Nov. 19, 1935. R. R. KEMMERER ET AL 2,021,654

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed June 22, 1934 2 Sheets-Sheet 1

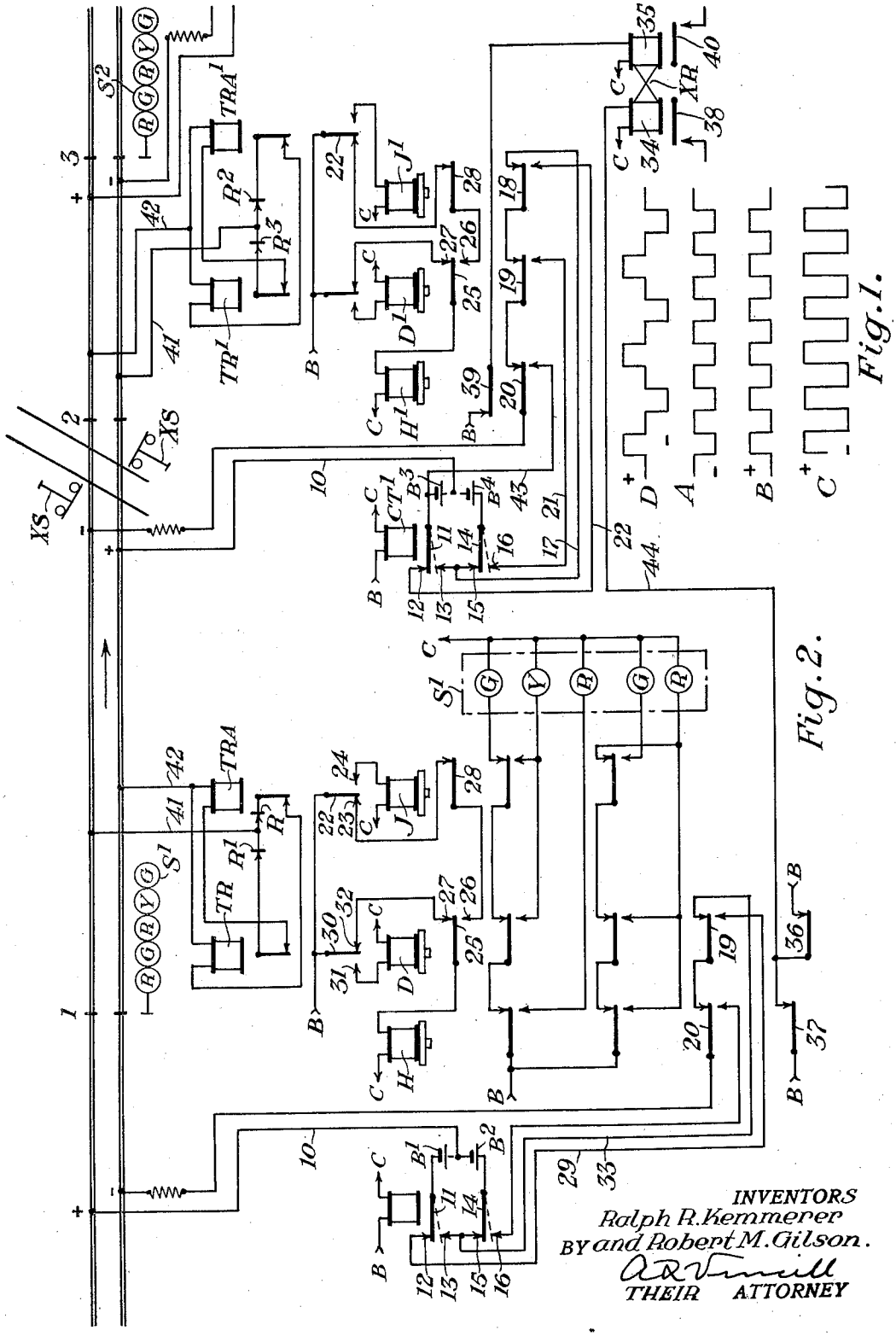


Fig. 1.

Fig. 2.

