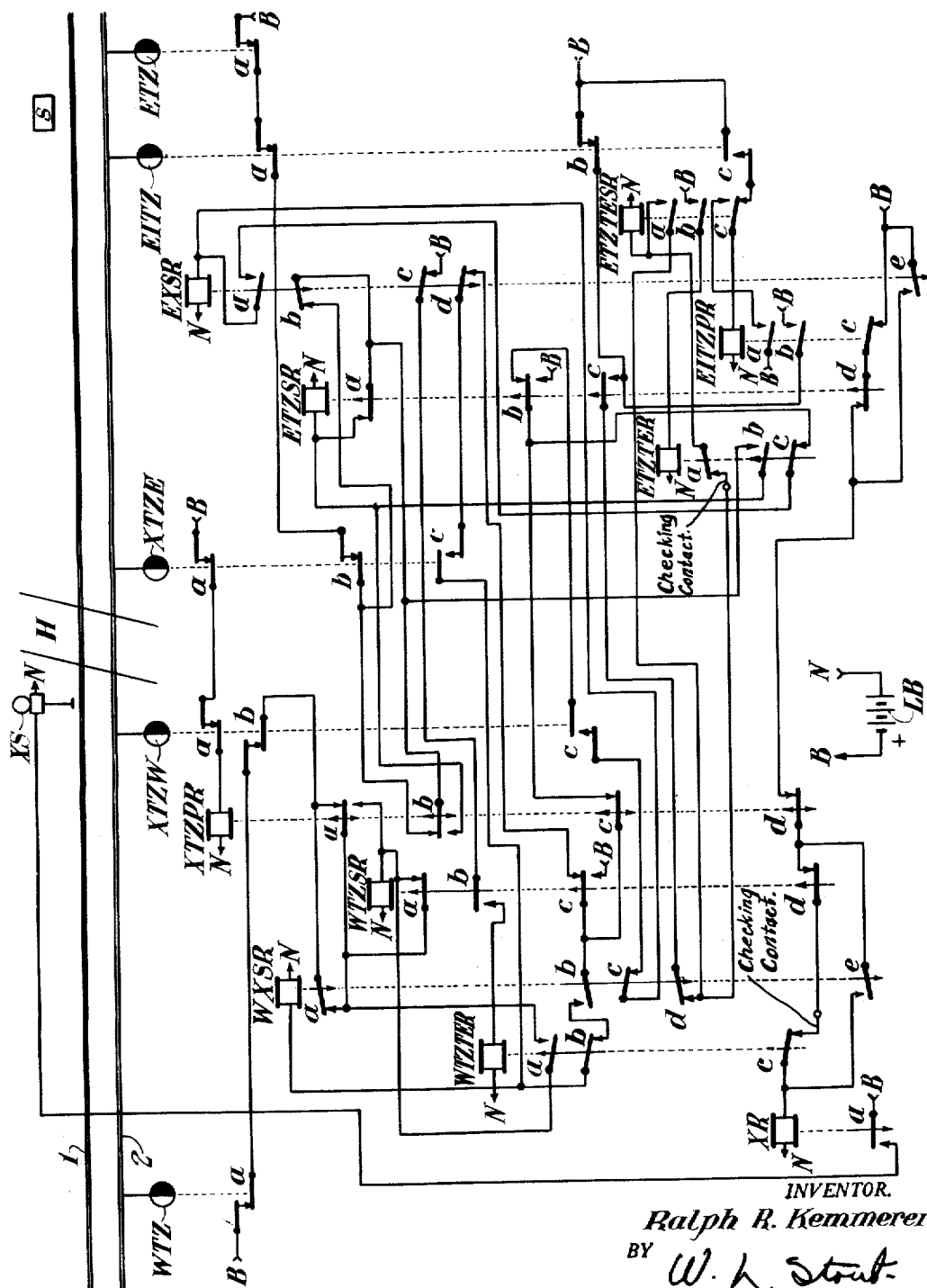


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HIGHWAY CROSSING PROTECTION CONTROL APPARATUS
EMPLOYING TRACK INSTRUMENT
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HIGHWAY CROSSING PROTECTION CONTROL APPARATUS EMPLOYING TRACK INSTRUMENT

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My invention relates to highway crossing protection control apparatus, and particularly to highway crossing protection control apparatus employing track instruments to effect the control of highway crossing signals.

At some locations along a railway, it is not practical or economical to resort to the use of track circuits to detect the presence of trains. At such locations, track instruments may be used to perform this function. At the intersection of a highway and a stretch of railway track over which traffic moves in both directions, directional control is necessary so that when a train approaching the crossing actuates the track instrument, the crossing signal will operate but when a train receding from the crossing actuates the track instrument, the crossing signal will not operate. Although track instruments responsive to the direction of traffic are known, they have not proved to be entirely satisfactory.

Accordingly, one object of my invention is to provide novel highway crossing protection control apparatus controlled by track instruments.

Another object of my invention is to provide novel highway crossing protection control apparatus controlled by track instruments and suitable for use on stretches of railway track over which traffic moves in both directions.

A further object of my invention is to provide in highway crossing protection control apparatus controlled by track instruments novel means for checking the operation of the track instruments.

Yet another object of my invention is to provide novel track instrument controlled highway crossing protection control apparatus for controlling a crossing signal so that when a train approaching the crossing passes a first predetermined point, the signal will commence operating, and if the train fails to traverse a given portion of the stretch in approach to the crossing beyond said first point in less than a predetermined time interval, the crossing signal operation will be discontinued, but when the train subsequently passes a second predetermined point, operation of the signal will again be started.

According to one embodiment of my invention useful where trains approach a railway-highway intersection from both directions and where trains approaching the intersection from one direction sometimes stop at a station between the crossing and a point where it is normally desirable to initiate the operation of the signal to provide the necessary warning time for high speed trains which do not stop at the station, I employ five track instruments. Two of these track instruments serve to initiate the operation of the warning signal and are located at a distance from the highway such that the desired warning indications will be initiated a sufficient time interval, such for example as twenty seconds, before the fastest train which is permitted to traverse the stretch will reach the highway after passing the instrument. Two more of the instruments serve to stop the operation of the signal as soon as a train which is approaching the crossing has passed the crossing, and are accordingly

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located adjacent the crossing on opposite sides of the crossing. These four instruments effect the control of the signal through a novel arrangement of control circuits employing directional and control stick relays and time element relays. The time element relays also function to stop the operation of the highway crossing signal when a train stops at the station, and the fifth track instrument is employed to initiate operation of the signal when a train which has stopped again proceeds toward the crossing. The fifth track instrument is accordingly located in a position to be actuated by trains as soon as they have passed the station. The control circuits include suitable means for insuring the proper operation of the apparatus.

Other objects of my invention will become clear hereinafter as the characteristic features of construction and mode of operation of my novel highway crossing protection control apparatus are described in detail.

The accompanying drawing is a diagrammatic view showing one form of highway crossing protection control apparatus embodying my invention.

