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APPROACH CONTROL APPARATUS FOR RAILWAY SIGNALING SYSTEMS

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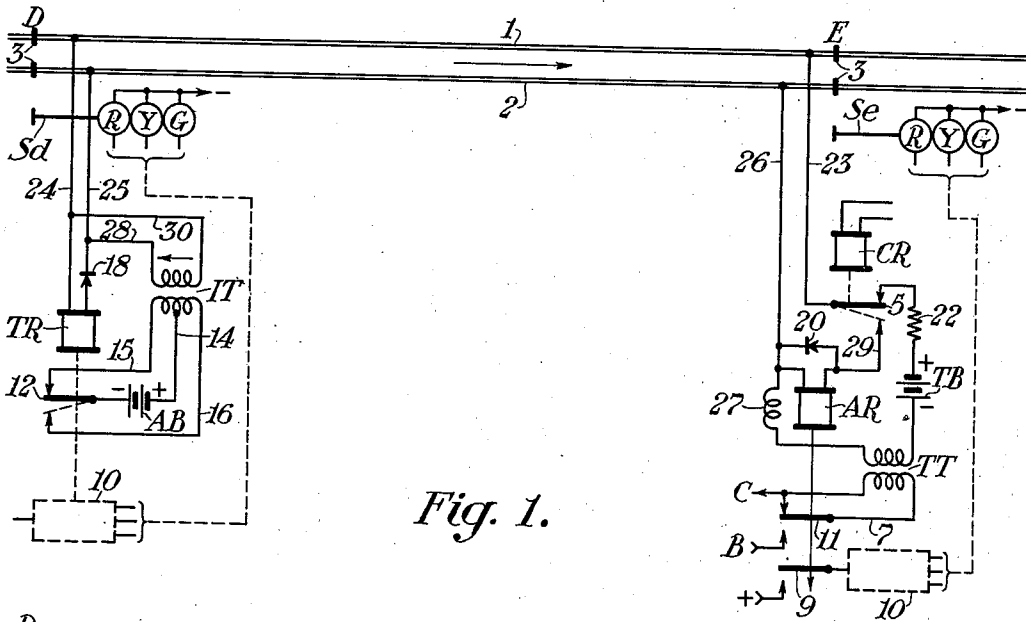


Fig. 1.

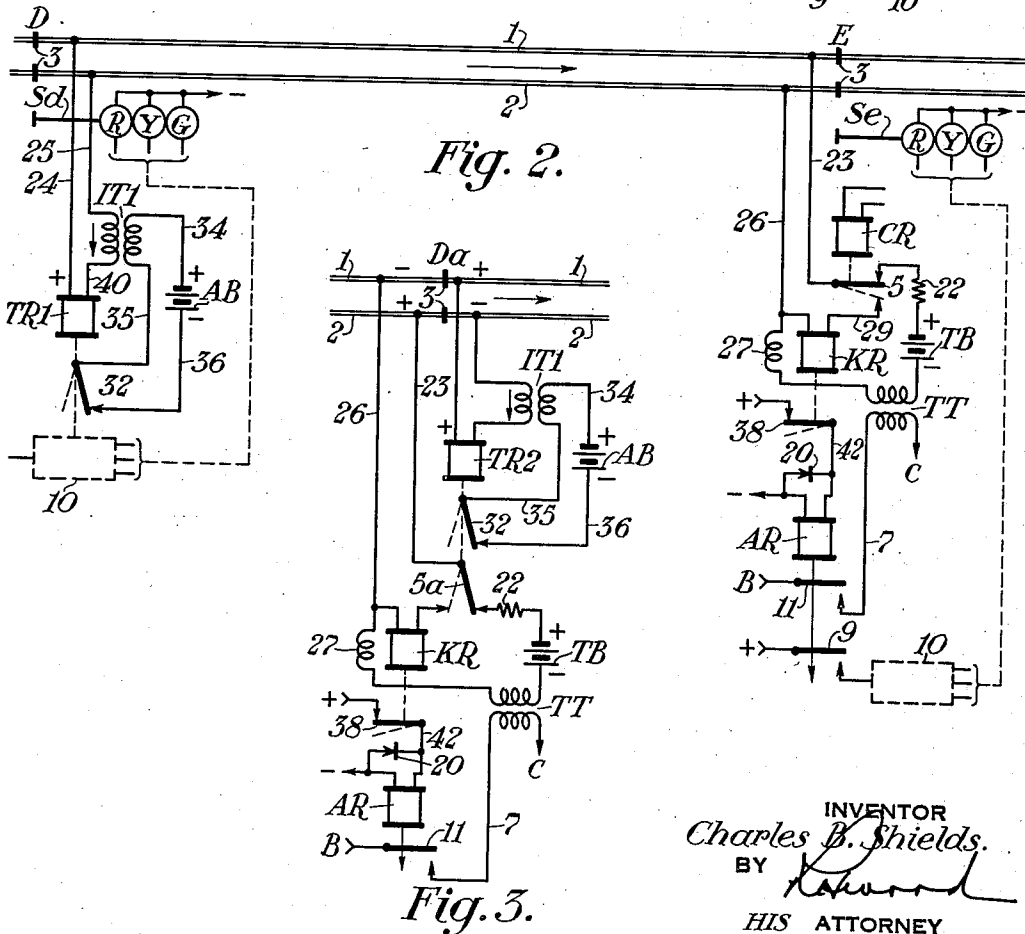


Fig. 2.