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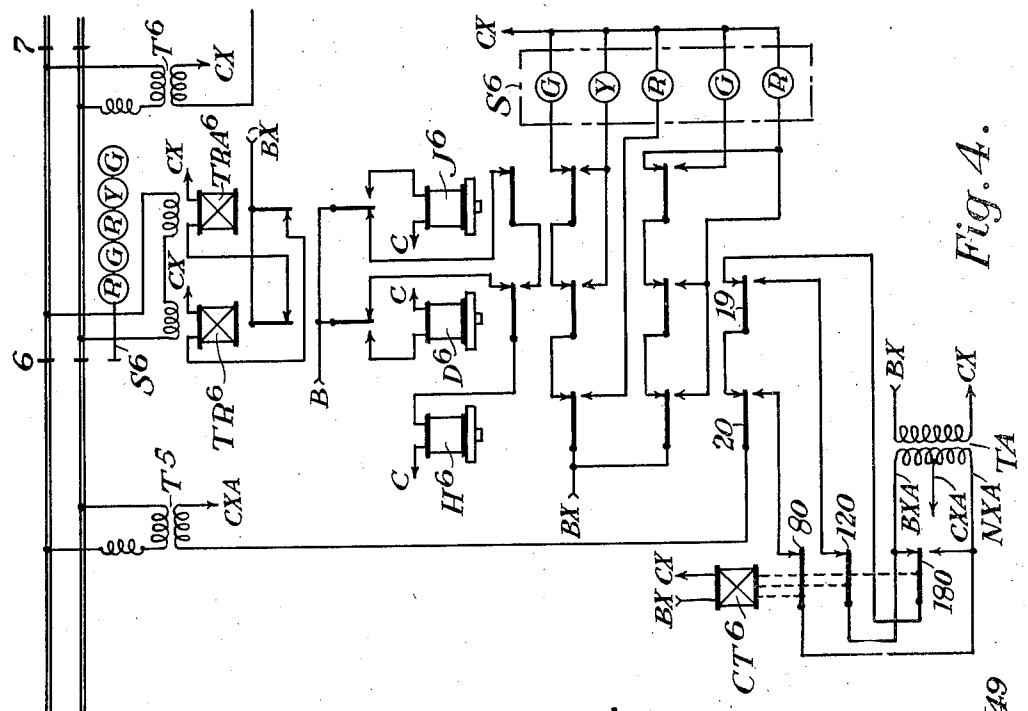


Fig. 4.

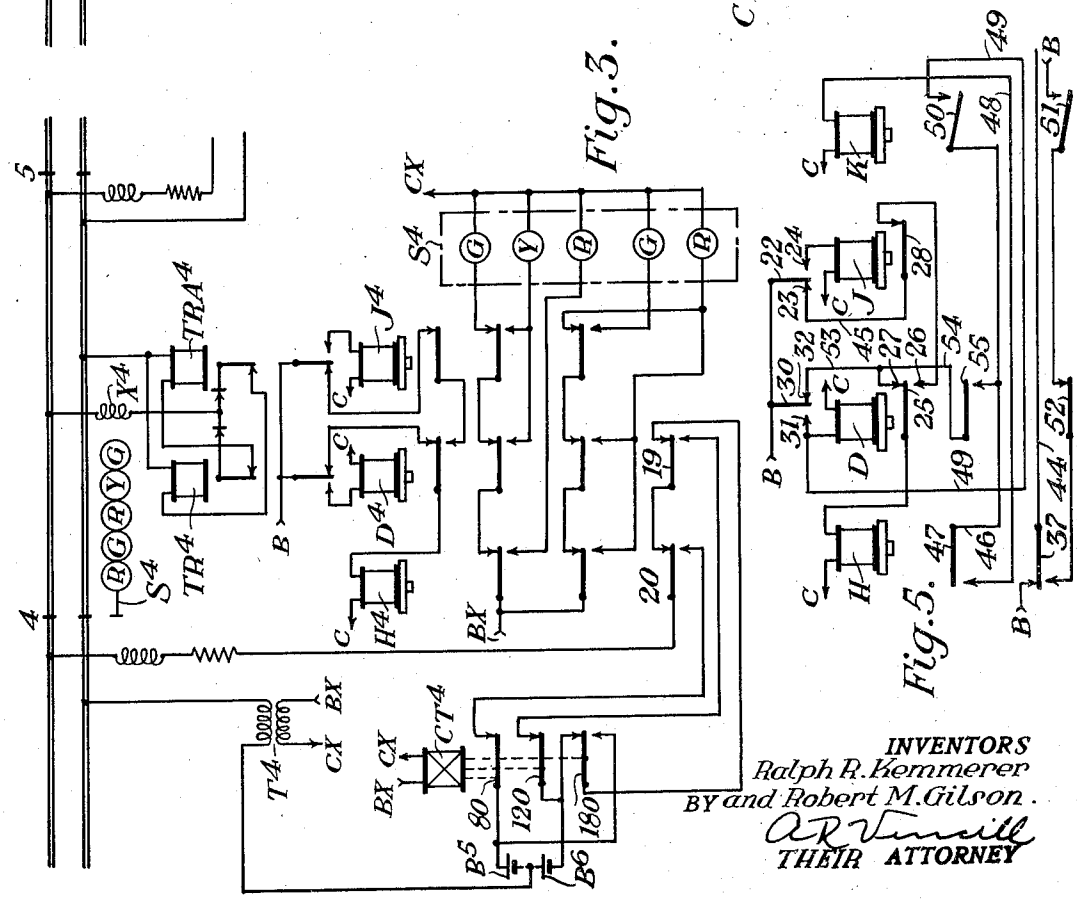


Fig. 3.