Referring now to the drawing, a stretch of track made up of the track rails 1 and 2 is intersected by a highway H. Located adjacent the intersection is a highway crossing signal XS for warning users of the highway of the approach of a train on the railway.

Positioned at predetermined points along the railway for controlling the operation of the signal XS in a manner which will be made clear presently are a plurality of track instruments WTZ, XTZW, XTZE, EITZ and ETZ. These track instruments may be of any suitable type but as here shown they are of the buffer type shown and described in Letters Patent of the United States No. 2,588,798, granted on March 11, 1952, to Herbert L. Bone et al. for Buffer Means. For purposes of my present invention it is sufficient to point out that each instrument includes one or more contacts which may be either normally open or normally closed, and which contacts become operated when the instrument is engaged by the wheels of a train. Each instrument also includes a buffer which is operative when the contacts are actuated for retaining them in their actuated positions for a predetermined time interval. The time interval is adjustable and is preferably so adjusted that once the contacts are actuated they will remain in their actuated position until the entire train has passed the contacts provided the train is traveling in excess of a predetermined minimum speed, such for example, as ten miles per hour. It will be clear, however, that the slow acting feature of the track instruments may be omitted without changing the operation of my novel apparatus.

Track instrument WTZ serves to initiate operation of signal XS for eastbound trains approaching the crossing while track instrument ETZ functions to initiate operation of signal XS for westbound trains. These instruments are preferably located at a distance from the crossing equal to the distance a train traveling at maximum permissive speed for the stretch will traverse in a minimum safe warning time, such for example, as twenty seconds. For instance, if the maximum permissive speed for the stretch is eighty miles per hour, or 117 feet per second, track instruments WTZ and ETZ will be located 2340 (117 x 20) feet from the crossing.

As will appear more fully hereinafter, track instrument EITZ serves to restart operation of the signal XS under certain conditions; that is, when a train which is approaching the crossing in a westbound direction has stopped at the station S after passing track instrument ETZ again starts toward the crossing. Therefore, this track instrument will usually be so positioned as to be actuated by such a train as soon as it starts to leave the station.

Track instruments XTZE and XTZW function to stop

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the signal XS when a train which is approaching the crossing has passed the crossing and are located adjacent the crossing on the right-hand and left-hand side, respectively, of the crossing.

The crossing signal XS is controlled by a highway crossing signal control relay XR so that when relay XR is released, crossing signal XS will operate.

Relay XR is controlled by control stick relays WTZSR and ETZSR, directional stick relays WXS and EXSR, a slow acting control or repeated relay XTZPR, and a control or repeater relay EITZPR.

The stretches of track between the contactors ETZ and WTZ are the equivalent of the usual approach sections which are provided when track relays are used. The control relays WTZSR and ETZSR are associated with these stretches and are controlled by the track instruments in such a manner that they will function in a manner similar to track relays; that is, each relay is normally energized but will be deenergized while a train occupies the associated stretch.

Directional stick relays WXS and EXSR are normally deenergized, and are each associated with one of the approach stretches so that when a train is receding from the intersection, the directional stick relay associated with the occupied stretch will be energized in order to provide an energizing path for relay XR so that crossing signal XS will be deenergized.

Time element relays WTZTER and ETZTER which partially control their associated control and directional stick relays are preferably of the type having a normally open front contact which will be closed only after the relay has been energized for a predetermined time interval, a normally closed back contact which will become open only after the relay has been energized for the predetermined time interval and a normally closed checking contact which will become open immediately upon energization of the time element relay. The checking contacts are herein designated as ordinary back contacts with a small circle at the base of the stationary contact finger.

Energy for the arrangement is supplied by a suitable source such as a battery LB having a positive terminal B and a negative terminal N.

As shown in the drawing, the apparatus is in its normal condition, the stretch of track being unoccupied. Accordingly, all the track instruments are in their normal conditions with their front contacts closed and their back contacts open. Therefore, relay XTZPR is energized by a circuit passing from positive terminal B of battery LB, over front contact *a* of track instrument XTZE, front contact *a* of track instrument XTZW and the winding of relay XTZPR to negative terminal N of battery LB. A stick circuit for maintaining relay WTZSR in its energized condition and passing from positive terminal B of battery LB, over front contact *a* of track instrument WTZ, front contact *b* of track instrument XTZW, back contact *a* of relay WXS in multiple with front contact *a* of relay XTZPR, front contact *a* of relay WTZSR and the winding of relay WTZSR to negative terminal N of battery LB is also established.

With relay WTZSR energized, the energizing circuit for relay WTZTER to be traced subsequently is open at back contact *b* of relay WTZSR and, accordingly, relay WTZTER is deenergized, thereby having its front contact *a* open, its back contact *b* and its checking contact *c* closed.

Furthermore, relay ETZSR is energized over a stick circuit passing from positive terminal B of battery LB, over front contact *a* of track instrument ETZ, front contact *a* of track instrument EITZ, front contact *b* of track instrument XTZE, front contact *b* of relay XTZPR in multiple with back contact *b* of relay EXSR, front contact *a* of relay ETZSR and the winding of relay ETZSR to negative terminal N of battery LB.

In the stick circuits heretofore traced for relays WTZSR and ETZSR, back contacts of stick relays WXS and EXSR, respectively, were included. Relays WXS and

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EXSR are therefore shown in their deenergized condition for reasons which will become clear as this description proceeds. Furthermore, for reasons which will become clear subsequently, relays ETZTER, ETZTESR and EITZPR are all deenergized.

With the relays in the condition described, a first or normal circuit is established for energizing highway crossing signal control relay XR which circuit may be traced from positive terminal B of battery LB, over back contact *c* of relay ETZPR, front contact *d* of relay ETZSR, front contact *d* of relay XTZPR, front contact *d* of relay WTZSR, checking contact *c* of relay WTZTER and the winding of relay XR to negative terminal N of battery LB. With relay XR energized the obvious energizing circuit for crossing signal XS is open at back contact *a* of relay XR and, accordingly, signal XS is deenergized. With the crossing signal deenergized highway traffic is free to move over the crossing.

I will now assume that a train enters the stretch from the left and moves through the stretch from left to right. As the front wheels of the train engage track instrument WTZ, front contact *a* of track instrument WTZ will become open thereby opening the previously traced stick circuit for relay WTZSR and causing that relay to release. Upon relay WTZSR releasing the previously traced energizing circuit for relay XR will become open at front contact *d* of relay WTZSR and relay XR will release to close the energizing circuit for crossing signal XS. Therefore, the signal XS will commence operating to warn traffic of the approach of a train. With relay WTZSR released a circuit will be established for energizing relay WTZTER, which circuit may be traced from positive terminal B of battery LB, over back contact *c* of relay EXSR, back contact *b* of relay WTZSR and the winding of relay WTZTER to negative terminal N of battery LB. Therefore, relay WTZTER will open its checking contact *c* but its back contact *b* will remain closed and its front contact *a* will remain open for a predetermined time interval. The opening of checking contact *c* of relay WTZTER will have no effect upon the remainder of the apparatus as checking contact *c* of relay WTZTER is included in the previously traced energizing circuit for relay XR which has already become open at front contact *d* of relay WTZSR. The predetermined time interval of operation of relay WTZTER will be sufficiently long to assure that the slowest moving train approaching the intersection from the left will reach track instrument XTZW prior to the expiration of the time interval. The purpose of the inclusion of relay WTZTER will be made clear hereinafter. When the train clears track instrument WTZ, its front contact *a* will become closed but this will have no immediate effect on the apparatus.

