Feb. 11, 1941. P. N. MARTIN 2,231,504

RAILWAY SIGNALING APPARATUS

Filed Jan. 5, 1940 2 Sheets-Sheet 1

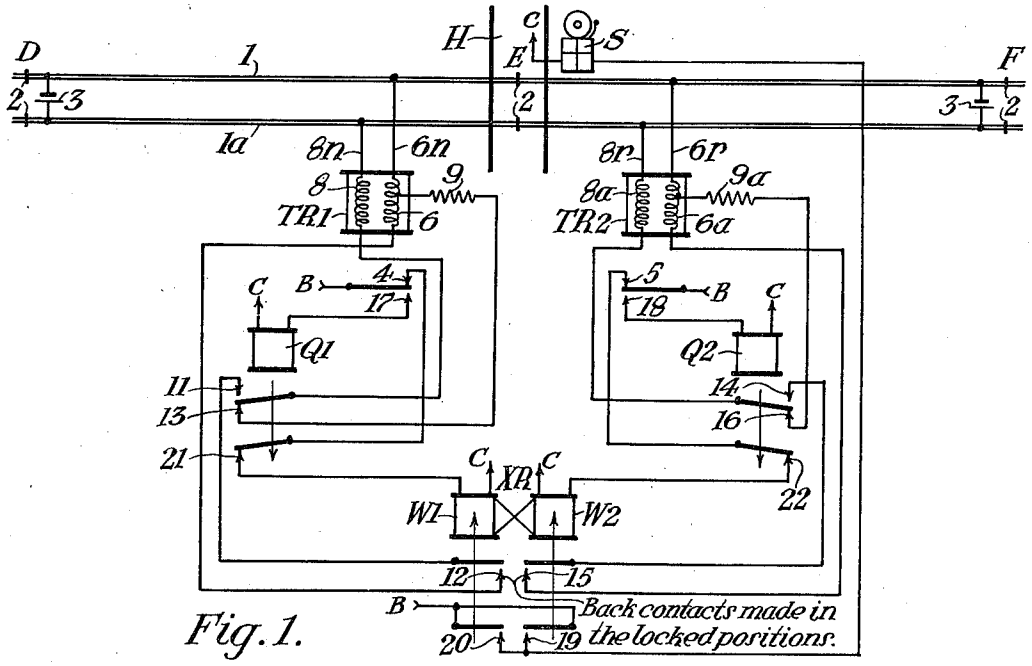


Fig. 1.

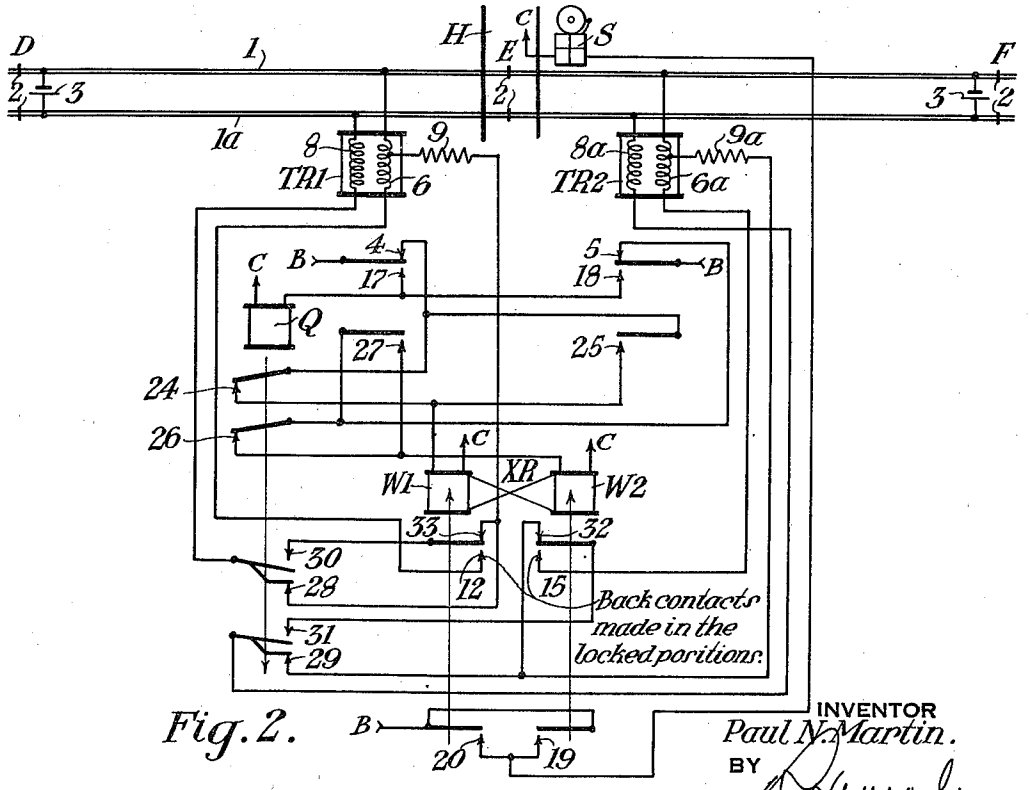


Fig. 2.