Fig. 5.

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Patented Nov. 19, 1935 2,021,654

UNITED STATES PATENT OFFICE

2,021,654

RAILWAY TRAFFIC CONTROLLING APPARATUS

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Application June 22, 1934, Serial No. 731,900

16 Claims. (Cl. 246—45)

Our invention relates to railway traffic controlling apparatus, and more specifically to apparatus for providing control of signals in a wayside and/or cab signaling system without the use of control line wires. Our invention also relates to the provision of track circuit detection for the control of highway crossing signals or other apparatus in a system of the above character.

We will describe several forms of railway traffic controlling apparatus embodying our invention, and will then point out the novel features thereof in claims.

Referring to the drawings, Fig. 1 is a diagrammatic view showing some codes which may be used to control the apparatus embodying our invention. Fig. 2 is a diagrammatic view showing one form of apparatus embodying our invention, adapted for operation on direct current codes, and including a cut section which may be used for controlling highway crossing signals. Fig. 3 is a diagrammatic view showing a modification of a portion of the apparatus of Fig. 2, also embodying our invention, in which alternating current codes for cab signal control may be superimposed upon the direct current codes used for the control of wayside signals. Fig. 4 is a diagrammatic view showing a further modification of the apparatus of Fig. 2, and also embodying our invention, in which alternating current codes are used throughout for signal control. Fig. 5 is a diagrammatic view showing a modified form of a portion of the apparatus illustrated in Fig. 2.

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

Referring to Fig. 1, the three codes illustrated diagrammatically therein comprise periodically interrupted current which may be either direct or alternating in character, according as it is desired to use track circuits and track relays of the direct current or alternating current type. Code A consists of periodically interrupted current of negative relative polarity; code B consists of periodically interrupted current of positive relative polarity; and code C consists of periodically interrupted current in which positive and negative code impulses are alternated, that is, code C comprises periodically pole-changed current. These codes are used for providing distinctive signal indications in a manner which will be clear from the description of the remaining figures of the drawings.

Referring now to Fig. 2, we have shown a stretch of track divided into sections 1—2 and 2—3, in which traffic normally moves from left to right, in the direction of the arrow. At location 2, the track is intersected by a highway, the intersection being protected by highway crossing signals XS. As determined by traffic conditions in advance, section 1—2 may be supplied with rail current of any one of the three codes illustrated in Fig. 1. The rail current is supplied from a battery group B^3—B^4 having its mid-point connected to one rail of the track, by a wire 10. The plus and minus terminals of the battery group are connected to contact fingers 11 and 14, respectively, of a constantly operating code transmitter CT^1. Code transmitter CT^1 alternately closes contacts 11—12 and 11—13, as well as contacts 14—15 and 14—16, and is shown supplying rail current in accordance with code C to section 1—2, over wire 17 and the front points of contacts 18, 19, and 20 of the decoding relays J^1, D^1, and H^1, respectively. Current of code A is supplied over wire 21, the back point of contact 19 and the front point of contact 20, under certain traffic conditions; whereas current of code B is supplied over wire 22, the back point of contact 18, and the front points of contacts 19 and 20, under certain other traffic conditions.

Section 1—2 is provided with a pair of two-position track relays TR and TRA which are polarized in such a manner as to operate from a deenergized position to an energized position only if current of the proper polarity is applied thereto, and to return to the deenergized position when current is removed therefrom. Any suitable polar relay having an armature biased to a deenergized position in the absence of current may be used. The track relays TR and TRA are so arranged that one relay will follow only the positive code impulses, whereas the other relay will follow only the negative code impulses. The purpose served by rectifiers R and R^1 is to block current of the undesired polarity from one or the other track relay, thereby decreasing the load on the track battery B^3—B^4.

Relays TR and TRA are sufficiently quick acting to follow the impulses of codes A, B, and C. Operated by the track relays TR and TRA is a group of decoding relays H, D, and J, which control the indications of a signal S^1; govern the supply of code current to the section in the rear of section 1—2; and also initiate the operation of the highway crossing apparatus at location 2.