Upon the front wheels of the train engaging track instrument XTZW, the normally closed front contacts *a* and *b* of track instrument XTZW will become open and its normally open back contact *c* will become closed. With contact *a* of track instrument XTZW open, relay XTZPR will become deenergized but it will not immediately release because of its slow release characteristic. With contact *c* of track instrument XTZW closed, an energizing circuit for relay EXSR will become established passing from positive terminal B of battery LB, over back contact *c* of relay WTZSR, front contact *c* of relay XTZPR, front contact *b* of relay ETZSR, back contact *c* of track instrument XTZW, back contact *c* of relay WXS and the winding of relay EXSR to negative terminal N of battery LB. Accordingly, relay EXSR will pick up and establish a first stick circuit for maintaining itself in its energized condition, which stick circuit may be traced from positive terminal B of battery LB, over back contact *c* of relay WTZSR, front contact *c* of relay XTZPR, back contact *c* of relay ETZTER, front contact *a* of relay EXSR and the winding of relay EXSR to negative terminal N of battery LB. The timing of relay XTZPR is so arranged that relay XTZPR may now re-

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lease thereby opening the energizing and stick circuits for relay EXSR which will remain picked up due to its slow release characteristic until a second stick circuit for relay EXSR becomes established in a manner to be described presently.

With relay EXSR now picked up, upon relay XTZPR releasing, both branches of the previously traced stick circuit for relay ETZSR will become open. Accordingly, relay ETZSR will become deenergized and will release, thereby establishing the second stick circuit for relay EXSR passing from positive terminal B of battery LB, over back contact *b* of relay ETZSR, back contact *c* of relay ETZTER, front contact *a* of relay EXSR and the winding of relay EXSR to negative terminal N of battery LB. With relay EXSR picked up, the previously traced energizing circuit for relay WTZTER will become open at back contact *c* of relay EXSR. Accordingly, back contact *b* of relay WTZTER will remain closed and checking contact *c* will again become closed.

When the train actuates track instrument XTZE, there will be no effect on the remainder of the apparatus other than the energizing circuits for relays XTZPR and ETZSR each being opened at an additional point. With relay XTZPR released, relay XR will remain deenergized and this condition will be maintained as long as the wheels of the train are coming in contact with track instrument XTZE. It will be obvious that relay XTZPR will be maintained in its released condition due to its slow pickup characteristic and the slow action of track instruments XTZW and XTZE. It will also be clear that one or the other of these features can be dispensed with provided that the other one is effective to maintain relay XTZPR continuously released until the train clears track instrument XTZE.

Upon the train clearing track instrument XTZW, an energizing circuit for relay WTZSR will become established passing from positive terminal B of battery LB, over front contact *a* of track instrument WTZ, front contact *b* of track instrument XTZW, back contact *a* of relay WXS, back contact *a* of relay XTZPR and the winding of relay WTZSR to negative terminal N of battery LB. Therefore, relay WTZSR will pick up and reestablish its previously traced stick circuit.

Upon the rear wheels of the train clearing track instrument XTZE, track instrument XTZE will be restored to its normal condition, its front contacts becoming closed and its back contact open. Accordingly, the energizing circuit for relay XTZPR will become reestablished and that relay will pick up to close a second energizing circuit for relay XR passing from positive terminal B of battery LB, over front contact *e* of relay EXSR, front contact *d* of relay XTZPR, front contact *d* of relay WTZSR, checking contact *c* of relay WTZTER and the winding of relay XR to negative terminal N of battery LB. Therefore, relay XR will pick up to open the energizing circuit for crossing signal XS and discontinue its operation.

Upon relay ETZSR releasing, a circuit will be established for energizing relay ETZTESR passing from positive terminal B of battery LB, over front contact *b* of track instrument EITZ, back contact *c* of relay ETZSR, back contact *d* of relay WXS, checking contact *a* of relay ETZTER and the winding of relay ETZTESR to negative terminal N of battery LB. Accordingly, relay ETZTESR will pick up and establish a stick circuit which is the same as its previously traced energizing circuit except that it includes front contact *a* of relay ETZTESR instead of checking contact *a* of relay ETZTER. With relay ETZTESR picked up an obvious circuit including front contact *b* of relay ETZTESR will be established for energizing relay ETZTER. Therefore, relay ETZTER will open its checking contact *a* and commence timing. The operation of the time element relay ETZTER is such that in a receding move of a train, the

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train will reach track instrument EITZ prior to relay ETZTER completing its timing action.

Upon the wheels of the train engaging track instrument EITZ, the normally closed front contacts *a* and *b* of track instrument EITZ will become open and its normally open back contact *c* will become closed. Accordingly, the previously traced stick circuit for relay ETZSR will become open at an additional point and the previously traced stick circuit for relay ETZTESR will become open at front contact *b* of track instrument EITZ. Therefore, relay ETZTESR will release and open the energizing circuit for relay ETZTER which will also release to close its checking contact *a*. Furthermore, an energizing circuit will be established for relay EITZPR, which circuit may be traced from positive terminal B of battery LB, over back contact *c* of track instrument EITZ, back contact *c* of relay ETZTESR and the winding of relay EITZPR to negative terminal N of battery LB. Upon relay EITZPR picking up, a second energizing circuit will be established for relay ETZTESR passing from positive terminal B of battery LB, over front contact *b* of relay EITZPR, back contact *c* of relay ETZSR, back contact *d* of relay WXS, checking contact *a* of relay ETZTER, and the winding of relay ETZTESR to negative terminal N of battery LB. With relay ETZTESR picked up, it will establish a second stick circuit which is identical with its second energizing circuit except that it includes front contact *a* of relay ETZTESR instead of checking contact *a* of relay ETZTER. With relay ETZTESR picked up, a stick circuit will be established for maintaining relay EITZPR in its energized condition which circuit may be traced from positive terminal B of battery LB, over front contact *a* of relay EITZPR, front contact *c* of relay ETZTESR and the winding of relay EITZPR to negative terminal N of battery LB. With relays ETZTESR and EITZPR energized relay ETZTER will again be supplied with energy over its previously traced energizing circuit. Accordingly, relay ETZTER will commence timing and will open its checking contact *a* which, however, is now shunted by front contact *a* of relay ETZTESR and, accordingly, relay ETZTESR will remain energized. When the train clears track instrument EITZ, track instrument EITZ will be restored to its normal condition but this will have no effect on the apparatus.