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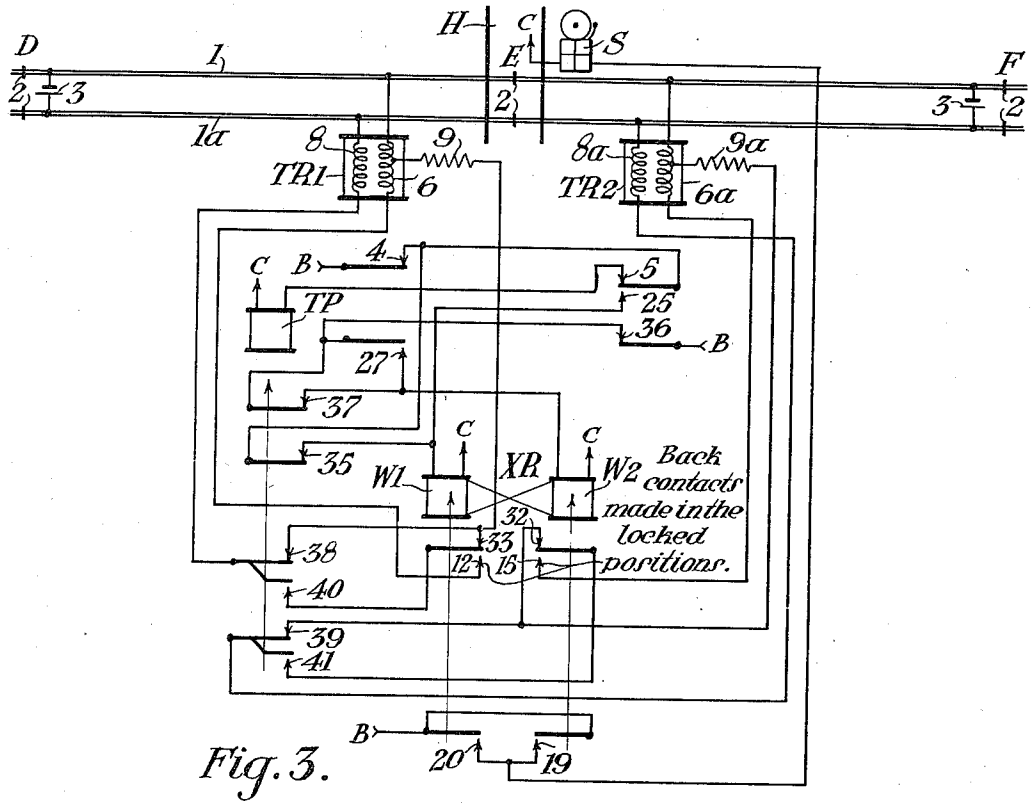


Fig. 3.

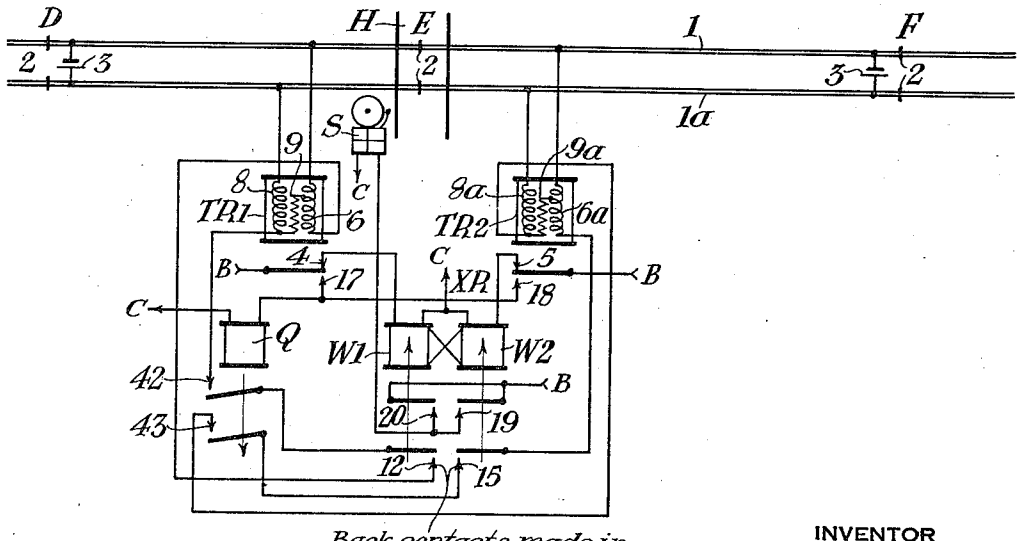


Fig. 4.

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UNITED STATES PATENT OFFICE

2,231,504

RAILWAY SIGNALING APPARATUS

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Application January 5, 1940, Serial No. 312,572

12 Claims. (Cl. 246—130)

My invention relates to railway signaling apparatus and has particular reference to the organization of such apparatus into novel and improved signaling systems wherein the control and operation of signaling devices are materially improved.

This application is a continuation in part of my copending application Serial No. 227,807 filed on August 31, 1938 for Railway signaling apparatus now U. S. Patent No. 2,199,957, granted May 7, 1940.

In the control of signaling devices by track relays incorporated into the ordinary track circuits, difficulty has been experienced in obtaining certainty of operation because the effectiveness of a train shunt upon a track relay is dependent upon many variable factors, among which are the speed and weight of the train, the condition of its car wheels, and the presence of rust and/or film on the surface of the track rails. The problem has become particularly acute in connection with the protection of highway crossings for tracks over which trains operate in either direction, because of the possibility that a high speed or lightweight train might lose its shunting effectiveness at or near the crossing and thus alter the directional control set up for the signal to effect its improper operation.

It is an object of my present invention to provide novel and improved signal control means wherein the shunting sensitivity of the control track circuits is improved so that improper signal operation will not be effected by momentary losses of train shunt in a control section.

Another object of my invention is the provision of novel and improved means for controlling directional operating means whereby to assure against loss of directional set-up upon momentary losses of train shunt in a control section.