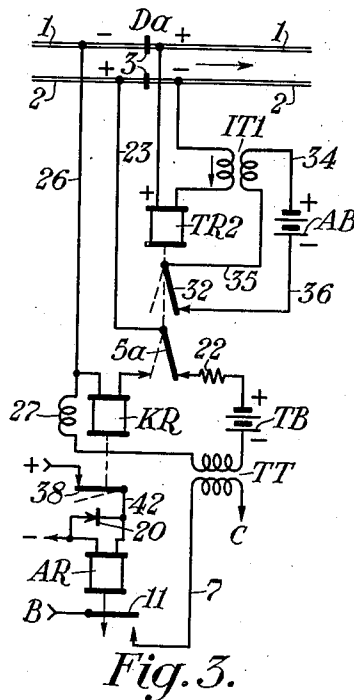


Fig. 3.

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APPROACH CONTROL APPARATUS FOR
RAILWAY SIGNALING SYSTEMS

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19 Claims. (Cl. 246—38)

My invention relates to approach control apparatus for use in railway signaling systems of the coded track circuit class and it has special reference to the employment of such apparatus for approach controlling various signaling functions without the use of line wires.

Generally stated, the object of my invention is to improve certain features of an approach control without line wire scheme wherein the rails of each unoccupied signal block length of track transmit code step pulses of auxiliary energy forwardly from the block entrance to effect the energization of a slow release approach relay at the block exit.

A more specific object is to supply the referred to pulses of auxiliary energy to the entrance end of each track circuit in an improved manner which avoids interference with the normal code following operation of the signaling system track relay at that location and which counteracts the effects of track storage energy.

Another object is to provide improved means for detecting the auxiliary energy pulses at the exit end of the track circuit and for energizing the associated slow release approach relay in step with them.

An additional object is to provide cut section facilities which are suitable for use with approach control schemes of the improved class herein disclosed.

In practicing my invention, I attain the above and other objects and advantages by generating the pulses of the auxiliary energy in a special impulse transformer which is controlled by the code following track relay; by supplying the track circuit with the full alternating current wave of the code frequency auxiliary energy thus provided; by rendering the track relay unresponsive to the "off" code period pulses of this energy; by using the coding device contact at the exit end of the signal block to rectify the received measure of this auxiliary energy before impressing it upon operating facilities for the approach relay; and by interposing a sensitive code following detector relay between the track rails and the operating winding of this approach relay.

I shall describe a few forms of approach control apparatus embodying my invention and shall then point out the novel features thereof in claims. These illustrative embodiments are disclosed in the accompanying drawing in which:

Fig. 1 is a diagrammatic representation of a section of railway track which is equipped with one preferred form of the approach control apparatus of my invention;

Fig. 2 is a similar showing of a modified form which my improved approach control equipment may take; and

Fig. 3 is a diagrammatic view of cut section facilities which are suitable for use with the approach control schemes of Figs. 1 and 2.

In the several views of the drawing like reference characters designate corresponding parts. Referring first to Fig. 1 the improved approach control apparatus of my invention is there disclosed in association with a coded track circuit system of automatic block signaling for a railway track 1—2 over which it will be assumed that traffic moves in the single direction indicated by the arrow, or from left to right in the diagram. The protected stretch of this track is divided into the customary successive sections by insulated rail joints 3 and the rails of each section form a part of a track circuit to which coded signal control energy is supplied in customary manner.

In Fig. 1, reference characters D and E respectively designate the entrance and the exit ends of one of these track sections which is illustratively shown as being a full signal block in length; character TR designates a code following track relay which is installed at the entrance of each of the sections and operated by energy received from the rails thereof; character TB a track battery or other direct current source provided at the section exit for the purpose of supplying these rails with the relay operating energy just referred to; character CR a coding device having a contact 5 which codes this energy by periodically interrupting the rail supply circuit; and character S the usual wayside signal which guards the entrance of each of the track blocks and which is controlled by the associated track relay TR through the medium of decoding apparatus 10.

The referred to coded track circuit system of automatic block signaling operates without the aid of line wires and includes all of the elements above named. Further comprised by the system are the customary facilities (not shown) for continuously operating each of the exit end relays CR at one or another of the usual plurality of distinctive code rates. Selection among these rates (which in a typical three indication system may consist of 75 and 180 energy pulses per minute) is made in accordance with advance traffic conditions by the decoding apparatus 10 functioning in customary manner.

This decoding apparatus (details not shown)

is controlled in the usual fashion by the associated track relay TR and it performs the further function of selectively setting up a lighting circuit for one or another of the lamps (G, Y and R in the typical three indication system above referred to) of the wayside signal S at the same location. In the arrangement represented, these signal lamps derive energizing current from a power source which is designated by the terminals "plus" and "minus".

For applications in which train carried cab signals (not shown) also are to be controlled, the representative coded track circuit signaling facilities still further include means at the exit end of each track section for additionally supplying the rails thereof with coded alternating current energy. In the form shown at location E in Fig. 1, these means include a track transformer TT having a secondary winding which is connected with the track rails over coding contact 5 of device CR during each "energy on" period of the signal control code (from battery TB) and a primary winding which at proper times is energized over a conductor 7 from a suitable alternating current source designated by the terminals B and C.

In order that certain functions of the signaling system may be rendered active only upon the approach of a train, the apparatus installed at each of the signal locations D, E, etc., is supplemented by an approach relay AR which is arranged to maintain the referred to functions inactive at all times except when the section of track to the rear of the location becomes occupied. In the illustrative arrangement which is shown at location E in Fig. 1, these approach controlled functions consist in lighting the wayside signal S (normally dark) and in supplying the rails of the track section to the rear of that signal with alternating current energy for cab signal control.