When the train actuates track instrument ETZ, front contact *a* of track instrument ETZ will become open but this will have no effect upon the apparatus.

When the train clears track instrument ETZ, there will be no immediate effect upon the arrangement but relay ETZTER will continue its timing action already started by the initial actuation of track instrument EITZ. The timing for relay ETZTER is arranged so that a train moving through the section will clear track instrument ETZ prior to relay ETZTER closing its front contact *b* and opening its back contact *c*. When relay ETZTER does close its front contact and open its back contact, an energizing circuit will be established for relay ETZSR passing from positive terminal B of battery LB, over front contact *a* of track instrument ETZ, front contact *a* of track instrument EITZ, front contact *b* of track instrument XTZE, front contact *b* of relay XTZPR, front contact *b* of relay ETZTER and the winding of relay ETZSR to negative terminal N of battery LB. Therefore, relay ETZSR will pick up. With relay ETZSR picked up and back contact *c* of relay ETZTER open, the previously traced second stick circuit for relay EXSR will become open. Accordingly, relay EXSR will release and close the previously traced first stick circuit for relay ETZSR. Therefore, relay ETZSR will remain picked up. With relay ETZSR picked up the previously traced stick circuit for relay ETZTESR will become open at back contact *c* of relay ETZSR. Accordingly, relay ETZTESR will release, thereby opening the energizing circuit for relay ETZTER and the stick circuit for relay

EITZPR. Accordingly, these relays will both release to thereby reestablish the original energizing circuit for relay XR. During the time that relays EXSR and ETZSR are transferring their contacts, relay XR will be deenergized but it will remain picked up due to its slow release characteristic. It will be seen therefore that relay XR will remain continuously picked up and signal XS will remain denenergized. In this manner the apparatus will be reset to its normal condition.

I now will assume that a train approaches the highway-railway intersection from the right and travels through the stretch from right to left. Upon the train actuating track instrument ETZ, the previously traced first stick circuit for relay ETZSR will become open at front contact *a* of track instrument ETZ and, accordingly, relay ETZSR will release. With relay ETZSR released, the previously traced first or normal energizing circuit for relay XR will become open at front contact *d* of relay ETZSR and, accordingly, relay XR will release to close the energizing circuit for crossing signal XS. Furthermore, upon the release of relay ETZSR, the previously traced first energizing circuit for relay ETZTESR will become established which circuit will be retraced from positive terminal B of battery LB, over front contact *b* of track instrument EITZ, back contact *c* of relay ETZSR, back contact *d* of relay WXS, checking contact *a* of relay ETZTER, and the winding of relay ETZTESR to negative terminal N of battery LB. Therefore, relay ETZTESR will pick up and establish its previously traced first stick circuit and the previously traced energizing circuit for relay ETZTER. Let it further be assumed that the train is moving through the stretch at a speed which will cause track instrument EITZ to be actuated prior to the closing of front contact *b* of time element relay ETZTER. When the train clears track instrument ETZ, it will be restored to its normal condition but this will not presently affect the apparatus.

Upon the front wheels of the train engaging track instrument EITZ, the stick circuit for relay ETZTESR will become open at front contact *b* of track instrument EITZ and, accordingly, relay ETZTESR will release and deenergize time element relay ETZTER. With relay ETZTESR released and track instrument EITZ actuated, the previously traced energizing circuit for relay EITZPR including back contact *c* of track instrument EITZ and back contact *c* of relay ETZTESR will become established and relay EITZPR will pick up. With relay EITZPR picking up, the second energizing circuit for relay ETZTESR will become established and relay ETZTESR will pick up to establish its second stick circuit and to reenergize relay ETZTER. Again let it be assumed that the train is moving at a sufficiently high speed so that it will reach track instrument XTZE prior to relay ETZTER closing its front contact *b*. When the train clears track instrument EITZ, it will return to its normal condition but this will have no effect on the apparatus.

When the train actuates track instrument XTZE, the energizing circuit for relay XTZPR will become open at front contact *a* of track instrument XTZE but relay XTZPR will not immediately release due to its slow release characteristic. Accordingly, an energizing circuit will be established for relay WXS which circuit may be traced from positive terminal B of battery LB, over back contact *b* of relay ETZSR, front contact *c* of relay XTZPR, front contact *c* of relay WTZSR, back contact *d* of relay EXSR, back contact *c* of track instrument XTZE and the winding of relay WXS to negative terminal N of battery LB. Accordingly, relay WXS will pick up and establish its first stick circuit passing from positive terminal B of battery LB, over back contact *b* of relay ETZSR, front contact *c* of relay XTZPR, front contact *b* of relay WXS, back contact *b* of relay WTZTER and the winding of relay WXS to negative terminal N of battery LB. When relay XTZPR releases, relay WXS will remain picked up due to its slow release characteristic

until a second stick circuit for relay WXS becomes established in a manner to be described presently.

With relay XTZPR released and relay WXS picked up, relay WTZSR will become deenergized and will release. With relay WTZSR released, the previously traced energizing circuit for relay WTZTER will become established and relay WTZTER will commence timing. Let it be assumed that the timing of relay WTZTER is so arranged that a train moving at the slowest speed through the stretch will clear track instrument WTZ prior to the closing of front contact *a* and the opening of back contact *b* of relay WTZTER. Furthermore, upon the release of relay WTZSR, a second stick circuit for relay WXS will become established passing from positive terminal B of battery LB, over back contact *c* of relay WTZSR, front contact *b* of relay WXS, back contact *b* of relay WTZTER and the winding of relay WXS to negative terminal N of battery LB. Accordingly, relay WXS will remain energized as long as relay WTZSR remains deenergized.

There will be no effect on the apparatus when the train actuates track instrument XTZW other than the opening of the energizing circuit for relay XTZPR at an additional point.

When the train clears track instrument XTZE, the track instrument will be restored to its normal condition and with relay XTZPR released, an energizing circuit for relay ETZSR will become established passing from positive terminal B of battery LB, over front contact *a* of track instrument ETZ, front contact *a* of track instrument EITZ, front contact *b* of track instrument XTZE, back contact *b* of relay EXSR, back contact *b* of relay XTZPR and the winding of relay ETZSR to negative terminal N of battery LB. Upon relay ETZSR picking up, it will establish its previously traced stick circuit for maintaining itself energized. With relay ETZSR stuck up, the previously traced second stick circuit for relay ETZTESR will become open at back contact *c* of relay ETZSR and, accordingly, relay ETZTESR will release and thereby open the stick circuit for relay EITZPR and the energizing circuit for relay ETZTER. Accordingly, these relays will also release.

When the train clears track instrument XTZW, relay XTZPR will pick up and establish a circuit for energizing relay XR which circuit may be traced from positive terminal B of battery LB, over back contact *c* of relay EITZPR, front contact *d* of relay ETZSR, front contact *d* of relay XTZPR, front contact *e* of relay WXS and the winding of relay XR to negative terminal N of battery LB. Accordingly, relay XR will pick up and open the energizing circuit for crossing signal XS thereby deenergizing the signal.