To achieve the above-mentioned and other important objects and characteristic features of my invention which will become readily apparent from the following description, I propose to employ a track relay, an auxiliary relay and a signal control relay, the latter two relays each being provided with delayed response characteristics. The auxiliary relay is controlled by the track relay and is utilized either alone or in conjunction with the signal control relay to control the shunting sensitivity of the track relay, and the track relay is utilized, either alone or jointly in conjunction with the auxiliary relay, to control the slow acting signal control relay. The signal control relay is proportioned to have a longer delayed response period than the auxiliary relay to insure that in the event of a loss of train shunt, the shunting sensitivity of the track relay is affected prior to effecting control over the control relay. When the track and auxiliary relays are jointly employed to govern the control relay, the delayed response periods of both the auxiliary and the control relays are available and must be expended in sequence before operation of the control relay can be effected, thereby avoiding false operation of the signal due to an intermittent train shunt of high resistance in a control section.

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

In the accompanying drawings, Fig. 1 is a diagrammatic view showing novel and improved railway signaling apparatus embodying my invention as applied to the control of a highway crossing signal. Figs. 2, 3 and 4 are diagrammatic views illustrating modified forms of the apparatus shown in Fig. 1, each also embodying my invention.

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

Signaling apparatus of the type heretofore proposed for controlling highway crossing signals ordinarily employs the usual track circuits wherein the connection of a track relay across the rails of the associated section contains no provision for varying the energization of the relay once it has picked up. Such track relays are, therefore, normally energized at an energy level which is somewhat above their pick-up energy level and which is considerably above their drop-away energy level, hence such relays require a train shunt sufficiently effective to by-pass the increment of energy above the release or drop-away energy value of the relay. This requires not only a relatively low resistance train shunt, but also requires the shunt to be effective for an appreciable time interval since the relay flux requires an appreciable time to die down from the normal energy level to the release level.

Apparatus embodying my invention diminishes the possibility of improper operation of the controlled signal resulting from a momentary loss of train shunt or from an intermittent high resistance train shunt in the control section. Effective maintenance of the operation and directional control of a signal is made possible by reducing the normal energy level of the track relay below its pick-up value, both by decreasing the effective turns of and by inserting resistance in series with the operating winding of the relay after it picks up, thereby enabling a higher re-

sistance train shunt to release the relay. The decrease in number of turns and the addition of resistance in series with the winding of the track relay not only decrease the energy level but also cause a more rapid flux decay on account of a decrease in inductance to resistance ratio, thus decreasing the release time of the relay. It follows that when a track relay picks up on a loss of shunt within a control section, the relay is at once transferred to its holding circuit, whereby its energization will be immediately reduced so that it will be more likely to release again before the directional control means which it governs has had an opportunity to become affected.

Referring to Fig. 1, the reference characters 1 and 1a designate the track rails of a stretch of railway track over which trains move in either direction, and which is intersected at grade by a highway H.

The reference character S designates a traffic controlling signal, here shown as a highway crossing signal. Signal S is preferably located adjacent the intersection and may be any one of the usual types, but as here shown is an audible signal in the form of an electric bell.

The track rails 1 and 1a are divided by means of the usual insulated rail joints 2 to form control sections D—E and E—F. Sections D—E and E—F preferably extend in opposite directions from the intersection and, preferably, the sections are of such length suitable to provide an adequate warning period to highway users of the approach of a train to the intersection. Each section is provided with a track circuit comprising a source of current, such as track battery 3, connected across the track rails at one end of the section in series with the usual current-limiting impedance (not shown), and the winding of the primary relay of a primary-secondary relay combination connected across the track rails at the other end. The track circuit for section D—E includes the operating winding of relay TR1 which is illustrated in Fig. 1 in the form of two coils 6 and 8 corresponding to the two coils of the usual track relay, and the track circuit for section E—F includes the operating winding of relay TR2, shown as the two coils 6a and 8a.

As shown in Fig. 1, the upper terminal of coil 6 of relay TR1 is connected with rail 1 over a wire 6n and the upper terminal of coil 8 of relay TR1 is connected with rail 1a over a wire 8n. Preferably, the connection of the coils of relay TR1 to the track rails includes a series resistor (not shown) as is the usual practice. The two lower terminals of coils 6 and 8 of relay TR1 are at times connected together over a series circuit including front contact 11 of a relay Q1, to be referred to later, and back contact 12 of an interlocking relay XR, also to be referred to later. A resistor 9 is connected between an intermediate terminal of coil 6 of relay TR1 and the lower terminal of coil 8 of relay TR1 at such times as back contact 13 of relay Q1 is closed. In like manner, the upper terminal of coil 6a of relay TR2 is connected with rail 1 over wire 6r and the upper terminal of coil 8a of relay TR2 is connected with rail 1a over wire 8r; the connection of the track relay coils to the track rails preferably including a series resistor (not shown). The two lower terminals of coils 6a and 8a are at times connected together over a series circuit including front contact 14 of a relay Q2, to be referred to later, and back contact 15 of interlocking relay XR. A resistor 9a is connected between an intermediate terminal of coil 6a of relay TR2 and the lower terminal of coil 8a of relay TR2 at such times as back contact 16 of relay Q2 is closed. It is readily apparent that the pick-up circuit of each track relay includes its entire operating winding and excludes the associated resistor 9 or 9a, as the case may be, whereas the holding circuit of each relay includes only a portion of its operating winding connected in circuit with the associated resistor 9 or 9a. It can be seen, therefore, that whenever a track relay is connected across the rails of its associated section by its pick-up circuit, the full operating winding of the relay is available to energize the relay and hence such relay is provided with a high energy level sufficient to pick up the relay even under unfavorable ballast conditions. However, whenever a track relay is connected across the track rails in its holding circuit, the reduced number of coil turns available to energize the relay and the interposition of a resistor in circuit with such coil turns decrease the energy level of such relay to a value only sufficiently above its release value to assure reliable operation of such relay under the various ballast conditions. It is to be understood, of course, that my invention is not restricted to the particular form of primary-secondary relay combination described above and chosen to serve as an illustration, but that the scope of my invention embraces any of the usual primary-secondary relay combinations wherein the primary relay is provided with a holding circuit and a pick-up circuit including a contact of the secondary relay.