When code A, which comprises negative current impulses, is supplied to section 1—2, relay TRA will operate, alternately opening contact 22—23 and closing contact 22—24, whereupon relay J will pick up. Each time that contact 22—24 closes, relay J will receive an impulse of

current to maintain this relay in the energized position. Relay TR will, of course, be deenergized. Consequently, relay D will remain deenergized, so that back contact 25—26 will be closed. Therefore, relay H will pick up and will be maintained energized due to the current impulses which it receives over the periodically closed contact 22—23 of relay TRA, front contact 28 of relay J, and back contact 25—26 of relay D. With relays J and H energized and relay D deenergized, signal S^1 will provide the Y/R indication, showing that the section immediately in advance of location 3 is occupied, which means that one block in advance of signal S^1 is clear. Code B will, therefore, be supplied to the section immediately in the rear of location 1, over wire 29, the back point of contact 19 of relay D, and the front point of contact 20 of relay H. It will be understood that relays J, D and H are sufficiently slow acting to bridge the operation of relays TRA and TR on code.

When the train clears the block which begins at location 3, code B comprising positive current impulses will be supplied to section 1—2, so that relay TR will now become operated, and relay TRA will be deenergized. The periodic closing of contact 30—31 will cause relay D to become energized, whereupon front contact 25—27 will close, and relay H will be maintained energized over the periodically closed contact 30—32 of relay TR, and front contact 25—27 of relay D. Relay J will, of course, be deenergized since relay TRA is not following code. Signal S^1 will now indicate Y/G showing that two blocks in advance of signal S^1 are clear. The section in the rear of block 1—3 will receive code C, over wire 33 and the front points of contacts 19 and 20 of relays D and H, respectively.

When more than two blocks in advance of signal S^1 are clear, section 1—2 will receive code C comprising periodically pole-changed current so that both relays TR and TRA will follow code, whereupon all three relays J, D, and H will be energized, and signals S^1 will indicate G/R, or "clear." From the above description, it will be understood that the relays J, D, and H reflect the condition of traffic in advance of signal S^1, in accordance with the code received by section 1—2.

Since sections 1—2 and 2—3 are cut sections of the block 1—3, it follows that whenever block 1—3 is unoccupied, both sections 1—2 and 2—3 will receive the same code. That is, when section 2—3 receives code C, for example, this code will be repeated into section 1—2 through the selective operation of relays H^1, D^1, and J^1; and similarly for codes A and B. Since the polarities of adjoining track circuits are staggered for the purpose of improving the broken down rail joint protection, it is necessary to reverse the track leads 41 and 42 of alternate track relay groups in order that the TRA relays will always operate on current of negative relative polarity, and the TR relays on current of positive relative polarity. This procedure makes possible a uniform arrangement of the H, D, and J decoding relays. Obviously, by interchanging relays TR and TRA, codes A and B can be interchanged, since from the standpoint of safety it is immaterial which of these two codes is used for establishing the desired signal indication.

We shall now describe the manner in which track circuit detection is obtained and made use of in the control of the highway crossing signals XS at location 2. Normally, with block 1—3 clear of traffic, both windings 34 and 35 of the interlocking relay XR which controls the operation of the crossing signals, are energized so that signals XS remain inoperative. When a train enters section 1—2 from the left, relays H, D and J will all be deenergized, and the circuit for winding 34 of relay XR, which circuit includes the control wire 44, will be interrupted at contact 36 of relay D, as well as at contact 37 of relay H, so that back contact 38 of relay XR will close. The closing of contact 38 initiates the operation of the crossing signals XS, the usual flasher relay and lamp control circuits being not shown, since these are well known and form no part of our invention.

When the train enters section 2—3, relays H^1, D^1, and J^1 will all be deenergized, and the circuit for winding 35 of relay XR will be interrupted at front contact 39 of relay H^1. However, since winding 34 was the first to release its associated contact 38, back contact 40 will be prevented from closing, by the usual latching arrangement with which the interlocking relay is provided. Signals XS will continue to operate until the train completely vacates section 1—2. It will be noted that when relays H^1, D^1 and J^1 are deenergized, section 1—2 is supplied with steady current of positive relative polarity over the back point of contact 20 of relay H^1. This steady current will cause relay TR to pick up, closing contact 30—31, whereupon relay D will become energized. As soon as relay D picks up, winding 34 of relay XR will become energized over contact 36 of relay D, so that signals XS will be restored to the inoperative condition due to the opening of back contact 38 of relay XR. It follows, therefore, that steady or uncoded energy may be used in the manner described for providing track circuit detection.

If a train should back into section 2—3, relays H^1, D^1, and J^1 will become deenergized and crossing protection will be provided through the opening of front contact 39 of relay H^1, which deenergizes winding 35 of relay XR and sets signals XS into operation.

If there are more than two cut sections within a block, the polarity of the steady current which is used for clearing out purposes may be staggered in cut sections which adjoin, so that the broken down rail joint protection will extend to the track clearing apparatus. The staggering of the steady current may be readily accomplished by disconnecting wire 43 from the positive terminal of battery B^3 and connecting it to the negative terminal of battery B^4. When steady negative current is used for clearing purposes, front contact 36 of relay D should be replaced by a front contact of relay J, since relay TR and consequently relay D will not respond when negative current is fed to the section.