When the train engages track instrument WTZ there will be no effect on the apparatus other than the opening of front contact *a* of track instrument WTZ which is included in a circuit already open at other points. After the train clears track instrument WTZ, relay WTZTER which became energized upon the release of relay WTZSR will close its front contact *a* and open its back contact *b* at the expiration of its timing period. Accordingly, an energizing circuit for relay WTZSR passing from positive terminal B of battery LB, over front contact *a* of track instrument WTZ, front contact *b* of track instrument XTZW, front contact *a* of relay XTZPR, front contact *a* of relay WTZTER and the winding of relay WTZSR to negative terminal N of battery LB will be established. Therefore, relay WTZSR will pick up and establish its previously traced stick circuit. Furthermore, upon back contact *b* of relay WTZTER opening, relay WXS will release to open the energizing circuit for relay XR including front contact *e* of relay XR. However, with relay WTZSR now energized, the previously traced energizing circuit for relay WTZTER will become open and relay WTZTER will become deenergized. With relay WTZSR picked up and relay WTZTER deenergized, the previously

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traced first or normal energizing circuit for relay XR will be reestablished. During the time that relays WTZSR, WXSX and WTZTER are transferring their contacts, relay XR will be deenergized but will remain picked up due to its slow release characteristic. With relay XR remaining picked up, signal XS will remain deenergized. In this manner the apparatus will be restored to its normal condition.

I will now assume that a train moves through the stretch from right to left and stops at station S located between track instruments ETZ and EITZ. Upon the wheels of the train engaging track instrument ETZ, front contact *a* of track instrument ETZ will become open thereby opening the energizing circuit for relay ETZSR and causing that relay to release. Upon the release of relay ETZSR, the first traced energizing circuit for relay ETZTESR will become established over back contact *c* of relay ETZSR and relay ETZTESR will pick up to establish its first traced stick circuit. With relay ETZTESR picked up, an energizing circuit for relay ETZTER will become established over front contact *b* of relay ETZTESR and relay ETZTER will commence timing, thereby opening its checking contact *a*. Furthermore, upon the release of relay ETZSR, the first energizing circuit for relay XR will become open at front contact *d* of relay ETZSR and relay XR will release to establish the energizing circuit for crossing signal XS will commence operating.

I will now assume that the train stops at station S. Accordingly, the condition just described above will be maintained until time element relay ETZTER closes its front contact *b* and opens its back contact *c*. With relay ETZTER picked up, the previously traced energizing circuit for relay ETZSR including front contact *b* of relay ETZTER will become closed. Therefore relay ETZSR will pick up and thereby open the previously traced first stick circuit for relay ETZTESR at back contact *c* of relay ETZSR. Accordingly, relay ETZTESR will release thereby deenergizing relay ETZTER which will also release to open its front contact *b* and close its checking contact *a* and its back contact *c*. With relay ETZSR picked up relay XR will now be energized by its previously traced first or normal energizing circuit and signal XS will discontinue its operation.

The above described condition of the apparatus will be maintained until the train once again commences moving toward the crossing and actuates track instrument EITZ. Upon track instrument EITZ being actuated, the energizing and stick circuits for relay ETZSR will become open at front contact *a* of track instrument EITZ, thereby causing relay ETZSR to release. Accordingly, the first or normal energizing circuit for relay XR will become open and relay XR will release to thereby energize crossing signal XS. Furthermore, relay EITZPR will become energized over a circuit which includes back contact *c* of track instrument EITZ and back contact *c* of relay ETZTESR. Therefore, relay EITZPR will pick up. With relay EITZPR picked up and relay ETZSR released, the previously traced second energizing circuit for relay ETZTESR will become established over front contact *b* of relay EITZPR and relay ETZTESR will pick up. Upon relay ETZTESR picking up, it will reestablish the energizing circuit for relay ETZTER which will again commence its timing action.

The condition just described will be maintained until the train actuates track instrument XTZE at which time the energizing circuit for relay XTZPR will become open but relay XTZPR will remain energized for a time interval due to its slow release characteristic. Furthermore, upon the actuation of track instrument XTZE, the previously traced energizing circuit for relay WXSX will become established and relay WXSX will pick up. Upon relay WXSX picking up, its previously traced first stick circuit will be established to maintain the relay in

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its energized condition. This condition will be maintained until relays XTZPR and WTZSR release as previously described at which time the previously traced second stick circuit for relay WXSX including back contact *c* of relay WTZSR will become established. With relay WXSX stuck up, the previously traced stick circuit for relay ETZTESR will become open at back *b* of relay WXSX and, accordingly, relay ETZTESR will release to deenergize relays ETZTER and EITZPR.

When the train actuates track instrument XTZW, there will be no effect on the apparatus except that the energizing circuit for relay XTZPR will be opened at an additional point.

When the train clears track instrument XTZE, with relay XTZPR released, the previously traced energizing circuit for relay ETZSR will become established over back contact *b* of relay XTZPR and, accordingly, relay ETZSR will pick up and establish its stick circuit.

Upon the rear wheels of the train clearing track instrument XTZW, relay XTZPR will pick up and establish the previously traced energizing circuit for relay XR including back contact *c* of relay EITZPR, front contact *d* of relay ETZSR, front contact *d* of relay XTZPR and front contact *e* of relay WXSX. Accordingly, upon the rear wheels of the train clearing track instrument XTZW, signal XS will become deenergized.

With relay WTZSR released, the previously traced energizing circuit for relay WTZTER will be closed and relay WTZTER will be timing. However, this timing operation is arranged to extend beyond the time it will take the train to clear track instrument WTZ.

Upon the train clearing track instrument WTZ and relay WTZTER picking up, the previously traced energizing circuit for relay WTZSR will become established over front contact *a* of relay WTZTER and relay WTZSR will pick up to restore the apparatus to its normal condition.

It will be clear that a restart track instrument corresponding in function to that of track instrument EITZ may be included in the left-hand or western approach to the crossing to provide a time cutout and restart feature in that approach, if necessary.

It will also be obvious that my invention is not limited to any particular type of track instrument but will operate as effectively with any type of apparatus which is governed by the movement of vehicles over a point in a stretch of track.

My novel highway crossing protection control apparatus not only provides means for controlling highway crossing signals by track instruments in a manner which simulates the control of highway crossing signals by track relays, but it also includes safety features which check the operation of the track instruments to assure that the instruments are functioning properly.

If while a train is moving through the stretch from left to right, track instrument WTZ or XTZW should become blocked in its actuated condition, it will be obvious that relay WTZSR cannot be picked up after track instrument XTZW is cleared and, accordingly, since relay WXSX will also be deenergized, signal XS will continue to operate since the energizing circuit for relay XS will be open at front contact *d* of relay WTZSR and front contact *e* of relay WXSX. Accordingly, signal maintainers will be given a positive indication that there is some defect in the apparatus and will promptly repair that defect and in the meantime highway traffic will move over the crossing with caution.