The former function is governed by a contact 9 of the approach relay AR and the latter by a companion contact 11 thereof. As arranged in Fig. 1, contact 11 further acts to short circuit the primary winding of the transformer TT and thus reduces the impedance which is introduced into the rail supply circuit by the secondary winding of that transformer when the track section D—E is vacant. Either of the functions just referred to may, of course, be controlled individually by the approach relay AR and it will be apparent, moreover, that signaling functions other than or in addition to the ones named may likewise be governed by the same relay.

When applied to coded signaling systems of the conventional character just considered, the improved approach control apparatus herein disclosed renders the relay AR at each signal location responsive to the approach of a train and does this, moreover, without the use of control line wires.

For each of the signal block lengths of the track 1—2 my improved apparatus comprises: (1) entrance end facilities which supply the rails of that block with pulses of auxiliary energy which are in step with recurring periods of the main track circuit code and (2) exit end facilities which receive these auxiliary pulses from the rails and energize the approach relay AR in step with them.

In the form shown at location D in Fig. 1, my improved entrance end facilities include an impulse transformer IT which is connected in energy supplying relation with the rails 1 and 2 of the track section D—E, a direct current source

of auxiliary energy represented as a battery AB, and a circuit through which this source supplies exciting current to the transformer IT under the control of a contact 12 of the associated code following track relay TR.

In the form shown at location E in Fig. 1, my improved exit end facilities include means for connecting the winding of the approach relay AR in energy receiving relation with the rails 1 and 2 of the track section D—E during each "off" period of the main track circuit code and means for making this relay AR sufficiently slow releasing to bridge the intervals between successive connections thereof with the track rails.

Considering first the entrance end facilities at location D, the contact 12 of the code following track relay TR is arranged to pole change the primary supply circuit for the impulse transformer IT in the customary manner. That is, each time that the relay TR becomes energized, this contact causes current to flow in one direction through one portion of the transformer primary (by way of a circuit which extends from the positive terminal of supply battery AB through conductor 14, the left half of the transformer winding, conductor 15, and front contact 12 back to the negative terminal of the supply battery) and each time that the relay becomes deenergized, the contact causes current to flow in the opposite direction through another portion of the winding (by way of a circuit which includes the right winding half and a conductor 16).

As long as relay TR follows code, the just described pole changing action causes an output alternating current voltage of code pulse frequency to be induced in the secondary winding of transformer IT. The polarity of the half wave of this output voltage which accompanies each releasing action of relay TR is indicated by the small arrow above the transformer and the polarity which accompanies each pick-up operation of the track relay is, of course, of opposite sign. To aid explanation the arrow designated polarity will be referred to as "positive" and the opposite polarity as "negative."

The connection of the impulse transformer IT with the track rails 1 and 2 is such that the positive half cycles of its output voltage (see arrow) tend to make rail 2 positive with respect to rail 1 while the negative half cycles make rail 1 positive with respect to rail 2. This relation coordinates with the poling of the track battery TB at location E which is such that each pulse of energy supplied thereby over the contact 5 of coding device CR makes rail 1 positive with respect to rail 2 and thus supplies the track relay TR at location D with energy which is effective to operate it.

During the "on" periods of the signal control code, the winding of this relay receives not only the usual pick up energy from the track battery TB but also aiding energy from the impulse transformer IT. This aiding energy is due to the negative half cycle of transformer output voltage which is produced upon each pick up operation of the track relay and its effect is to make the pick up action stronger and more certain.

In order that the "off" period or positive half cycles of output voltage of transformer IT will not interfere with the released condition of the track relay TR which accompanies each signal control code "off" period, a rectifier 18 is included in the winding supply circuit for that relay. While not interfering with the supply of energy to the relay when track rail 1 is positive with re-

spect to rail 2 this rectifier blocks off all reverse flow of current such as the positive half cycles of the output voltage of transformer IT tend to produce. This permits the relay TR to be of the represented single element non-polarized design. Were the rectifier 18 to be omitted it would be necessary to resort to a track relay of a polarized type such as is represented at TR in Fig. 2.

Considering next the exit end facilities at location E in Fig. 1, coding contact 5 of device CR is arranged to connect the winding of the approach relay AR in energy receiving relation with the track rails 1 and 2 during each "off" period of the signal control code and to interrupt this connection during each "on" period of that code. In consequence, the approach relay winding is connected with the rails only when the impulse transformer IT at the entrance end of the section is supplying a positive half cycle of output voltage to them. This action of the contact 5 thus is a rectifying one and it permits a direct current relay to be operated from alternating current track circuit energy of the referred to code pulse frequency.

The slow release characteristics mentioned previously in connection with the approach relay AR may be imparted to that relay in any one of a number of well known manners, such as by the use of a rectifier or other snubbing element bridged across the relay winding as shown at 20 in Fig. 1. This element is so proportioned that it delays the release of the relay contacts for a time which is sufficient to bridge the spacing between consecutive pulses of auxiliary energy which are received from transformer IT at the lowest of the several signal control codes which contact 5 of device CR produces during operation of the signaling system. With an arrangement of the type represented, each individual pulse of the thus received auxiliary energy is effective to pick up the contacts of relay AR. Once picked up, however, these contacts so remain as long as the pulses of the auxiliary energy continue to be received at code spaced intervals.