Referring to Fig. 3, the form of the invention disclosed in this figure is similar to Fig. 2, except that provision is made for superimposing alternating current codes for the control of locomotive cab signals, upon the direct current codes A, B, and D, which control the wayside signals. The system of track relays TR^4 and TRA^4 is identical with the track relay system of Fig. 2 except that a reactor X^4 is inserted in one of the track leads for the purpose of limiting the amount of alternating current which is permitted to flow in the track relay windings. Similarly, the system of decoding relays H^4, D^4, and J^4, and the method of controlling the associated wayside signal S^4, are the same as in Fig. 2, so

that it is unnecessary to repeat in detail how these portions of the system operate.

It will be noted that in addition to the battery B^5—B^6 which furnishes direct track circuit current for operating the track relays TR and TRA, we have provided a track transformer T^4 which has a primary winding constantly energized from an alternating current source BX—CX and which supplies alternating current for cab signal control from its secondary winding. The secondary winding of transformer T^4 is connected in series with one or the other half of the battery B^5—B^6, and includes one or another of the code transmitter contacts **80**, **120**, or **180**, as determined by traffic conditions in advance which, in turn, are reflected in the energized or deenergized condition of the relays H^4, D^4, and J^4. The continuously operating code transmitter CT^4 serves, therefore, not only to interrupt periodically the battery current for establishing the three wayside signal control codes A, B, and D, but also provides the three cab signal control codes comprising alternating current which is periodically interrupted at the rate of 80, 120, or 180 times per minute, by the contacts **80**, **120**, and **180**, respectively. In this manner, it becomes possible to operate locomotives equipped with frequency code decoding equipment of standard type over territory provided with wayside circuits and apparatus of the type herein disclosed.

Contacts **80** and **120** of the code transmitter CT^4 are designed to provide substantially equal "on" and "off" code intervals. Due to the fact that contact **180** must pole-change the direct current to establish code D, and at the same time must establish the equal "on" and "off" intervals of the 180 code, this contact must provide a transfer time interval between the front and back contact points of substantially equal duration to one of the "on" intervals of the code. That is, the transfer time between front and back points of contact **180** represents an "off" code interval.

The manner in which the supply of track current is controlled by the decoding relays is the same as in Fig. 2. That is, if three blocks or more, in advance of signal S^4 are unoccupied, all three of the decoding relays H^4, D^4, and J^4 will be energized, and contact **180** will feed code D, as well as 180 code, to the rails of the rear section, over the front points of contacts **19** and **20** of relays D^4 and H^4, respectively. If but two blocks in advance of signal S^4 are unoccupied, relays D^4 and H^4 will be energized, and relay J^4 will be deenergized. The codes supplied to the rear section under this condition will remain as before; that is, code D for wayside control and 180 code for cab signaling.

If but one block in advance of signal S^4 is clear, relays J^4 and H^4 will be energized, and relay D^4 will be deenergized. Under this condition, the rear section will receive code B and 120 code, over contact **120**, the back point of contact **19** of relay D^4, and the front point of contact **20** of relay H^4. If block 4—5 is occupied, relays J^4, D^4, and H^4 will all be deenergized, and the rear section will receive code A and 80 code, over contact **80** and the back point of contact **20** of relay H^4.

It will be noted that in the case of Fig. 3, the impulses in codes A, B, and D are not uniform in the three codes, as they are in the codes illustrated in Fig. 1 which are used in the arrangement shown in Fig. 2. The reason for this is that code D is produced by a contact which operates at the rate of 180 times per minute, whereas codes B and A are produced by contacts which operate at the rates of 120 and 80 times per minute, respectively. However, no disadvantage results from this non-uniformity, provided that relays TR and TRA are sufficiently rapid to follow the relatively fast impulses of code D, and relays J, D, and H are sufficiently slow acting to bridge the slower impulses of code A.

Referring to Fig. 4, the circuits of this figure are substantially the same as those shown in Fig. 2, with the exception that in Fig. 4, codes A, B, and D comprise alternating current impulses and are used for controlling alternating current track circuits, whereby the same rail current may be used for controlling both wayside and cab signaling apparatus.

