of said second control stick relay and the track relay for said crossing section, a first and a seond and a third pickup circuit and also a stick circuit for said approach stick relay each controlled by a front contact of the track relay for said first approach control section, said first and second pickup circuits also controlled by a front contact of said timing stick relay, said first pickup circuit also controlled by said front contact of said time element device, said second pickup circuit also controlled by a front contact of said first directional relay and by a back contact of the track relay for said crossing section, said third pickup circuit also controlled by a front contact of said second directional relay, a crossing signal control relay controlled by a front contact of the track relay for said crossing section and by a front contact of said second control stick relay in multiple with a front contact of said first directional relay and also by a front contact of said first control stick relay in multiple with a front contact of said repeater relay and with a front contact of said second directional relay, and means controlled by a back contact of said crossing signal control 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, an approach stick relay, a timing stick relay, a time element device having a front contact which is open while said device is deenergized but which becomes closed when said device has been energized a measured period of time, said time element device having also a back contact which becomes opened in response to energization of said time element device and which again becomes closed upon the lapse of a second measured period of time after said time element device becomes deenergized, means including a front contact of said timing stick relay for controlling energization of said time element device, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach 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 timing stick relay each controlled by a front contact of the track relay for said first approach control section and by a back contact of said approach stick relay and said pickup circuit also controlled by a back contact of said repeater relay and by said back contact of said time element device, a first directional relay controlled by the track relays for said first approach control section and said crossing section to become energized when a train on said first approach control section approaching said intersection enters said crossing section, a second directional relay controlled by the track relays for said second approach control section and said crossing section to become energized when a train on said second approach control section approaching said intersection enters said crossing section, a first and a second and a third pickup circuit and also a stick circuit for said approach stick relay each controlled by a front contact of the track relay for said first approach control section, said first and second pickup circuits also controlled by a front contact of said timing stick relay, said first pickup circuit also controlled by said front contact of said time element device, said second pickup circuit also controlled by a front contact of said first directional relay and by a back contact of the track relay for said crossing section, said third pickup circuit also controlled by a front contact of said second directional relay, a crossing signal control relay controlled by said track relays and by said traffic directional relays and also by said repeater relay to be normally energized but to become deenergized when a train occupies either of said approach control sections while approaching said intersection or when a train occupies said crossing section but to become energized when a train leaves said crossing section, and

means controlled by a back contact of said crossing signal control 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 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, an approach stick relay, a time element device having a contact which is open while said device is deenergized but which becomes closed when said device has been energized a measured period of time, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, means controlled by a front contact of the track relay for said first approach control section and by back contacts of said approach stick relay and said repeater relay for energizing said time element device, a first directional relay controlled by the track relays for said first approach control section and said crossing section to become energized when a train enters said crossing section from said first approach control section, a second directional relay controlled by the track relays for said second approach control section and said crossing section to become energized when a train enters said crossing section from said second approach control section, a first and a second and a third pickup circuit and a stick circuit for said approach stick relay each controlled by a front contact of the track relay for said first approach control section, said first pickup circuit also controlled by said contact of said time element device, said second pickup circuit also controlled by a front contact of said first directional relay and by a back contact of the track relay for said crossing section, said third pickup circuit also controlled by a front contact of said second directional relay, and means controlled by said track relays and by said directional relays and also by said repeater relay to be normally energized but to become deenergized when a train occupies either of said approach control sections while approaching said intersection or when a train occupies said crossing section and to become energized when a train leaves said crossing section for controlling said highway crossing signal.

4. In a control system for a highway crossing signal adjacent the intersection of a highway with a stretch of railway track which comprises 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 traffic means which is in a first condition when the corresponding section is unoccupied but which assumes a second condition in response to occupancy of the corresponding section by a train, the combination comprising, an approach stick relay, time element means, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, means controlled by the traffic means for said first approach control section in its first condition and by back contacts of said approach stick relay and said repeater relay for energizing said time element means, a first directional relay controlled by the traffic means for said first approach control section and said crossing section to become energized when a train enters said crossing section from said first approach control section, a second directional relay controlled by the traffic means for said second approach control section and said crossing section to become energized when a train enters said crossing section from said second approach control section, a first and a second and a third pickup circuit and also a stick circuit for said approach stick relay each controlled by said traffic means for said first approach control section in its first condition, said first pickup circuit also controlled by a contact which becomes closed by said time element means after said time element means has been energized a measured period of time, said second pickup circuit also controlled by a front contact of said first directional relay and by the traffic means for said crossing section in its second condition, said third pickup circuit also controlled by a front contact of said second directional relay, and means controlled by the traffic means for said crossing section in its second condition or by the traffic means for said second approach control section in its second condition while said first directional relay is deenergized or by the traffic means for said first approach control section in its second condition while said repeater relay and said second directional relay are both deenergized for effecting operation of said highway crossing signal.