In operation of the complete approach control system of Fig. 1, the track rails 1 and 2 of section D—E act in the usual manner to transmit energy from one end of the section to the other as long as the section remains unoccupied. Each time, under such conditions, that contact 5 of the coding device CR is in the uppermost or "on" code period position, the track battery TB picks up the track relay TR over a circuit which may be traced from the positive terminal of the battery TB through a current limiting impedance 22, front contact 5 of device CR, conductor 23, track rail 1, conductor 24, the winding of relay TR, rectifier 18, conductor 25, track rail 2, conductor 26, an impedance 27, and the secondary of transformer TT back to the negative terminal of the track battery.

Each time that the coding contact 5 occupies the lowermost or "off" code period position, the track relay TR releases and contact 12 thereof so acts in the exciting circuit of the impulse transformer IT as to cause a positive pulse (see the small arrow) of output voltage to be induced in the secondary of that transformer. This positive pulse energizes the approach relay AR at the exit location E over a circuit which extends from the left terminal of the secondary winding of transformer IT through conductors 28 and 29, track rail 2, conductor 26, the winding of relay AR, conductor 29, back contact 5 of coding device CR, conductor 23, track rail 1, and conduc-

tors 24 and 30 back to the right terminal of the transformer secondary.

These recurring code step pulses of auxiliary energy cause the slow release approach relay to hold its contacts 9 and 11 continuously picked up, thereby maintaining the wayside signal Se and the track transformer TT at location E deenergized as long as the track section D—E remains vacant.

Assume, now, that a train comes into the track section D—E. The usual shunting action of its wheels and axles cuts off the transmission over the rails 1 and 2 of auxiliary energy to the approach relay AR. Now continuously deenergized, that relay releases and contacts 9 and 11 thereof complete the energizing circuits for signal Se and transformer TT at location E.

In consequence, the named wayside signal lights the particular lamp selected by the decoding equipment 10 and the transformer TT supplies the track rails with a pulse of alternating current energy from source B—C each time that the contact 5 of coding device CR occupies its uppermost position. This energy is, as has been mentioned, suitable for the control of train current cab signals and the circuit over which it is fed into the rails may be traced from the right terminal of the secondary winding of transformer TT through battery TB, impedance 22, front contact 5 of device CR, conductor 23, track rail 1, the wheels and axles (not shown) of the train, track rail 2, conductor 26 and impedance 27 back to the left terminal of the transformer secondary.

As soon as the rear of the departing train clears location E, the track circuit again transmits coded direct current energy to the track relay TR at location D; contact 12 of that relay once more pole changes the supply circuit for the impulse transformer IT; it again supplies the track rails with alternating current energy of code pulse frequency; these rails transmit this auxiliary energy forwardly to location E; and the there located approach relay AR receives the positive pulses thereof over coding contact 5 of device CR. In again picking up, contacts 9 and 11 of relay AR restore the associated wayside signal Se and the cab signal supply transformer TT to their normally inactive state.

A very practical advantage of my improved auxiliary energy supply facilities of Fig. 1 is that they operate to counteract the effects of track storage energy. Such energy tends to accumulate in the rails and ballast of each of the signaling system track circuits as a result of repeated application thereto of direct current code pulses from the track battery TB. In the absence of some counteracting influence, difficulty in operating the code following track relay TR is likely to be encountered due to a build up between the rails 1 and 2 of track storage voltage which, over a period of time, may become sufficient to prevent relay TR from releasing during the "off" code periods.

As has been seen, the polarity of the auxiliary energy which transformer IT supplies during these "off" periods is such as to make rail 2 positive with respect to rail 1. This being opposite to the polarity of the "on" period or signal control energy from the track battery TB (which makes rail 1 positive with respect to rail 2), the usual tendency for the track circuit to accumulate the storage energy above described is directly neutralized by the "off" period auxiliary energy

mentioned. In systems of the type herein disclosed in which it is not permissible to short circuit the rails 1 and 2 during the "off" periods of the signal control code, this "bucking" action greatly aids in keeping the track storage potential below an objectionable value.

Referring now to Fig. 2 I have there represented the improved approach control facilities of my invention in a somewhat modified form. Considering first the entrance end facilities at location D, these differ from those shown in Fig. 1 in that the code following track relay is of the direct current polarized type shown at TR1 and the impulse transformer IT1 introduces its output energy into the track rails 1 and 2 over a circuit which includes a serial connection of the operating winding of the track relay. In addition, the auxiliary battery AB supplies the primary winding of the transformer with current which flows in only one direction and over a circuit which includes a polar contact 32 of the track relay.

The polar track relay TR1 is arranged to move this contact 32 to the right position (shown heavy) each time that the track rails 1 and 2 supply the relay with a pulse of track battery voltage of the normal polarity (track rail 1 positive and rail 2 negative). When, however, the relay is deenergized or should it receive energy of the opposite polarity this contact 32 occupies the left position (shown dotted).

When in its right or "energy on" position this track relay contact completes for the impulse transformer IT1 an energizing circuit which may be traced from the positive terminal of the auxiliary battery AB through conductor 34, the primary winding of the transformer, conductor 35, contact 32 of relay TR and conductor 36 back to the negative terminal of the battery AB. Each time that the contact shifts to the left or "energy off" position, it interrupts this circuit and thus allows the transformer flux to collapse and induce in the transformer secondary a pulse of output voltage having the polarity represented by the small arrow. It will be noted that this is opposite to that of the normal track circuit energy to which the polar relay TR1 is designed to respond and as the resulting current circulates in the reverse direction through the winding of this relay no false response is thereby produced.