The relays Q1 and Q2 are associated respectively with relays TR1 and TR2, and preferably are provided with slow releasing characteristics. Relay Q1 is energized over a simple circuit including back contact 17 of relay TR1, and so serves as an auxiliary or secondary relay for relay TR1. Relay Q2 is energized over a simple circuit including back contact 18 of relay TR2, and so serves as an auxiliary or secondary relay for relay TR2.

The interlocking relay XR, referred to previously, may be of any suitable type, such as, for example, the relay covered by United States Letters Patent No. 1,799,629, granted to W. K. Lockhart and T. J. O'Meara on April 7, 1931. This type of relay is well-known and is characterized by the provision of two windings W1 and W2 so arranged that when the left-hand winding W1 is deenergized, the downward movement of the armature associated therewith operates a mechanical locking device which keeps the armature associated with the right-hand winding W2 "locked up" in approximately its mid position, so that a subsequent deenergization of winding W2 while winding W1 is still deenergized cannot close back contact 19. However, if the right-hand winding W2 is first to be deenergized, then back contact 20 is prevented from closing when the left-hand winding W1 becomes deenergized during the interval that winding W2 is still deenergized. Winding W1 is provided with back contact 12 which is so arranged as to be closed when winding W1 is in either its full released or its "locked up" position. Back contact 15 of winding W2 is similarly arranged to close in either the "locked up" or full released position of winding W2. Winding W1 is energized over a circuit passing from one terminal B of a suitable source of current, such as a battery not shown,

through front contact 4 of relay TR1, back contact 21 of relay Q1 and the winding W1 of relay XR to the other terminal C of the source of current. Winding W2 is energized over a circuit passing from terminal B through front contact 5 of relay TR2, back contact 22 of relay Q2 and the winding W2 of relay XR to terminal C. The windings W1 and W2 preferably are provided with slow pick-up characteristics.

Signal S is provided with an energizing circuit passing from terminal B through back contact 19 or back contact 20 of relay XR and the winding of signal S to terminal C. It can be seen, therefore, that back contact 20 of winding W1 and back contact 19 of winding W2 function as signal control contacts, winding W1 serving as an operating relay for governing signal S for eastbound traffic, and winding W2 serving as an operating relay for governing signal S for westbound traffic. The interlocking feature of relay XR, as will appear more clearly later, serves as directional means for preventing winding W1 from functioning as an operating relay for westbound traffic, and prevents winding W2 from functioning as an operating relay for eastbound traffic.

The apparatus of Fig. 1 assumes its normal condition, that is, the condition illustrated in the drawings, when the stretch of track D—F is unoccupied. In this condition of the apparatus, relays TR1, TR2 and windings W1 and W2 of relay XR are energized, and relays Q1, Q2 and signal S are deenergized. It should be noted that when relays Q1 and Q2 are deenergized, relays TR1 and TR2 are connected across the track rails in their holding circuits whereby the energy levels of such relays are reduced nearly to their respective release values.

I shall now assume that an eastbound train, that is, a train operating from left to right as viewed in Fig. 1, enters section D—E. When this happens, relay TR1 is shunted and quickly releases whereupon its front contact 4 is opened to interrupt the energizing circuit for winding W1 so that winding W1 releases, and back contact 17 of relay TR1 is closed to complete the energizing circuit for relay Q1 so that relay Q1 picks up. The releasing of winding W1 closes back contact 20 to complete the energizing circuit for signal S and thereby initiate the operation of the signal, and winding W1 also closes back contact 12 to prepare the pick-up circuit of relay TR1. The picking up of relay Q1 opens back contact 13 and closes front contact 11 to shift track relay TR1 from its holding to its pick-up circuit.

If the resistance of the train shunt varies intermittently as the train passes through section D—E, the primary relay TR1 might pick up and release, following the variations of train shunt resistance, but the operating winding W1 will not pick up and operate signal control contact 20. In the case of the ordinary track relay controlling an operating relay, the operating relay usually will pick up and release in response to each fluctuation of the track relay, thus such relay momentarily opens the signal control contact to cause momentary interruptions and improper operation of the controlled signaling device. With the apparatus of Fig. 1, however, after a train enters the section and causes relay TR1 and winding W1 to release and relay Q1 to pick up, if a high resistance train shunt occurs so that the track relay TR1 picks up over its pick-up circuit, the auxiliary relay Q1 will release at the end of its slow release period to open its front contact 11 and to close its back contact 13 thereby shifting the track relay from its pick-up circuit to its holding circuit and so reducing its energization. This reduced energization will, under ordinary variations of train shunt, be sufficient to release the track relay. Since winding W1 is energized over a circuit which includes a back contact of relay Q1 as well as a front contact of track relay TR1, such winding is but momentarily energized in the event of a loss of shunt because ordinarily the track relay releases immediately upon being shifted to its holding circuit. It should, however, be noted that this arrangement provides improved assurance against improper operation of the signal control contacts in the event of loss of shunt, inasmuch as the slow response period of both the auxiliary relay and the signal control winding must successively elapse prior to effecting operation of such control contacts. Thus, the entire slow release interval of relay Q1 is available in which the train shunt may be restored before the track relay is shifted automatically to its holding circuit. Then, since winding W1 is supplied with energy only after relay Q1 releases to connect track relay TR1 in its holding circuit, the entire slow response period of the signal control winding W1 is available in which the track relay flux is permitted to die down and the track relay to be released prior to the signal contact being operated. It follows that when winding W1 is combined with track relay TR1 and auxiliary relay Q1 in the manner set forth hereinbefore, such relays cooperate to avoid false operation of traffic controlling devices due to an intermittent train shunt of high resistance in a control section.