Furthermore, if while a train is traveling through the stretch from left to right, track instrument ETZ, EITZ or XTZ should become blocked in its actuated condition, relay ETZTER will commence timing and after a predetermined time interval will pick up. With relay ETZTER picked up the previously traced second stick circuit for directional stick relay EXSR will become open at back contact *c* of relay ETZTER and ac-

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cordingly relay EXSR will release. Furthermore, with any of these track instruments blocked in their actuated condition, relay ETZSR will also be deenergized. Therefore, the two parallel branches of the energizing circuit for relay XR including front contact *d* of relay ETZSR and front contact *e* of relay EXSR will both be open and relay XR will release. Therefore, signal XS will operate to provide an indication that there is a defect in the apparatus and warn highway users to move over the crossing with caution.

If a train is traveling through the stretch from right to left and track instrument ETZ, EITZ or XTZE should become blocked in its actuated condition, relay ETZSR will remain released and relay XR will also remain released to thereby energize signal XS. It will be obvious that on a train moving from right to left relay EXSR will not be energized and accordingly the energizing circuit for relay XR including front contact *e* of relay EXSR will also be open.

Furthermore, with a train traveling from right to left if either track instrument XTZW or WTZ becomes blocked in its actuated condition, relay WTZSR will be released, thereby opening the branch of energizing circuit for relay XR including front contact *d* of relay WTZSR and, furthermore, relay WXS, which was picked up when the train actuated track instrument XTZE, will become released after a predetermined time interval when back contact *b* of relay WTZTER becomes open. With relays WXS and WTZSR both released, no energy will be supplied to relay XR and that relay will release thereby energizing signal XS. It will therefore be obvious that if any of the track instruments were to become blocked in their actuated condition, regardless of the direction of the train movement, signal XS will commence operating to provide a positive indication of a defect in the apparatus.

Although I have herein shown and described only one form of highway crossing protection control apparatus embodying my invention, it will be clear 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 highway crossing protection apparatus, a warning device, track instruments defining the limits of approach sections adjacent the crossing, a normally energized control stick relay associated with each approach section and governing the operation of the warning device, means for deenergizing each of said control stick relays effective upon the associated approach section becoming occupied, a time element relay associated with each approach section, means effective only when the associated control stick relay is deenergized for energizing the associated time element relay, a directional stick relay associated with each approach section, means for at times energizing each of said directional stick relays, and means effective unless the associated time element relay has been energized for a predetermined time interval for maintaining the associated directional stick relay in its energized condition.

2. In highway crossing protection apparatus, track instruments defining the limits of approach sections terminating adjacent the crossing, a normally energized control stick relay associated with each approach section, a warning signal governed by said control stick relay, means for deenergizing each of said control stick relays effective upon the associated approach section becoming occupied, a time element relay associated with each approach section and having a normally closed contact which becomes open only when said time element relay has been energized for a predetermined time interval, means effective only when the associated control stick relay is deenergized for energizing the associated time element relay, a directional stick relay associated

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with each approach section, means for at times energizing each of said directional stick relays, and a stick circuit for each directional stick relay including a back contact of the associated control stick relay and said contact of the associated time element relay.

3. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a normally energized control stick relay governing the operation of the warning signal, means controlled by said first and second track instruments and effective when said first track instrument is actuated by a train approaching the intersection for deenergizing said control stick relay; means controlled by said first, second and third track instruments and effective when said train clears said second track instrument for energizing said control stick relay; means controlled by said first, second and third track instruments and effective when said third track instrument is actuated by a train approaching the intersection for deenergizing said control stick relay; a time interval means; and means controlled by said first, second and third track instruments and said time interval means and effective only when said control stick relay has been deenergized for a predetermined time interval for energizing said control stick relay.

4. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay for governing operation of the warning signal, means effective only when said control stick relay is deenergized for energizing said time element relay, means effective only when said first and second track instruments are in their normal condition and said third track instrument is in its actuated condition for energizing said control stick relay, means effective only when said first and second track instruments are in their normal condition and said time element relay has been energized for a predetermined time interval for energizing said control stick relay; and means effective when said first, second and third track instruments are in their normal condition for maintaining said control stick relay energized.

5. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay, means including a back contact of said control stick relay for energizing said time element relay; means including a front contact of said first track instrument, a front contact of said second track instrument and a contact closed when said third track instrument is actuated for energizing said control stick relay; means including a front contact of said first track instrument, a front contact of said second track instrument and a contact closed when said time element relay has been energized for a predetermined time interval for energizing said control stick relay; and a stick circuit for said control stick relay including a front contact of said first track instru-

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ment, a front contact of said second track instrument and a contact closed when said second and third track instruments are in their normal condition.

6. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay, a circuit including a back contact of said control stick relay for energizing said time element relay, a normally deenergized directional stick relay, means controlled by said third track instrument and effective when a train approaching the intersection actuates said third track instrument for energizing said directional stick relay, means effective until after said train has cleared said first track instrument for maintaining said directional stick relay energized; a circuit including a front contact of said first track instrument, a front contact of said second track instrument, a back contact of said directional stick relay and a contact closed when said third track instrument is actuated for energizing said control stick relay; a circuit including a front contact of said first track instrument, a front contact of said second track instrument, a contact closed when said second and third track instruments are in their normal condition and a contact closed when said time element relay has been energized for a predetermined time interval for energizing said control stick relay; and a stick circuit for said control stick relay including a front contact of said first track instrument, a front contact of said second track instrument and a back contact of said directional stick relay in multiple with a contact closed when said second and third track instruments are in their normal condition.

7. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument located a distance from the intersection on said one side of the highway less than the distance said first track instrument is located from the intersection, a third track instrument adjacent the intersection on said one side of the highway, a fourth track instrument adjacent the intersection on the other side of the highway, a normally energized control stick relay; means controlled by said first, second and third track instruments and effective when a train approaching the intersection actuates said first track instrument for deenergizing said control stick relay; a first means controlled by said first, second and third track instruments and said control stick relay and effective only when said train takes more than a predetermined time interval while traveling from said first to said second track instrument for energizing said control stick relay; means controlled by said first, second and third track instruments and effective when said train actuates said second track instrument for deenergizing said control stick relay provided said control stick relay has been energized by said first energizing means; a second means controlled by said first, second, third and fourth track instruments and effective when said train clears said third track instrument for energizing said control stick relay; a third means controlled by said first, second, third and fourth track instruments and effective when a train approaching said intersection actuates said fourth track instrument for deenergizing said control stick relay; a time interval means; and a third means controlled by said first, second and third track instruments and said time interval means and effective only when said control stick relay has been de-

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energized for a predetermined time interval for energizing said control stick relay.

8. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument located a distance from the intersection on said one side of the highway less than the distance said first track instrument is located from the intersection, a third track instrument adjacent the intersection on said one side of the highway, a fourth track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay, means controlled by said control stick relay for energizing said time element relay; means effective only when said first, second and third track instruments are in their normal condition and said fourth track instrument is actuated for energizing said control stick relay; means effective only when said first, second and third track instruments are in their normal condition and said time element relay has been energized for a predetermined time interval for energizing said control stick relay; and means effective when said first, second, third and fourth track instruments are in their normal condition for maintaining said control stick relay energized.

9. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument located a distance from the intersection on said one side of the highway less than the distance said first track instrument is located from the intersection, a third track instrument adjacent the intersection on said one side of the highway, a fourth track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay, means including a back contact of said control stick relay for energizing said time element relay; means including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument, and a contact closed when said fourth track instrument is actuated for energizing said control stick relay; means including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument and a contact closed when said time element relay has been energized for a predetermined time interval for energizing said control stick relay; and a stick circuit for said control stick relay including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument and a contact closed when said third and fourth track instruments are in their normal condition.

10. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument located a distance from the intersection on said one side of the highway less than the distance said first track instrument is located from the intersection, a third track instrument adjacent the intersection on said one side of the highway, a fourth track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a control stick relay, a circuit including a back contact of said control stick relay for energizing said time element relay, a normally deenergized directional stick relay, means controlled by said fourth track instrument and effective

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when a train approaching the intersection actuates said fourth track instrument for energizing said directional stick relay, means effective until after said train has cleared said first track instrument for maintaining said directional stick relay energized; a circuit including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument, a back contact of said directional stick relay and a contact closed when said fourth track instrument is actuated for energizing said control stick relay; a circuit including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument, a contact closed when said time element relay has been energized for a predetermined time interval and a back contact of said directional stick relay in multiple with a contact closed when said third and fourth track instruments are in their normal condition for energizing said control stick relay; and a stick circuit for said control stick relay including a front contact of said first track instrument, a front contact of said second track instrument, a front contact of said third track instrument and a back contact of said directional stick relay in multiple with a contact closed when said third and fourth track instruments are in their normal condition.

11. In apparatus for controlling a warning signal adjacent the intersection of a highway and a stretch of track over which traffic may move in both directions, a first track instrument located a predetermined distance from the intersection on one side of the highway, a second track instrument located a distance from the intersection on said one side of the highway less than the distance said first track instrument is located from the intersection, a third track instrument adjacent the intersection on said one side of the highway, a fourth track instrument adjacent the intersection on the other side of the highway, said track instruments having a normal and an actuated condition, a time element relay, a time element stick relay, a repeater relay, a control stick relay; a circuit including a front contact of said second track instrument, a back contact of said control stick relay and a contact closed only when said time element relay is deenergized for energizing said time element stick relay; a circuit including a front contact of said repeater relay, a back contact of said control stick relay and a contact closed only when said time element relay is deenergized for energizing said time element stick relay; a stick circuit for said time element stick relay including a front contact of said second track instrument and a back contact of said control stick relay, another stick circuit for said time element stick relay including a front contact of said repeater relay and a back contact of said control stick relay, a circuit including a back contact of said second track instrument and a back contact of said time element stick relay for energizing said repeater relay, a stick circuit for said repeater relay including a front contact of said time element stick relay, a circuit including a front contact of said time element stick relay for energizing said time element relay, a normally deenergized directional stick relay, means controlled by said fourth track instrument and effective when a train approaching the intersection actuates said fourth track instrument for energizing said directional stick relay, means effective until after said train has cleared said first track instrument for maintaining said directional stick relay energized; a circuit including a front contact of each of said first, second and third track instruments and a contact closed when said fourth track instrument is actuated for energizing said control stick relay; a circuit including a front contact of each of said first, second and third track instruments, a contact closed when said time element relay has been energized for a predetermined time interval and a back contact of said directional stick relay in multiple with a contact closed when said third and fourth track instru-

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ments are in their normal condition for energizing said control stick relay; and a stick circuit for said control stick relay including a front contact of each of said first, second and third track instruments and a back contact of said directional stick relay in multiple with a contact closed when said third and fourth track instruments are in their normal condition.

12. In combination with a stretch of railway track intersected by a highway, a first track instrument a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a fourth track instrument a predetermined distance from the intersection of said other side of the highway, first and second stick relays, first and second time element means; means controlled by said first, second and third track instruments for controlling said first control stick relay; means controlled by said first and second track instruments and said first time element means for controlling said first control stick relay; means controlled by said second, third and fourth track instruments for controlling said second control stick relay; a second means controlled by said third and fourth track instruments and said second time element means for controlling said second control stick relay, means controlled by said first control stick relay for controlling said first time element means, means controlled by said second control stick relay for controlling said second time element means, first and second directional stick relays, means controlled by said first and second control stick relays and said third track instrument for controlling said first directional stick relay, means controlled by said first and second control stick relays and said second track instrument for controlling said second directional stick relay; and warning means adjacent said intersection and controlled by said first and second control stick relays, said first and second directional stick relays and said second and third track instruments.

13. In combination with a stretch of railway track intersected by a highway, a first track instrument a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a fourth track instrument a predetermined distance from the intersection on said other side of the highway, first and second control stick relays, first and second time element means; means effective when said first and second track instruments are in their normal condition and said third track instrument is actuated for energizing said first control stick relay, means effective when said first and second track instrument are in their normal condition and said first time element means has been energized for a predetermined time interval for energizing said first control stick relay, means effective when said first and second track instruments are in their normal condition for maintaining said first control stick relay energized, means effective when said third and fourth track instruments are in their normal condition and said second track instrument is actuated for energizing said second control stick relay, means effective when said third and fourth track instruments are in their normal condition and said second time element means has been energized for a predetermined time interval for energizing said second control stick relay, means effective when said third and fourth track instruments are in their normal condition for maintaining said second control stick relay energized, means effective only when said first control stick relay is deenergized for energizing said first time element means, means effective only when said second control stick relay is deenergized for energizing said second time element means, first and second directional stick relays; means effective when said second

control stick relay is deenergized, said first control stick relay is energized and said third track instrument is actuated for energizing said first directional stick relay; means effective only when said second control stick relay is deenergized for maintaining said first directional stick relay energized, means effective only when said first control stick relay is deenergized and said first time element relay has not been energized for a predetermined time interval for maintaining said first directional stick relay energized; means effective when said first control stick relay is deenergized, said second control stick relay is energized and said second track instrument is actuated for energizing said second directional stick relay; means effective only when said first control stick relay is deenergized for maintaining said second directional stick relay energized, means effective only when said second control stick relay is deenergized and said second time element relay has not been energized for a predetermined time interval for maintaining said second directional stick relay energized; and warning means adjacent said intersection and controlled by said first and second control stick relays, said first and second directional stick relays and said second and third track instruments.