In the manner just explained the impulse transformer IT1 supplies the rails 1 and 2 of the track section D-E with a pulse of auxiliary energy at the beginning of each of the "off" periods of the main track circuit code and these rails, in turn, transmit the auxiliary energy forwardly to the exit end location E as long as the section remains vacant.

Considering now the facilities which are represented at this exit location E of Fig. 2, these are generally equivalent to the corresponding facilities which have been described in connection with Fig. 1. They differ, however, in that a sensitive code following detector relay KR is interposed between the track rails and the slow release approach relay AR as disclosed and claimed by a copending application Serial No. 221,317 filed July 26, 1938 by Edward U. Thomas. The function of this relay KR is to increase the sensitivity of the exit end apparatus, thereby enabling the approach relay to respond to comparatively weak pulses of auxiliary energy which may be received from the track circuit.

From a comparison of the diagrams of Figs. 1 and 2 it will be seen that the winding of detector

relay KR of Fig. 2 is connected by coding contact 5 with the track rails 1 and 2 during each "off" period of the main track circuit code in the same manner as is the winding of relay AR in Fig. 1. Instead of being slow releasing, however, this interposed detector relay is quick acting in both the pick up and the drop out directions and in consequence its contact 38 picks up upon the occasion and for the duration of each of the pulses of auxiliary energy which the winding of the relay receives from the impulse transformer IT1 at the entrance end of the section. Between pulses, of course, relay KR releases in the usual code following manner.

Controlled by this contact 38 of relay KR is an energizing circuit for the winding of the associated approach relay AR which circuit is shown as being identified with local power supply terminals "plus" and "minus". With the arrangement shown the recurring auxiliary energy pulses from the impulse transformer IT1 cause the local source just referred to, to supply similarly timed pulses of energizing current to the relay AR.

As in the case of Fig. 1, this approach relay AR is provided with a pair of contacts 9 and 11 which control the energizing circuits for the associated wayside signal S and the track transformer TT. As in the case of Fig. 1, also, the relay AR has slow releasing characteristics imparted thereto by any suitable means as the use of a bridging rectifier 20 or other snubbing element. This element may, of course, be replaced by internal design expedients (not shown) which produce a comparable effect.

In operation of the complete approach control system of Fig. 2, each time, under vacant conditions of track section D-E, that contact 5 of the coding device CR is in the uppermost or "on" period position, the track battery TB picks up the track relay TR over a circuit which may be traced from the positive terminal of the battery TB through impedance 22, front contact 5 of device CR, conductor 23, track rail 1, conductor 24, the winding of relay TR1, conductor 40, the secondary winding of impulse transformer IT1, conductor 25, track rail 2, conductor 26, impedance 27 and the secondary of transformer TT back to the negative terminal of the track battery. When relay TR is thus picked up, the exciting circuit for the impulse transformer IT1 is completed at contact 32.

Each time that the coding contact 5 occupies the lowermost or "off" period position, the track relay TR releases and contact 32 thereof interrupts the exciting circuit just referred to. This causes the transformer IT1 to supply the track rails 1 and 2 with a pulse of auxiliary energy which picks up the detector relay KR over a circuit extending from the lower terminal of the transformer secondary through conductor 40, the winding of track relay TR1, conductor 24, track rail 1, conductor 23, back contact 5 of coding device CR, conductor 29, the winding of relay KR, conductor 26, track rail 2, and conductor 25 back to the upper terminal of the secondary winding of transformer IT1. As the polarity of this auxiliary energy is opposite to that of the normal signal control energy from battery TB, the polarized track relay TR1 does not falsely respond thereto during the "off" periods of the signal control code.

In receiving these code step pulses of this auxiliary energy, the detector relay KR at the section exit responds to them in code following manner. Each time that contact 38 of this relay

picks up in response to one of these received pulses it energizes the slow release approach relay AR over a circuit which extends from the positive terminal of the local source, through front contact 38, conductor 42 and the winding of relay AR back to the negative terminal of the local source.

As long as this recurrent energization of the slow release approach relay AR continues, the relay holds its contacts 9 and 11 continuously picked up. In this manner the signal Se and the track transformer TT at location E are maintained in their normally inactive condition as long as the track section D—E remains vacant.

In the event that a train comes into this section D—E the usual shunting action of its wheels and axles cuts off the transmission both of the coded signal control energy and also of the return approach or auxiliary energy. In consequence relay KR continuously releases and the approach relay AR becomes continuously deenergized. In now releasing, contacts 9 and 11 thereof light the associated wayside signal Se and supply the track circuit with coded alternating current for cab signal control.

As soon as the rear of the departing train clears location E, rails 1 and 2 again transmit coded direct current energy to the track relay TR1. In responding thereto, that relay causes the impulse transformer IT1 again to generate a pulse of auxiliary energy at the beginning of each of the "off" code periods. The rails once more transmit this auxiliary energy forwardly to the exit end of the section, code following detector relay KR there responds, contact 34 thereof periodically completes the energizing circuit for the slow release approach relay AR and it, in turn, picks up to restore the associated wayside signal and alternating current track circuit supply facilities to their normally inactive condition.

Referring now to Fig. 3 I have there represented cut section facilities suitable for use with the approach control system of Fig. 2. Such facilities are required when the signal block length of track (such as D—E in Fig. 2) must be divided into two electrically separate track circuit sections. One point of such division is indicated at Da in Fig. 3.