When the train enters section E—F, relay TR2 quickly releases, thereby opening front contact 5 to open the energizing circuit for winding W2 so that winding W2 releases its armature to its "locked up" position wherein back contact 19 is prevented from closing. Relay TR2 also closes its back contact 18 to complete the energizing circuit for relay Q2, and when relay Q2 picks up, relay TR2 is shifted from its holding circuit to its pick-up circuit.

In the event that intermittent variations of train shunt occur while the train occupies both sections D—E and E—F, one or the other or both of the track relays might pick up and release but the operating winding W1 will not pick up and so interrupt the signal operation, nor will winding W2 pick up to affect the directional set-up for signal S. That is to say, if relay TR1 picks up due to a high resistance shunt, the relay is transferred to its holding circuit and releases prior to winding W1 picking up, as explained hereinbefore. If relay TR2 picks up due to high resistance shunt, relay Q2 releases at the end of its slow release period to connect relay TR2 across the track rails in its holding circuit, thereby reducing the energization of relay TR2 with the result that relay TR2 releases to reopen the circuit for winding W2 and thus prevent the directional control of signal S from being altered.

When the train vacates section D—E, relay TR1 picks up to interrupt the circuit of relay Q1 whereupon the latter relay releases to connect relay TR1 across the track rails in its holding circuit, and with relay TR1 picked up and relay Q1 released, the energizing circuit of winding W1 is completed so that winding W1 picks up to terminate operation of signal S. With the train entirely within section E—F, an intermittent variation in train shunt might result in relay TR2 picking up and releasing, but winding W2 does

not at once pick up and so does not affect the directional control of signal S, as explained hereinbefore.

When the train vacates section E—F, relay TR2 picks up to cause relay Q2 to release and winding W2 to pick up so that the apparatus is restored to its normal condition.

The operation of the apparatus of Fig. 1 for a westbound train is similar to the operation just described for an eastbound train, and it is believed that the latter operation will be apparent from the foregoing description together with an inspection of Fig. 1 without further detailed description.

Referring now to Fig. 2, a modification of the apparatus of Fig. 1 is shown wherein a single normally deenergized secondary relay Q cooperates with relay XR to control a pick-up circuit for both track relays TR1 and TR2, the slow release secondary relay Q being energized over a simple circuit including back contact 17 of relay TR1 or back contact 18 of relay TR2. The slow release period of relay Q, as will be explained hereinafter, preferably is shorter than the slow pick-up periods of the windings W1 and W2 of relay XR.

Winding W1 is provided with an energizing circuit which may be traced from terminal B through front contact 4 of relay TR1, back contact 24 of relay Q and winding W1 of relay XR to terminal C, and at times back contact 25 of relay TR2 provides an alternate path around back contact 24 of relay Q in the circuit of winding W1. Winding W2 is normally energized over a circuit which extends from terminal B through front contact 5 of relay TR2, back contact 26 of relay Q and winding W2 of relay XR to terminal C, and at times back contact 27 of relay TR1 provides an alternate path around back contact 26 of relay Q in the circuit of winding W2. The operating circuit for signal S is the same as traced in connection with the apparatus of Fig. 1.

In the normal condition of the apparatus, as illustrated in Fig. 2, signal control windings W1 and W2 are energized, auxiliary relay Q is deenergized, track relay TR1 is connected across the rails of its associated section over its normal holding circuit which is completed at back contact 28 of relay Q, and track relay TR2 is connected across the rails of its associated track section over its normal holding circuit which includes back contact 29 of relay Q. If, now, relay Q becomes energized in response to a train entering either one of the track sections and shunting the track relay associated with such section, then that track relay is shifted to its pick-up circuit while the other track relay is maintained in its holding circuit. For example, if an eastbound train enters section D—E to shunt relay TR1, relay Q becomes energized and winding W1 is released to set signal S into operation. Winding W2, however, remains energized since back contact 27 of relay TR1 is closed to hold the energizing circuit for winding W2 completed at that point when back contact 26 of relay Q is opened upon the energization of the latter relay. Relay TR1 now is connected across the rails of section D—E in its pick-up circuit, which circuit includes, in addition to to full coils 6 and 8 of relay TR1, a circuit path connecting such coils together and extending from coil 8 through front contact 30 of relay Q and back contact 12 of winding W1 to coil 6. Relay TR2 is maintained in its holding circuit by a circuit path which extends from coil 8a of relay TR2 through front contact 31 of relay Q, front contact 32 of winding W2 and resistor 9a to a mid tap of coil 6a.