14. In combination with a stretch of railway track intersected by a highway, a first track instrument a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a fourth track instrument a predetermined distance from the intersection on said other side of the highway, first and second control stick relays, first and second time element relays; means including a contact closed when said first track instrument is in its normal condition, a contact closed when said second track instrument is in its normal condition and a contact closed when said third track instrument is actuated for energizing said first control stick relay; means including a contact closed when said first track instrument is in its normal condition, a contact closed when said second track instrument is in its normal condition and a contact closed when said first time element relay has been energized for a predetermined time interval for energizing said first control stick relay; a stick circuit including a contact closed when said first track instrument is in its normal condition and a contact closed when said second track instrument is in its normal condition for energizing said first control stick relay; means including a contact closed when said fourth track instrument is in its normal condition, a contact closed when said third track instrument is in its normal condition and a contact closed when said second track instrument is actuated for energizing said second control stick relay; means including a contact closed when said fourth track instrument is in its normal condition, a contact closed when said third track instrument is in its normal condition and a contact closed when said second time element relay has been energized for a predetermined time interval for energizing said second control stick relay; a stick circuit including a contact closed when said fourth track instrument is in its normal condition and a contact closed when said third track instrument is in its normal condition for energizing said second control stick relay; means including a back contact of said first control stick relay for energizing said first time element relay means including a back contact of said second control stick relay for energizing said second time element relay, first and second directional stick relays, means including a back contact of said second control stick relay, a front contact of said first control stick relay and a contact closed when said third track instrument is actuated for energizing said first directional stick relay; a stick circuit including a back contact of said second control stick relay for energizing said first directional stick relay, a stick circuit including

a back contact of said first control stick relay and a contact closed unless said first time element relay has been energized for a predetermined time interval for energizing said first directional stick relay; means including a back contact of said first control stick relay, a front contact of said second control stick relay and a contact closed when said second track instrument is actuated for energizing said second directional stick relay, a stick circuit including a back contact of said first control stick relay for energizing said second directional stick relay, a stick circuit including a back contact of said second control stick relay and a contact closed unless said second time element relay has been energized for a predetermined time interval for energizing said second directional stick relay, a signal control relay, means including a front contact of said first control stick relay, a contact closed when said second and third track instruments are in their normal condition and a front contact of said second control stick relay for energizing said signal control relay; means including a front contact of said second directional stick relay, a contact closed when said second and third track instruments are in their normal condition and a front contact of said first control stick relay for energizing said signal control relay; means including a front contact of said second control stick relay, a contact closed when said second and third track instruments are in their normal condition and a front contact of said first directional stick relay for energizing said signal control relay; a crossing signal adjacent said intersection, and means including a back contact of said signal control relay for energizing said crossing signal.

15. In combination with a stretch of railway track intersected by a highway, a first track instrument a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a fourth track instrument a predetermined distance from the intersection on said other side of the highway and located at a greater distance from the intersection than said fourth track instrument, a first control stick relay, a first time element relay; means effective when said first and second track instruments are in their normal condition and said third track instrument is actuated for energizing said first control stick relay; means effective when said first and second track instruments are in their normal condition and said first time element relay has been energized for a predetermined time interval for energizing said first control stick relay, means effective when said first and second track instruments are in their normal condition for maintaining said first control stick relay energized, means effective only when said first control stick relay is deenergized for energizing said first time element relay, a second control stick relay, a second time element relay; means effective when said second track instrument is actuated and said third, fourth and fifth track instruments are deactuated for energizing said second control stick relay; means effective when said third, fourth and fifth track instruments are in their normal condition and said second time element relay has been energized for a predetermined time interval for energizing said second control stick relay; means effective when said third, fourth and fifth track instruments are in their normal condition for maintaining said second control stick relay energized; means effective only when said second control stick relay is deenergized for energizing said second time element relay, first and second directional stick relays; means effective when said second control stick relay is deenergized, said first control stick relay is energized and said third track instrument is actuated for energizing said first directional stick relay, means effective only when said second control stick relay is deenergized for maintaining said first direc-

tional stick relay energized, means effective when said first control stick relay is deenergized and said first time element relay has not been energized for a predetermined time interval for maintaining said first directional stick relay energized; means effective when said first control stick relay is deenergized, said second control stick relay is energized and said second track instrument is actuated for energizing said second directional stick relay, means effective when said first control stick relay is deenergized for maintaining said second directional stick relay energized, means effective when said second control stick relay is deenergized and said second time element relay has not been energized for a predetermined time interval for maintaining said second directional stick relay energized, and warning means adjacent said intersection and controlled by said first and second control stick relays, said first and second directional stick relays and said second and third track instruments.

16. In combination with a stretch of railway track intersected by a highway, a first track instrument a predetermined distance from the intersection on one side of the highway, a second track instrument adjacent the intersection on said one side of the highway, a third track instrument adjacent the intersection on the other side of the highway, a fourth track instrument a predetermined distance from the intersection on said other side of the highway, a fifth track instrument on said other side of the highway and located at a greater distance from the intersection than said fourth track instrument, a first control stick relay, a first time element relay; means including a contact closed when said first track instrument is in its normal condition, a contact closed when said second track instrument is in its normal condition and a contact closed when said third track instrument is actuated for energizing said first control stick relay; means including a contact closed when said first track instrument is in its normal condition, a contact closed when said second track instrument is in its normal condition and a contact closed when said first time element relay has been energized for a predetermined time interval for energizing said first control stick relay; a stick circuit including a contact closed when said first track instrument is in its normal condition and a contact closed when said second track instrument is in its normal condition for energizing said first control stick relay, means including a contact closed when said first control stick relay is deenergized for energizing said first time element relay, a second control stick relay, a second time element relay; means including a contact closed when said second track instrument is actuated, a contact closed when said third track instrument is in its normal condition, a contact closed when said

fourth track instrument is in its normal condition and a contact closed when said fifth track instrument is in its normal condition for energizing said second control stick relay; means including a contact closed when said third track instrument is in its normal condition, a contact closed when said fourth track instrument is in its normal condition, a contact closed when said fifth track instrument is in its normal condition and a contact closed when said second time element relay has been energized for a predetermined time interval for energizing said second control stick relay; a stick circuit including a contact closed when said third track instrument is in its normal condition, a contact closed when said fourth track instrument is in its normal condition and a contact closed when said fifth track instrument is in its normal condition for energizing said second control stick relay; means including a back contact of said second control stick relay for energizing said second time element relay, first and second directional stick relays, means including a back contact of said second control stick relay, a front contact of said first control stick relay and a contact closed when said third track instrument is actuated for energizing said first directional relay; a stick circuit including a back contact of said second control relay for energizing said first directional stick relay, another stick circuit including a back contact of said first control stick relay and a contact closed unless said first time element relay has been energized for a predetermined time interval for energizing said first directional stick relay; means including a back contact of said first control stick relay, a front contact of said second control stick relay and a contact closed when said second track instrument is actuated for energizing said second directional stick relay; a stick circuit including a back contact of said first control stick relay for energizing said second directional stick relay, another stick circuit including a back contact of said second control stick relay and a contact closed unless said second time element relay has been energized for a predetermined time interval for energizing said second directional stick relay; and warning means adjacent said intersection and controlled by said first and second control stick relays, said first and second directional stick relays and said second and third track instruments.

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