The apparatus which I have there represented combines features of both the entrance end and the exit end facilities of Fig. 2. This apparatus performs three functions. First, it repeats around the insulating joints 3 and into the rails 1 and 2 of the rear track section the direct current pulses of coded energy which are received from the rails of the forward section. Second, it supplements these repeated pulses by an alternating current component suitable for cab signal control when a train comes into the rear section. And third, it repeats around the insulated joints 3 and into the rails 1 and 2 of the forward section, the pulses of auxiliary energy which the rails of the rear section transmit to the cut location from the impulse transformer IT1 (not shown) at the entrance of the rear section.

Aiding in all three of the named functions is a code following track relay TR2 which is operated by energy received from the forward section rails. This relay has the same response characteristics as does polar relay TR1 of Fig. 2 and differs therefrom only in being provided with second polar contacts 5a. This second contact is in addition to member 32 and corresponds to member 5 of coding device CR of Fig. 2. It serves to control the completion of a circuit through which a track

battery TB at the cut section supplies direct current energy to the rails of the rear track section.

During the "off" periods of the signal control code, moreover, this contact 5a connects the winding of a detector relay KR in energy receiving relation with the rear section rails.

As in the case of Fig. 2, this detector relay KR has a contact 38 which locally controls the energization of a slow release approach relay AR. This approach relay is provided with but one contact 11 which when released connects the primary winding of the track transformer TT with the alternating current source B—C and thereby causes the rear section rails also to receive coded alternating current suitable for cab signal control. The first named contact 32 of code following relay TR2 controls the exciting circuit for an impulse transformer IT1 in the same manner as in Fig. 2 and this transformer passes auxiliary energy from source AB into the forward section track circuit during each "off" period of the main signal control code.

In operation of the cut section facilities of Fig. 3, each pulse of coded energy received from the forward section operates relay TR2 and causes a corresponding energy pulse to be repeated from battery TB into the rear section rails over contact 5a in the right or "energy on" position. During each "off" period of this main code, contact 32 causes the impulse transformer IT1 to supply the forward section rails with a pulse of auxiliary energy of the character previously described in connection with Fig. 2. During these "off" periods also, contact 5a of relay TR2 connects the winding of relay KR in energy receiving relation with the rear section rails. In responding to auxiliary energy received therefrom this detector relay effects an in-step local energization of approach relay AR over contact 38. Being slow releasing, relay AR holds contact 11 continuously picked up and thereby deenergizes the primary of transformer TT.

The actions just described continue as long as both the forward and the rear track sections remain vacant. When a train comes into the rear section, relay KR becomes deenergized and causes relay AR to release contact 11 and thereby supply the rear section rails with alternating current energy suitable for cab signal control. As the train advances beyond location Ea into the forward section relay TR2 releases continuously and thus discontinues the supply of auxiliary energy pulses to the forward section.

When the rear of the departing train clears location Da the relay KR again receives auxiliary energy pulses from the rear track circuit over contact 5a now continuously in the left or energy "off" position and this causes relay AR to receive local energization to pick up contact 11 and discontinue the supply of cab signal energy. As the rear of the train clears the exit end of the forward section, relay TR2 again receives coded energy. In responding thereto, it repeats the pulses thereof into the rear section rails and causes the impulse transformer IT1 to supply the forward section with the auxiliary pulses for approach control.

In order to effect broken down insulated rail joint protection in conventional manner, the track circuits of either of the systems of Figs. 1 and 2 may have their polarities staggered without interfering with the operation of the approach control apparatus herein disclosed. One manner in which this staggering of adjacent track circuits may be carried out is shown in Fig. 3. There the track

circuit ahead of location Ea has a polarity of signal control energy which makes rail 1 positive with respect to rail 2 while the track circuit to the rear of the same that adjoins 3 has a polarity wherein rail 2 is positive with respect to rail 1.

From the foregoing it will be seen that I have provided improved facilities for systems of approach control wherein use is made of forwardly fed pulses of auxiliary energy supplied to the track circuit during the "off" periods of the main signal control code. When arranged in the manner of Fig. 1, the entrance end impulse transformer IT which generates these pulses supplies the full wave of code frequency alternating current output energy to the rails of the track circuit and the coding contact 5 of the device CR at the exit end performs a rectifying function by connecting the winding of the approach or receiving relay with the rails only during preselected half cycles of this auxiliary energy. This Fig. 1 arrangement also possesses the before explained advantage with respect to counteracting any track circuit storage action in that the voltage from the impulse transformer opposes the track circuit storage voltage each time that the code following track relay TR releases.

When arranged in the modified manner of Fig. 2, the impulse transformer IT₁ is found to offer some simplification in the entrance end facilities. Regarding the exit end facilities of Fig. 2, the interposition of the code following detector relay KR between the rails and the slow release approach relay AR is found substantially to increase the sensitivity of the approach control system and it thus reduces the intensity of the auxiliary energy which must be employed.

As shown in Fig. 3, I have still further provided cut section facilities which are suitable for use with approach control schemes of the improved class herein disclosed. As these schemes are entirely a function of the track circuit and apparatus which is directly associated therewith, all of the improvements which I have made therein are independent of the coding and decoding facilities of the coded signaling system and hence these improvements are usable with signaling systems which employ a wide variety of different types and forms of such facilities.

While I have explained my invention in applications wherein both the lights of the wayside signal and the supply of alternating current cab signal energy are approach controlled, it will be understood that either one of these functions may be performed separately and that other comparable functions may also be provided for.