In the event of a loss of shunt while the train occupies section D—E, the slow response periods of both the auxiliary relay Q and the winding W1 of the interlocking relay XR controlling the signal are available and must sequentially elapse prior to affecting the operation of signal S and the directional control set up by the releasing of the armature of winding W1. Hence, if relay TR1 picks up on a loss of shunt in section D—E, the releasing of relay Q at the end of its slow release period transfers relay TR1 to its holding circuit to reduce its energization so that relay TR1 is again released, but because of the slow pick-up characteristics of winding W1, such winding does not become picked up should the energizing circuit for such winding be completed momentarily during the short interval that relay TR1 is picked up and relay Q is released. The apparatus of Fig. 2 accordingly functions in the manner previously pointed out in detail in connection with Fig. 1 to insure that a loss of shunt in a control section does not affect the operation of the controlled signal and of the directional control established for such signal. When the train enters section E—F, relay TR2 is shunted and winding W2 releases to its interlocked position, wherein relay TR2 is connected in its pick-up circuit by a circuit path extending from coil 8a through front contact 31 of relay Q and back contact 15 of winding W2 (closed in the interlocked as well as the full released position of winding W2) to coil 6a. At this time, that is, with sections D—E and E—F both occupied by the train, relay Q is removed from control of each of the windings of relay XR since back contact 27 of relay TR1 is closed to provide a shunt path around the opened back contact 26 of relay Q interposed in the control circuit of winding W2, and back contact 25 of relay TR2 shunts the opened back contact 24 of relay Q interposed in the enegizing circuit of winding W1. It is readily apparent, therefore, that when the train vacates section D—E and relay TR1 picks up over its pick-up circuit path, winding W1 is energized over its alternate path including front contact 4 of relay TR1 and back contact 25 of relay TR2, and as a result operation of signal S is terminated. Relay TR1 now is connected in its holding circuit by a circuit path extending from coil 8 through front contact 30 of relay Q, front contact 33 of winding W1 and resistor 9 to a mid terminal of coil 6 of relay TR1.

When the train occupies section E—F in receding from the intersection, relay Q is restored to control of winding W2 since back contact 27 of relay TR1 is opened. It is readily apparent, therefore, that in the event of a loss of shunt in section E—F, the slow response periods of relay Q and winding W2 are sequentially available to insure against improper operation of signal S and against loss of the directional control of the signal which was established in response to the prior release of winding W1 actuating the locking mechanism of relay XR to the condition wherein the subsequent release of winding W2 holds the armature of the latter winding in its interlocked position.

When the train vacates section E—F, the apparatus of Fig. 2 is restored to its normal condition since the picking up of relay TR1 causes relay Q to release at the end of its slow release period to transfer both track relays to their re-

spective normal holding circuits, and with relay TR2 picked up and relay Q released, the energizing circuit of winding W2 is completed whereupon that winding picks up at the end of its slow pick-up period.

From the foregoing description of the apparatus of Fig. 2, it is readily apparent that the release sensitivity of both track relays is controlled through the medium of a single auxiliary relay cooperating with the associated windings of the interlocking relay. It further is apparent that the single auxiliary relay of Fig. 2 functions in a manner similar to the individual auxiliary relays provided for each track relay in Fig. 1 to exert a control over the associated signal control winding of the interlocking relay whereby there is sequentially available the slow response periods of both the auxiliary relay and the signal control winding prior to the signal control contact and the directional set-up of the interlocking relay being affected.

Fig. 3 illustrates a modified arrangement of the apparatus of Fig. 2 wherein a normally energized slow pick-up relay TP replaces the normally deenergized auxiliary relay Q of Fig. 2. Relay TP is normally energized over a circuit extending from terminal B through front contact 4 of relay TR1, front contact 5 of relay TR2 and the winding of relay TP to terminal C.

Since the auxiliary relay of Fig. 3 normally is energized, such relay controls the windings of relay XR through the medium of control circuits corresponding to similar circuits traced in Fig. 2, except that front contacts 35 and 37 of relay TP replace back contacts 24 and 26 of relay Q interposed respectively in the energizing circuits of windings W1 and W2. Also, relays TR1 and TR2 normally are held in their respective normal holding circuits over front contacts 38 and 39, respectively, of relay TP.

It is believed that the operation of the apparatus of Fig. 3 will be readily apparent from an inspection of the drawings taken in connection with the foregoing description of the apparatus of Fig. 2, it being noted that the function of each back contact of relay Q in Fig. 2 is performed by a front contact of relay TP in Fig. 3, and conversely the function of each front contact of relay Q in Fig. 2 is performed by a back contact of relay TP of Fig. 3.

It should be pointed out that relays Q and TP are each illustrated in Figs. 2 and 3 as controlling the release sensitivity of the track relays by means of dependent front and back contact arrangements of the continuity transfer or make-before-break type. These contact arrangements are to be preferred since they permit the track relays to be connected at all times in circuit with the track rails, consequently there is avoided the danger that a track relay might lose its energization during the travel of the armature of the auxiliary relay from its back point to its front, or vice versa. Accordingly, it should be pointed out that although such contact arrangements are not shown provided for auxiliary relays Q1 and Q2 in Fig. 1, it is contemplated that in actual practice continuity transfer type contacts may be provided on such auxiliary relays to control the release sensitivity of the associated track relays.

Fig. 4 illustrates a further modified arrangement of the apparatus of Fig. 2, wherein the track relays TR1 and TR2 normally are connected across the rails of the associated section over holding circuits wherein the resistors 9 and 9a are permanently connected between the lower terminals of one coil and a mid terminal of the other coil of the relay. In Fig. 4, a single slow releasing normally deenergized auxiliary relay Q is employed to cooperate with the two windings of the interlocking relay to control the release sensitivity of the track relays by at times completing for such relays pick-up circuit paths connecting the lower terminals of the two relay coils together. A pick-up circuit path for relay TR1 may be traced from coil 8 through front contact 42 of relay Q and back contact 12 of winding W1 to coil 6; and similarly a pick-up circuit path for relay TR2 extends from coil 8a through front contact 43 of relay Q and back contact 15 of winding W2 to coil 6a of relay TR2.