The three codes A, B, and D are now supplied from a transformer TA having a mid-tap on the secondary at terminal CXA, in addition to the end terminals BXA and NXA. Code A comprises periodically interrupted alternating current of negative relative instantaneous polarity and is supplied to track transformer T^5 from terminals NXA—CXA of transformer TA, over the 80 code contact of code transmitter CT^6 and the back point of contact **20** of relay H^6. Code B comprises periodically interrupted alternating current of positive relative instantaneous polarity and is supplied from terminals BXA—CXA of transformer TA, over the 120 code contact of transmitter CT^6 and the back point of contact **19** of relay D^6 as well as the front point of contact **20** of relay H^6. Similarly, code D comprises periodically reversed current supplied alternately from terminals BXA—CXA and NXA—CXA of transformer TA, over the 180 code contact of transmitter CT^6 and the front points of contacts **19** and **20** of relays D^6 and H^6, respectively. The operation of contact **180** of transmitter CT^6 is similar to the operation of the corresponding contact **180** of transmitter CT^4 of Fig. 3, in that the "off" code interval is produced during the transit time of contact **180** between its front and back points.

It will be apparent from the foregoing that the instantaneous relative polarities of the impulses in codes A and B are opposite, so that by properly connecting the control windings of the two-element two-position alternating current track relays TR^6 and TRA^6 to the track, relay TRA^6 will respond only to impulses of code A, whereas relay TR^6 will respond only to impulses of code B, both relays responding alternately to code D. In this manner, the same selective code response of relays J^6, D^6, and H^6 may be obtained as previously described in connection with Figs. 2 and 3. The manner in which the circuits of Fig. 4 provide signal control in accordance with traffic conditions in advance will, therefore, be clear without added description. Should section 6—7 contain a highway crossing, or should it be desired to provide train detection for any other purpose, a detection circuit such as that shown in Fig. 2 at wire **44** and contacts **36** and **37** of relays D and H, respectively, can be readily incorporated into Fig. 4, for this purpose. Accordingly, steady or uncoded alternating current of one or the other relative instantaneous polarity (with respect to the mid-tap CXA of transformer TA) may be used as the detection current, in the manner previously described in connection with Fig. 2.

Referring to Fig. 5, the circuit shown in this

figure is a modification of the detection circuit or highway crossing control circuit of Fig. 2. In the case of the Fig. 2 circuit, there is a remote possibility of incorrect operation, should one or the other of the track relays TR, TRA, fail to release due to the occurrence of some mechanical defect, or other cause, at the instant that a train enters section 1—2. Under the above condition, relay D, or relay J will be maintained energized, and contact 36 will remain closed, thus preventing the release of relay XR which initiates operation of the highway crossing protection. To avoid this condition, we have provided an additional relay K which checks that the track relays TR and TRA are deenergized upon the entrance of a train into the section, and which also requires that the proper track relay be energized and relay K picked up before the highway crossing apparatus can be restored to normal, upon the exit of a train.

Under normal conditions, with no train in the associated track section, relay K remains deenergized. When a train enters the section, track relays TR and TRA will both be deenergized, so that contacts 30—32 and 22—23 will remain closed, and any of the relays J, D, and H which may have been energized will release. The release of relay H opens the energizing circuit for wire 44 at the front point of contact 37 of relay H, so that operation of the highway crossing apparatus is initiated. Relay K will now pick up over a circuit which includes back contact 30—32, wires 53 and 54, back contact 55 of relay D, wire 46, back contact 47 of relay H, and wire 48, to the winding of relay K. The pick-up of relay K closes contact 51, but wire 44 does not become energized due to the fact that front contact 52 of relay D remains open.

As long as the train remains in the section, relay K will remain energized. Upon the exit of the train, relay TR will pick-up on steady energy, and relay D will be picked up over contact 30—31. As soon as front contact 52 of relay D closes, wire 44 will become energized, to clear out the highway crossing apparatus, because front contact 51 of relay K, and back contact 37 of relay H will both be closed at this time. Relay K will remain energized over a stick circuit which includes contact 30—31, wire 49, front contact 50 of relay K, wire 46, back contact 47 of relay H, and wire 48, to the winding of relay K. Relays TR, D, and K will all remain picked up until the train completely clears section 2—3, at which time the steady energy in block 1—2 will be replaced by coded energy supplied in accordance with code A. Relay K will remain energized for a short interval following the application of code to relay TRA, until relays J and H pick up. Relay H will pick up after a few operations of contact finger 22, over contact 22—23, wire 45, front contact 28 of relay J, and back contact 25—26 of relay D. As soon as relay H picks up, the energizing circuit for wire 44 will be transferred to front contact 37 of relay H, and the stick circuit for relay K will be interrupted at back contact 47, so that relay K will release and the apparatus will be restored to its normal condition.

It will be apparent from the foregoing description of Fig. 5 that should relay TR fail to release due to some mechanical defect or other cause, upon the entry of a train, operation of the highway crossing apparatus will be initiated, nevertheless, because the energizing circuit for wire 44 will be open at front contact 51 of relay K. Furthermore, complete clearing out of the apparatus, following the exit of a train will not occur, unless relay K is first picked up, and then released; the release of relay K being impossible unless contact finger 22 operates periodically, thus checking that relay TRA is following the impulses of the code.