Although I have herein shown and described only a few forms of approach control apparatus embodying my invention, it will be 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 section of track which forms a part of a railway signaling system of the coded track circuit class, approach control apparatus comprising an approach governing relay at the exit end of the section, a source of trackway energy also at said exit end, a coding contact which repeatedly connects the rails of said section first to said source and then to the winding of said relay, a code following track relay located at the entrance end of the

section and operated by energy received from said rails, a transformed also located at said entrance end and having an output winding connected with said rails, a direct current source of auxiliary energy, and a circuit controlled by said track relay for connecting said source with said transformer in such recurrent manner that during each of the "off" periods of the received trackway code that transformer is caused to generate an impulse of output energy which is transmitted over said rails to said exit end approach governing relay.

2. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway track of: (1) exit end facilities comprising means for supplying coded energy to the rails of the section, a traffic governing relay, and means for connecting the winding of said relay across said rails during each "off" period of the trackway code; and (2) entrance end facilities comprising a code following track relay operated by energy received from said section rails, a transformer connected in energy supplying relation with said rails, a direct current energizing circuit for said transformer, and a contact of said track relay included in said circuit and acting to control it in such manner that the transformer supplies the rails with a pulse of auxiliary energy during each of the "off" periods of the received trackway code.

3. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway track of means for supplying coded energy to the rails of said section, a traffic governing relay, means for connecting the winding of said relay in energy receiving relation with said rails during each "off" period of the trackway code, a code following track relay operated by energy received from said rails, a transformer connected in energy supplying relation with the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said circuit and acting to control it in such manner that the transformer supplies the rails with a pulse of auxiliary energy during each of the "off" periods of the received trackway code, and means for preventing said track relay from responding to said auxiliary energy pulses.

4. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway track of means for supplying coded energy to the rails of said section, a code following track relay operated by energy received from said rails, a transformer connected in energy supplying relation with the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said circuit and acting to control it in such manner that the transformer supplies the rails with a pulse of auxiliary energy during each of the "off" periods of the received trackway code, means for rendering said track relay unresponsive to said auxiliary energy pulses, an approach governing relay excited by the said "off" period pulses of auxiliary energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

5. For use with a section of railway track which is included in the signaling system of the coded

track circuit class, approach control apparatus comprising a slow release approach relay at the exit end of the section, a source of trackway energy also at said exit end, a coding contact which repeatedly connects the rails of said section first to said source and then to the winding of said approach relay, a code following track relay connected with said rails at the entrance end of the section, a transformer also located at said entrance end and having an output winding connected across said rails, a direct current source of auxiliary energy, and a circuit connecting said direct current source with said transformer over a front contact of said track relay.

6. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway track of: (1) exit end facilities comprising means for supplying coded energy to the rails of the section, an approach relay having slow release characteristics, and means for connecting the winding of said relay across said rails during each "off" period of the trackway code; and (2) entrance end facilities comprising a code following track relay operated by energy received from said section rails, a transformer having an output winding connected across said rails, a direct current energizing circuit for said transformer, and a contact of said track relay included in said circuit and acting to control it in such manner that the transformer supplies the rails with a pulse of auxiliary energy during each "off" period of the received trackway code.

7. In combination, a section of railway track, means for supplying coded energy to the rails of said section, a code following track relay which is capable of responding to said coded energy, a circuit including a rectifier for connecting the operating winding of said relay across said rails in such manner that the winding receives such coded energy from the rails, a transformer, a circuit for connecting the output winding of said transformer across the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said energizing circuit and acting to control it in such manner that during each "off" period of the received trackway code the transformer is caused to supply the rails with a pulse of auxiliary energy of polarity which is opposite to that for which said rectifier is poled, an approach governing relay excited by the said "off" period pulses of auxiliary energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

8. In combination with a section of railway track, means for supplying coded energy to the rails of said section, a code following track relay operated by energy received from said rails, a transformer connected across the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said circuit and acting to control it in such manner that the transformer produces an output voltage having one polarity during each "on" period of the received trackway code and the opposite polarity during each "off" period of that code, a rectifier including in the winding supply circuit for said track relay and poled to prevent said opposite polarity transformer energy from reaching that relay, an approach governing relay excited by the said "off" period pulses of oppo-

site polarity energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

9. In combination with a section of railway track, means for supplying the rails of said section with coded direct current energy of a given polarity, a code following track relay operated by said given polarity energy received from said rails, a transformer connected across the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said circuit and acting to control it in such manner that the transformer produces an output voltage having the said given polarity during each "on" period of the received trackway code and having the opposite polarity during each "off" period of that code, means for preventing said track relay from responding to said opposite polarity energy, an approach governing relay excited by the said "off" period pulses of opposite polarity energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

10. In combination with a section of railway track, means for supplying the rails of said section with coded direct current energy of a given polarity, a code following track relay operated by said given polarity energy received from said rails, a transformer connected across the section rails, a direct current energizing circuit for said transformer, a contact of said track relay included in said circuit and acting to control it in such manner that the transformer produces an output voltage having the said given polarity during each "on" period of the received trackway code and having the opposite polarity during each "off" period of that code, an approach governing relay excited by the said "off" period pulses of opposite polarity energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

11. For use with a section of railway track which is included in a signaling system of the coded track circuit class, approach control apparatus comprising a code following detector relay at the exit end of the section, a source of trackway energy also at said exit end, a coding contact which repeatedly connects the rails of said section first to said source and then to the winding of said detector relay, a slow release approach relay located at said exit end also and energized in step with the responses of said receiver relay, a code following track relay located at the entrance end of the section and operated by energy received from said rails, a transformer also located at said entrance end and having an output winding connected with said rails, a direct current source of auxiliary energy, and a circuit connecting said source with said transformer over a front track contact of said track relay.

12. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway

track of: (1) exit end facilities comprising means for supplying coded energy to the rails of the section, a detector relay of the code following type, means for connecting the winding of said relay across said rails during each "off" period of said trackway code, a slow release approach relay, and means for energizing the winding of said approach relay in step with the responses of said detector relay; and (2) entrance end facilities comprising a code following track relay operated by energy received from said section rails, a transformer connected in energy supplying relation with said rails, a direct current energizing circuit for said transformer, and a contact of said track relay included in said circuit and acting to control it in such manner that the transformer supplies the rails with a pulse of auxiliary energy during each of the said "off" periods of the received trackway code.

13. In combination, a section of railway track, means for supplying coded energy to the rails of said section, a code following track relay which is capable of responding to said coded energy, a transformer, a circuit connecting the output winding of said transformer and the operating winding of said relay in series across the rails of said track section and serving to transmit said coded energy to said winding, a direct current energizing circuit for said transformer, a contact of said track relay included in said energizing circuit and acting to control it in such manner that during each "off" period of the received trackway code the transformer is caused to supply a pulse of auxiliary energy to said rails, an approach governing relay excited by the said "off" period pulses of auxiliary energy that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

14. In combination with a section of railway track, means for supplying coded energy to the rails of said section, a code following track relay operated by energy received from said rails, a transformer connected in energy supplying relation with the section rails by way of a circuit which serially includes the operating winding of said relay and the output winding of the transformer, a direct current energizing circuit for said transformer, a contact of said track relay included in said energizing circuit and acting to control it in such manner that the transformer produces a pulse of output voltage during each "off" period of the received trackway code, an approach governing relay excited by the said "off" period pulses of transformer output voltage that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

15. In combination with a section of railway track, means for supplying the rails of said section with coded direct current energy of a given polarity, a code following track relay which is responsive to energy of said given polarity and unresponsive to energy of the opposite polarity, a transformer, a circuit connecting the output winding of said transformer and the operating winding of said relay in series across the rails of said track section and serving to transmit said coded energy to said winding, a direct current

energizing circuit for said transformer, a contact of said track relay included in said energizing circuit and acting to control it in such manner that during each "off" period of the received trackway code the transformer produces a pulse of output voltage which is transmitted to said rails and which reacts upon said track relay in said opposite polarity manner, an approach governing relay excited by the said "off" period pulses of transformer output voltage that are transmitted over said rails under vacant conditions of said section, and traffic governing apparatus controlled by said approach governing relay and rendered active when that relay becomes continuously deenergized in response to the presence of a train in said section.

16. In a railway signaling system which includes a section of track to the rails of which coded track circuit energy is supplied over a continuously operating coding contact at the section exit and from the said rails of which operating energy is received by a code following track relay at the section entrance, the combination of means controlled by said track relay for supplying said rails with a pulse of auxiliary energy during each "off" period of the received track circuit code, a code following detector relay located at the section exit and being capable of responding to said auxiliary energy, a circuit controlled by said coding contact for connecting said detector relay in energy receiving relation with said rails during each of said "off" code periods, a slow release approach relay energized in step with the responses of said detector relay, and traffic controlling apparatus governed by said approach relay and rendered inactive as long as that relay is picked up.

17. In a system for approach controlling a signaling function by the use of rail transmitted energy, the combination with a section of railway track comprising means including a coding contact for supplying coded energy to the rails of the section at the exit end thereof, a detector relay of the code following type also at said section exit, means controlled by said coding contact for connecting the winding of said relay across said rails during each "off" period of the trackway code, means for supplying said rails with auxiliary energy which is effective to pick up said detector relay, a slow release approach relay likewise at said section exit, means for energizing the winding of said approach relay in step with the response of said detector relay, and traffic controlling apparatus governed by said approach relay and rendered inactive as long as that relay is picked up.

18. In combination with adjoining forward and rear sections of railway track, a code following track relay connected in energy receiving relation with the rails of said forward section, a transformer connected in energy supplying relation with said rails and energized over a direct current circuit which includes a front contact of said track relay, a source of energy for said rear track section, a code following detector relay, a circuit completed over a front contact of said track relay for connecting the rails of said rear section to said energy source, and a circuit completed over a back contact of said track relay for connecting said rear section rails to the winding of said detector relay.

19. In combination with adjoining forward and rear sections of railway track, a code following track relay connected in energy receiving relation with the rails of said forward section, a trans-

former connected in energy supplying relation with said rails and energized over a direct current circuit which includes a front contact of said track relay, a source of energy for said rear track section, a code following detector relay, a circuit 5 completed over a front contact of said track relay for connecting the rails of said rear section to said energy source, a circuit completed over a back contact of said track relay for connecting said rear section rails to the winding of said detector relay, and a slow release approach relay energized in step with the responses of said de- 5 tector relay.

CHARLES B. SHIELDS.

CERTIFICATE OF CORRECTION.

Patent No. 2,184,877.

December 26, 1939.

CHARLES B. SHIELDS.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, second column, line 2, claim 1, for the word "transformed" read transformer; page 7, first column, line 40, claim 7, for "the winding receives such" read that winding receives said"; line 71, claim 8, for "including" read included; page 8, second column, line 41, claim 17, for "comprising" read of; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of January, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)