It is believed that the operation of the apparatus of Fig. 4 will readily be apparent from an inspection of the drawings, it being noted that operation and directional control of the signal is maintained by virtue of the slow pick-up characteristics of the windings of the interlocking relay and the relatively shorter slow release characteristics of relay Q. For example, with a train in section D—E, a momentary loss of shunt might permit the track relay TR1 to pick up but since relay Q releases because of its relatively quicker release period prior to winding W1 picking up, the pick-up circuit of relay TR1 is opened and the energy level of such relay is decreased so that relay TR1 will be shunted quickly upon the restoration of a moderately low resistance train shunt across the track rails. Relay TR1 thus will release again prior to the expiration of the slow pick-up interval of winding W1 with the result that operation and directional control of the signal is not affected. Similarly, a loss of train shunt in section E—F while the train is occupying both sections D—E and E—F, does not result in loss of directional control. In the event of a loss of shunt in either section D—E or E—F while the train occupies both sections D—E and E—F, the interlocking mechanism of relay XR functions to maintain operation and directional control of the signal since such mechanism is arranged in such manner that once the armature controlled by winding W2 is released to its mid or locked position, both windings of relay XR must be energized again before the armature of winding W2 can drop to its full released position. It is obvious that the slow pick-up characteristics of winding W2 will operate in a similar manner to prevent false operation of the signal if, with the train entirely on section E—F, relay TR2 becomes energized due to a loss of train shunt.

It is to be understood that while apparatus embodying my invention has been described in connection with the control of highway crossing signals, such apparatus is equally suitable for controlling any railway signaling device that it is desired to be protected against improper operation due to intermittent or high resistance train shunts in a control section.

Although I have herein shown and described only a few forms of railway signaling 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 combination with a stretch of railway track intersected by a highway and provided with two track sections which extend in opposite directions from the highway, a highway crossing

signal located adjacent said intersection, two track relays one for each of said track sections, two track circuits one for each of said sections and each normally effective to create in the associated track relay a first energy level which is sufficient to maintain that relay picked up but which is insufficient to pick up that relay, an interlocking relay having two windings each having a slow pick-up period and each controlled by a different one of said two track relays, circuit means controlled by each of said two windings for operating said signal, auxiliary relay means controlled by both of said two track relays and having a slow response period which is shorter than the slow pick-up period of the windings of said interlocking relay, and circuit means for each of said two track relays controlled by said auxiliary relay means and by the associated interlocking relay winding for conditioning each track relay to create a second energy level which is sufficient to pick up such track relay.

2. In combination with a stretch of railway track intersected by a highway and provided with two track sections which extend in opposite directions from the highway, a highway crossing signal located adjacent said intersection, two track relays one for each of said track sections, two track circuits one for each of said sections and each normally effective to create in the associated track relay a first energy level which is sufficient to maintain that relay picked up but which is insufficient to pick up that relay, slow acting auxiliary relay means controlled by said two track relays, circuit means controlled by said auxiliary relay means for at times conditioning each of said two track relays to create a second energy level which is sufficient to pick up that relay, an interlocking relay having two windings one for each of said two track relays, circuit means controlled by each of said two windings for operating said signal when a train approaches the intersection in either of said two sections but preventing such operation when the train recedes from the intersection in the other of said two sections, and two energizing circuit means one for each of said windings and each circuit means controlled by the associated track relays and by said auxiliary relay means at the expiration of its slow response period, whereby the slow response period of said auxiliary relay means is utilized upon loss of shunt in either of said sections to prevent improper energization of the winding of the interlocking relay associated with such section.

3. In combination with a stretch of railway track intersected by a highway and provided with two track sections which extend in opposite directions from the highway, a highway crossing signal located adjacent said intersection, two track relays one for each of said track sections, two track circuits one for each of said sections and each normally effective to create in the associated track relay a first energy level which is sufficient only to maintain that relay picked up, two slow acting auxiliary relays one for each of said track relays, circuit means controlled by each of said auxiliary relays for at times conditioning its associated track relay to create a second energy level which is sufficient to pick up such relay, an interlocking relay having two windings one for each of said two tracks relays, circuit means controlled by each of said two windings for operating said signal when a train approaches the intersection in either of said two track sections but preventing such operation when the train recedes from the intersection through the other of said two sections, and two energizing circuit means one for each of said two windings and each circuit means controlled jointly by the associated track relay and by its associated auxiliary relay at the expiration of its slow response period, whereby the slow response period of the auxiliary relay is utilized upon loss of shunt in either of said sections to prevent improper energization of the winding of the interlocking relay associated with such section.

4. In combination, a track relay, a slow acting auxiliary relay, a slow acting operating relay, means controlled by said track relay for energizing said auxiliary relay, means controlled jointly by said track relay and by said auxiliary relay for energizing said operating relay, a holding circuit controlled by said auxiliary relay for establishing in said track relay a given energy level sufficient to maintain such track relay picked up, a pick-up circuit also controlled by said auxiliary relay for creating in said track relay a second energy level sufficient to pick up such track relay, and a signal control contact governed by said operating relay.

5. In combination, a track relay, a normally deenergized slow release auxiliary relay, circuit means controlled by a back contact of said track relay for energizing said auxiliary relay, a normally energized slow pick-up control relay, circuit means controlled by a front contact of said track relay and a back contact of said auxiliary relay for energizing said control relay, a holding circuit including a back contact of said auxiliary relay for creating in said track relay a given energy level sufficient only to maintain that relay in a picked-up condition, a pick-up circuit including a front contact of said auxiliary relay for creating in said track relay a second energy level which is sufficient to pick up that relay, and a signal control contact controlled by said control relay.