Although we have herein shown and described only a few forms of railway traffic controlling apparatus embodying our 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 our invention.

Having thus described our invention, what we claim is:

1. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse relative polarity and at other times with periodically varied current of normal relative polarity, a first polar relay receiving energy from said rails and responsive to current impulses of reverse relative polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal relative polarity only, a contact of said first relay included in the energizing circuit for said second relay, a contact of said second relay included in the energizing circuit for said first relay, and signaling apparatus controlled by said first and second relays.

2. In combination, a section of railway track, means for at times supplying the rails of said section with coded current of reverse polarity and at other times with coded current of normal polarity, a first and a second code following polar relay selectively responsive to code current impulses of reverse and normal polarity respectively, a circuit for energizing said first relay connected across the rails of said section and including a first rectifier poled in such manner as to permit current of reverse polarity to flow in said first relay, a circuit for energizing said second relay connected across the rails of said section and including a second rectifier poled in such manner as to permit current of normal polarity to flow in said second relay, and signaling apparatus selectively controlled by said first and second relays according as one or the other of said relays is following said code current impulses.

3. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity, a first and a second polar relay selectively responsive to periodic current impulses of reverse and normal polarity respectively, a first circuit for energizing said first relay connected across the rails of said section and including a first rectifier poled to permit current of reverse polarity to flow in said first relay, a second circuit for energizing said second relay connected across the rails of said section and including a second rectifier poled to permit current of normal polarity to flow in said second relay, a contact of said first relay included in said second circuit, a contact of said second relay included in said first circuit, and signaling apparatus controlled by said first and second relays.

4. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity, a first polar relay

receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, three decoding relays controlled by said first and second polar relays in such manner that the first and third decoding relays become energized when said first polar relay is operating and said second and third decoding relays become energized when said second polar relay is operating, and signaling apparatus controlled by said decoding relays.

5. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with current of alternately normal and reverse polarity, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only; three decoding relays controlled by said first and second polar relays in such manner that the first and third decoding relays become energized when said first polar relay is operating, said second and third decoding relays become energized when said second polar relay is operating, and all three decoding relays become energized when both of said polar relays are operating; and signaling apparatus controlled by said decoding relays.

6. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with current of alternately normal and reverse polarity, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only; a contact of said first polar relay included in the energizing circuit for said second polar relay, a contact of said second polar relay included in the energizing circuit for said first polar relay; three decoding relays controlled by said first and second polar relays in such manner that the first and third decoding relays become energized when said first polar relay is operating, said second and third decoding relays become energized when said second polar relay is operating, and all three decoding relays become energized when both of said polar relays are operating; and signaling apparatus controlled by said decoding relays.

7. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with current of alternately normal and reverse polarity, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving current from said rails and responsive to current impulses of normal polarity only, three decoding relays, means including a front contact of said first polar relay for energizing the first of said decoding relays, means including a front contact of said second polar relay for energizing the second of said decoding relays; means for at times energizing the third of said decoding relays over a circuit including a back contact of said first polar relay and a front and a back contact of the first and second decoding relays respectively, and for at other times energizing said third decoding relay over a circuit including a back contact of said second polar relay and a front contact of said second decoding relay; and signaling apparatus controlled by said decoding relays.

8. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with steady current, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only; and signaling apparatus selectively controlled according as one of said relays is steadily energized or one or the other of said relays is following normal or reverse current impulses respectively.

9. In combination, a section of railway track intersected by a highway; means for supplying one or another of three signal controlling codes comprising periodically varied current of reverse polarity, periodically varied current of normal polarity, current of alternately normal and reverse polarity, and for supplying steady track clearing current to the rails of said section, said three codes and said steady current being selected in accordance with traffic conditions in advance of said section; a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of positive polarity only; a wayside signal controlled by said two relays in such manner as to provide one of four indications according as said first relay is operating on code current of reverse polarity, said second relay is operating on code current of normal polarity, both said relays are operating on code current of alternately normal and reverse polarity, or neither of said relays is operating; and means controlled by one of said two relays effective when said one relay is energized by said track clearing current for controlling signaling apparatus at said highway intersection.

10. In combination, a section of railway track intersected by a highway, means for supplying periodically varied current of reverse or of normal polarity, respectively, to the rails of said section according as the next section in advance is occupied or unoccupied, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, signaling apparatus controlled by said two relays, highway crossing apparatus at said highway intersection controlled by said two relays in such manner as to become operated when a train enters said section and both of said relays are released, means effective when the train clears said highway intersection for supplying steady current to the rails of said section whereby one of said two relays will become steadily energized, and means effective when said one relay is steadily energized for restoring said highway crossing apparatus to the inoperative condition.