5. In a control system for a highway crossing signal adjacent the intersection of a highway with a stretch of railway track which comprises 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 traffic means which is in a first condition while the corresponding section is unoccupied but which assumes a second condition in response to occupancy of the corresponding section by a train, the combination comprising, an approach stick relay, time element means, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, means controlled by the traffic means for said approach control section in its first condition and by back contacts of said approach stick relay and said repeater relay for energizing said time element means, a directional relay controlled by the traffic means for said approach control section and said crossing section to become energized when a train enters said crossing section from said approach control section, a first and a second pickup circuit and also a stick circuit for said approach stick relay each controlled by said traffic means for said approach control section in its first condition, said first pickup circuit also controlled by a contact which becomes closed by said time element means when said time element means has been energized a measured period of time, said second pickup circuit also controlled by a front contact of said directional relay and by the traffic means for said crossing section in its second condition, and means controlled by the traffic means for said crossing section in its second condition or by the traffic means for said approach control section in its second condition while said repeater relay is deenergized for effecting operation of said highway crossing signal.

6. In a control system for a highway crossing signal adjacent the intersection of a highway with a stretch of railway track which comprises 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 traffic means which is in a first condition while the corresponding section is unoccupied but which assumes a second condition in response to occupancy of the corresponding section by a train, the combination comprising, an approach stick relay, time element means, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, a timing stick relay, a pickup and a stick circuit for said timing stick relay each controlled by the traffic means for said approach control section in its first condition,

said pickup circuit also controlled by a back contact of said repeater relay, means controlled by a front contact of said timing stick relay for energizing said time element means, a directional relay controlled by the traffic means for said approach control section and said crossing section to become energized when a train enters said crossing section from said approach control section, a first and a second pickup circuit and also a stick circuit for said approach stick relay each controlled by said traffic means for said approach control section in its first condition, each of said pickup circuits also controlled by a front contact of said timing stick relay, said first pickup circuit also controlled by a contact which becomes closed by said time element means when said time element means has been energized a measured period of time, said second pickup circuit also controlled by a front contact of said directional relay and by the traffic means for said crossing section in its second condition, and means controlled by the traffic means for said crossing section in its second condition or by the traffic means for said approach control section in its second condition while said repeater relay is deenergized for effecting operation of said highway crossing signal.

7. In a control system for a highway crossing signal adjacent the intersection of a highway with a stretch of railway track which comprises 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 traffic means which is in a first condition while the corresponding section is unoccupied but which assumes a second condition in response to occupancy of the corresponding section by a train, the combination comprising, an approach stick relay, time element means, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, means controlled by the traffic means for said approach control section in its first condition and by a back contact of said repeater relay for energizing said time element means, a directional relay controlled by the traffic means for said approach control section and said crossing section to become energized when a train enters said crossing section from said approach control section, a first and a second pickup circuit and also a stick circuit for said approach stick relay each controlled by said traffic means for said approach control section in its first condition, said first pickup circuit also controlled by a contact which becomes closed by said time element means when said time element means has been energized a measured period of time, said second pickup circuit also controlled by a front contact of said directional relay, and means controlled by the traffic means for said crossing section in its second condition or by the traffic means for said approach control section in its second condition while said repeater relay is deenergized for effecting operation of said highway crossing signal.

8. In a control system for a highway crossing signal adjacent the intersection of a highway with a stretch of railway track which comprises 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 traffic means which is in a first condition while the corresponding section is unoccupied but which assumes a second condition in response to occupancy of the corresponding section by a train, the combination comprising, an approach stick relay, time element means, a repeater relay, a control circuit for said repeater relay controlled by a front contact of said approach stick relay and including an energy storing device in multiple with the winding of said repeater relay, means controlled by the traffic means for said approach control section in its first condition and by a back contact of said repeater relay for energizing said time element means, a first and a second pickup circuit and also a stick circuit for said approach stick relay each controlled by said traffic means for said approach control section in its first condition, said first pickup circuit also controlled by a contact which becomes closed by said time element means when said time element means has been energized a measured period of time, said second pickup circuit also controlled by said traffic means for said crossing section in its second condition, and means controlled by the traffic means for said crossing section in its second condition or by the traffic means for said approach control section in its second condition if said repeater relay is deenergized for effecting operation of said highway crossing signal.

9. In a control system for a highway crossing signal adjacent an intersection of a highway with a stretch of railway track, in combination, crossing signal control means, slow release relay means for actuating said crossing signal control means, an approach stick relay, a timing stick relay, a time delay device, a track circuit including a track relay located on said stretch a predetermined distance from said intersection, said approach stick relay having a pickup circuit controlled by a front contact of said track relay and front contacts of said timing stick relay and said time delay device, and a stick circuit controlled by said front contact of said track relay, a pickup circuit for said slow release means controlled by a front contact of said approach stick relay, said timing stick relay having a pickup circuit controlled by back contacts of said approach stick relay, said slow release relay means and said time delay device and said front contact of said track relay, a stick circuit for said timing stick relay shunting said back contacts of said slow release relay means and said time delay means, and a pickup circuit for said time delay means controlled by a front contact of said timing stick relay.

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