6. The combination with a section of railway track having a source of current connected across the track rails at one end, a track relay normally connected in a low energy level circuit across the track rails at the other end, and a normally deenergized slow release auxiliary relay provided with an energizing circuit controlled by said track relay, of a normally energized slow pick-up signal control relay, circuit means for energizing said signal control relay including in series a front contact of said track relay and a back contact of said auxiliary relay, circuit means controlled jointly by said auxiliary relay and by said signal control relay for connecting said track relay across the track rails of said section in a high energy level circuit, and a signal control contact controlled by said signal control relay.

7. The combination with a section of railway track provided with a source of current, a track relay, a normally deenergized slow release auxiliary relay controlled by a back contact of said track relay, a slow pick-up signal control relay, and a signal control contact governed by said signal control relay, of circuit means including in series a front contact of said track relay and a back contact of said auxiliary relay for energizing said signal control relay, and circuit means controlled by said auxiliary relay and by said signal control relay for connecting said track relay across the rails of said section in a low or a high energy level circuit according as said auxiliary relay is released or picked up.

8. In combination with a stretch of railway track intersected by a highway and provided with two track sections which extend in opposite directions from the highway, a highway crossing signal located adjacent said intersection, two track relays one for each of said track sections, two track circuits one for each of said sections and each normally effective to create in the associated track relay a first energy level which is sufficient only to maintain that relay picked up, a slow acting auxiliary relay controlled by contacts of each of said two track relays, an interlocking relay having two windings one for each of said two track relays, circuit means controlled by each of said two windings for operating said signal, energizing circuit means for each of said two windings normally controlled by a front contact of the associated track relay and by a contact of said auxiliary relay closed at the expiration of its slow response period whereby in the event of loss of shunt in a track section operation of such winding is avoided for the slow response period of said auxiliary relay, other circuit means controlled by a front contact of the associated track relay and a back contact of the other track relay for at times energizing each winding of said interlocking relay whereby to terminate operation of said signal by such winding after a train passes the highway intersection, and two circuit means one for each track relay and each circuit means controlled jointly by the associated winding and by said auxiliary relay for conditioning the associated track relay to create in such relay a second energy level which is sufficient to pick up such relay.

9. The combination in a highway crossing signaling system of the class wherein a highway crossing signal positioned adjacent a railway-highway intersection is controlled by railway traffic through the medium of two track relays each normally connected in a low energy level track circuit provided for a different one of two track sections located on opposite sides of the intersection, of slow acting auxiliary relay means controlled by both of said track relays, an interlocking relay having two windings one for each of said track relays, circuit means controlled by each of said two windings for operating said signal, circuit means controlled jointly by said auxiliary relay means and by the associated track relays for energizing each of said two windings at the end of the slow response period of said auxiliary relay means whereby to prevent improper operation of said signal in the event of a loss of shunt in either of said two sections, and circuit means controlled jointly by said auxiliary relay means and by the windings of the interlocking relay for selectively connecting each of said track relays in circuit with the rails of its associated section to create in that relay a high energy level.

10. The combination in a highway crossing signaling system of the class wherein a highway crossing signal is controlled by railway traffic through the medium of two track relays each normally connected in a low energy level track circuit provided for a different one of two track sections which are located on the opposite sides of a railway-highway intersection, of two slow acting auxiliary relays each controlled by a different one of said track relays, an interlocking relay having two windings one for each of said track relays, circuit means controlled by each of said two windings for operating said signal, each of said two windings having an energizing circuit including in series a contact of the associated track relay and a contact of its associated slow acting auxiliary relay closed at the expiration of the slow response period of such relay, and circuit means controlled by each of said auxiliary relays for connecting its associated track relay in circuit with the rails of its associated track section in a high energy level circuit.

11. The combination in a highway crossing signaling system of the class wherein a highway crossing signal is controlled by railway traffic through the medium of two track relays each normally connected in a low energy level track circuit provided for a different one of two track sections located on the opposite sides of a railway-highway intersection, of a slow acting auxiliary relay controlled by both of said track relays, an interlocking relay having two windings one for each of said track relays, circuit means controlled by each of said two windings for operating said signal, circuit means for energizing each of said two windings controlled jointly by the associated track relay and by said auxiliary relay at the end of its slow response period whereby to prevent improper operation of said signal in the event of loss of shunt in either of said track sections, other circuit means for energizing each of said two windings controlled jointly by both of said track relays in such manner that each winding is deenergized when and only when the track section of its associated track relay is occupied, and circuit means for each of said track relays controlled jointly by said auxiliary relay and by the associated winding of the interlocking relay for connecting such track relay to the rails of its associated track section in a high energy level circuit.

12. The combination in a highway crossing signaling system of the class wherein a highway crossing signal is controlled by railway traffic through the medium of two track relays each having only a portion of its winding connected in a track circuit provided for a different one of two track sections located on opposite sides of a railway-highway intersection, of a slow acting auxiliary relay controlled by both of said track relays, an interlocking relay having two windings one for each of said track relays, circuit means controlled by each of said two windings for operating said signal, circuit means for energizing each of said two windings controlled jointly by the associated track relay and by said auxiliary relay at the expiration of its slow response period whereby the slow response period of said auxiliary relay is available to prevent improper operation of said signal in the event of loss of shunt in either of said track sections, other energizing circuit means for each of said two windings controlled by a front contact of the associated track relay and a back contact of the other track relay for terminating operation of said signal after a train passes the highway intersection, and circuit means controlled jointly by said auxiliary relay and by the windings of said interlocking relay for interposing the full winding of each of said track relays in the track circuit of its associated section.

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