11. In combination, a section of railway track

intersected by a highway, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with steady current, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, three decoding relays, means including a front contact of said first polar relay for energizing the first decoding relay, means including a front contact of said second polar relay for energizing the second decoding relay; means for at times energizing the third decoding relay over a circuit including a back contact of said first polar relay and a front and a back contact of the first and second decoding relays respectively, and for at other times energizing said third decoding relay over a circuit including a back contact of said second polar relay and a front contact of said second decoding relay; a wayside signal controlled by said three decoding relays, highway crossing apparatus at said highway intersection, a control relay for governing said crossing apparatus, and an energizing circuit for said control relay including a front contact of one of said decoding relays.

12. In combination, a section of railway track intersected by a highway, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with steady current, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, three decoding relays, means including a front contact of said first polar relay for energizing the first decoding relay, means including a front contact of said second polar relay for energizing the second recoding relay; means for at times energizing the third decoding relay over a circuit including a back contact of said first polar relay and a front and a back contact of the first and second decoding relays respectively, and for at other times energizing said third decoding relay over a circuit including a back contact of said second polar relay and a front contact of said second decoding relay; a wayside signal controlled by said three decoding relays, highway crossing apparatus at said highway intersection, a control relay for governing said crossing apparatus, and two energizing circuits for said control relay one of which includes a front contact of said third decoding relay and the other of which includes a front contact of one of the remaining two decoding relays as determined by the polarity of the steady current supplied to the rails of said section.

13. In combination, a section of railway track, means for at times supplying the rails of said section with coded alternating current of reverse instantaneous relative polarity and at other times with coded alternating current of normal instantaneous relative polarity, a first two-element relay receiving energy from said rails and responsive to rail current impulses of said reverse relative polarity only, a second two-element relay receiving energy from said rails and responsive to rail current impulses of said normal relative polarity only, a contact of said first relay included in the energizing circuit for one element of said second relay, a contact of said second relay included in the energizing circuit for one element of said first relay, and signaling apparatus controlled by said first and second relays.

14. In combination, a section of railway track, means for at times supplying the rails of said section with a first code for controlling wayside signals as well as cab signals, said first code comprising alternating current of reverse instantaneous relative polarity periodically varied at a first frequency, means for at other times supplying the rails of said section with a second code for controlling wayside signals as well as cab signals, said second code comprising alternating current of normal instantaneous relative polarity periodically varied at a second frequency, a first two-element relay receiving energy from said rails and responsive to rail current impulses of said reverse polarity only, a second two-element relay receiving energy from said rails and responsive to rail current impulses of said normal polarity only, a contact of said first relay included in the energizing circuit for one element of said second relay, a contact of said second relay included in the energizing circuit for said first relay, and signaling apparatus controlled by said first and second relays.

15. In combination, a section of railway track, means for at times supplying the rails of said section with periodically varied unidirectional current of reverse polarity and at other times with periodically varied unidirectional current of normal polarity and at still other times with current of alternately normal and reverse polarity, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, means effective when the first of said two relays is operating for supplying the rails of the rear section which adjoins said given section with periodically varied unidirectional current of normal polarity for wayside signal control as well as with alternating current periodically varied at a first frequency for cab signal control, means effective when the second of said two relays is operating for supplying the rails of said rear section with unidirectional current of alternately normal and reverse polarity for wayside signal control as well as with alternating current periodically varied at a second frequency for cab signal control, and a wayside signal controlled by said two relays.

16. In combination, a section of railway track intersected by a highway, means for at times supplying the rails of said section with periodically varied current of reverse polarity and at other times with periodically varied current of normal polarity and at still other times with steady current, a first polar relay receiving energy from said rails and responsive to current impulses of reverse polarity only, a second polar relay receiving energy from said rails and responsive to current impulses of normal polarity only, three decoding relays, means effective when said first polar relay is operating for energizing the first and third of said decoding relays, means effective when said second polar relay is operating for energizing the second and third of said decoding relays, a slow acting relay, a pickup circuit for said slow acting relay including a back contact of said first polar relay and a back contact of both said first and third decoding relays; a stick circuit for said slow acting relay

including a front contact of said first polar relay, a front contact of the slow acting relay, and said back contact of the third decoding relay; a wayside signal controlled by said three decoding relays, highway crossing apparatus at said highway intersection, a control relay for governing said crossing apparatus, and two energizing circuits for said control relay one of which includes a front contact of said third decoding relay, and the other of which includes a front contact of said slow acting relay, a front contact of said first decoding relay, and a back contact of said third decoding relay.

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