Nov. 26, 1935. F. H. NICHOLSON 2,021,944

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 25, 1934

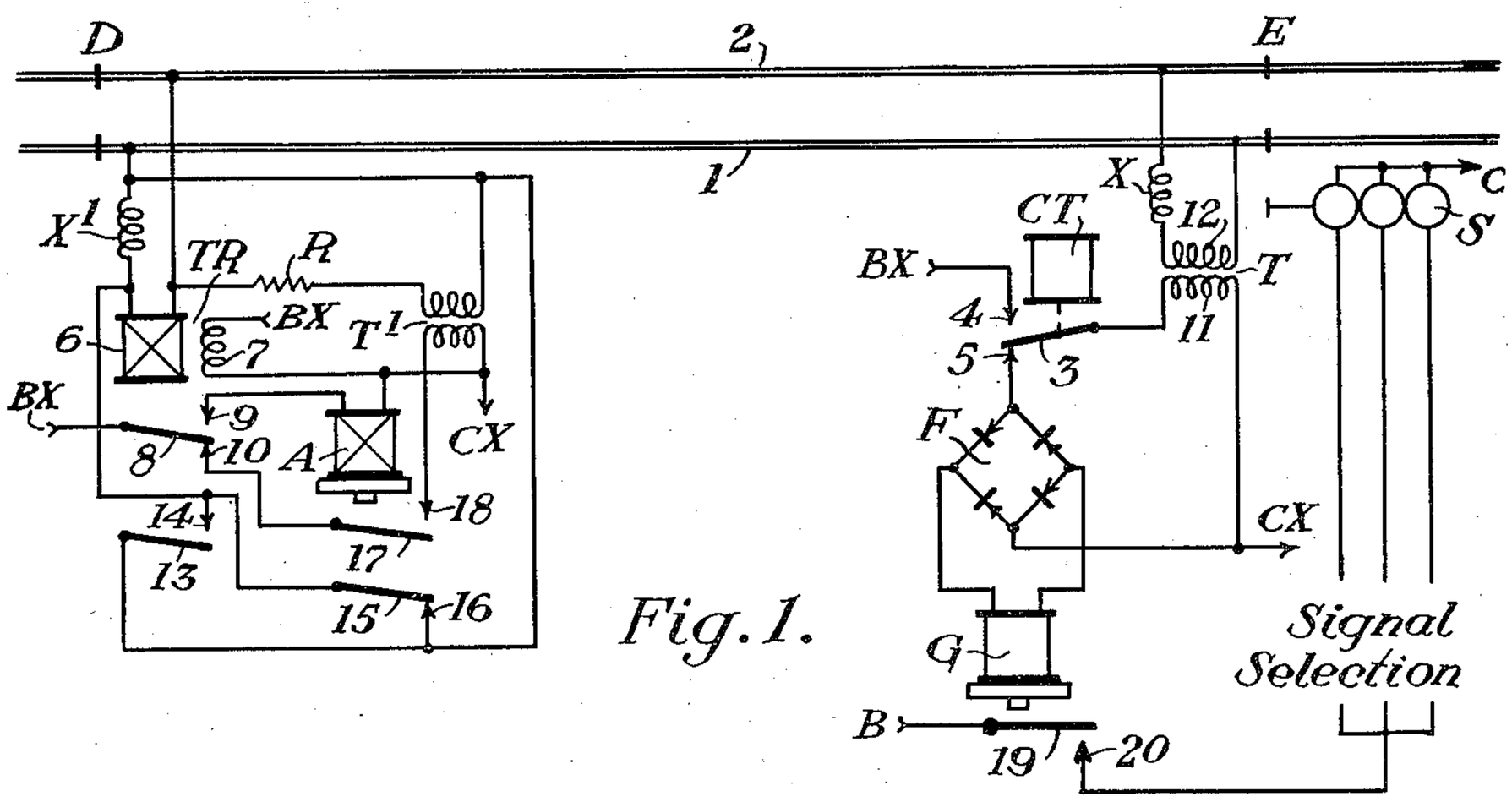


Fig. 1.

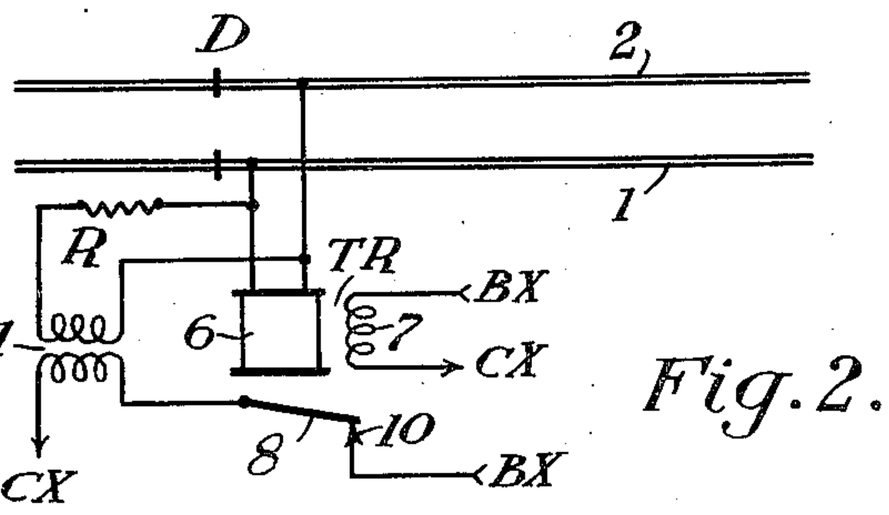


Fig. 2.

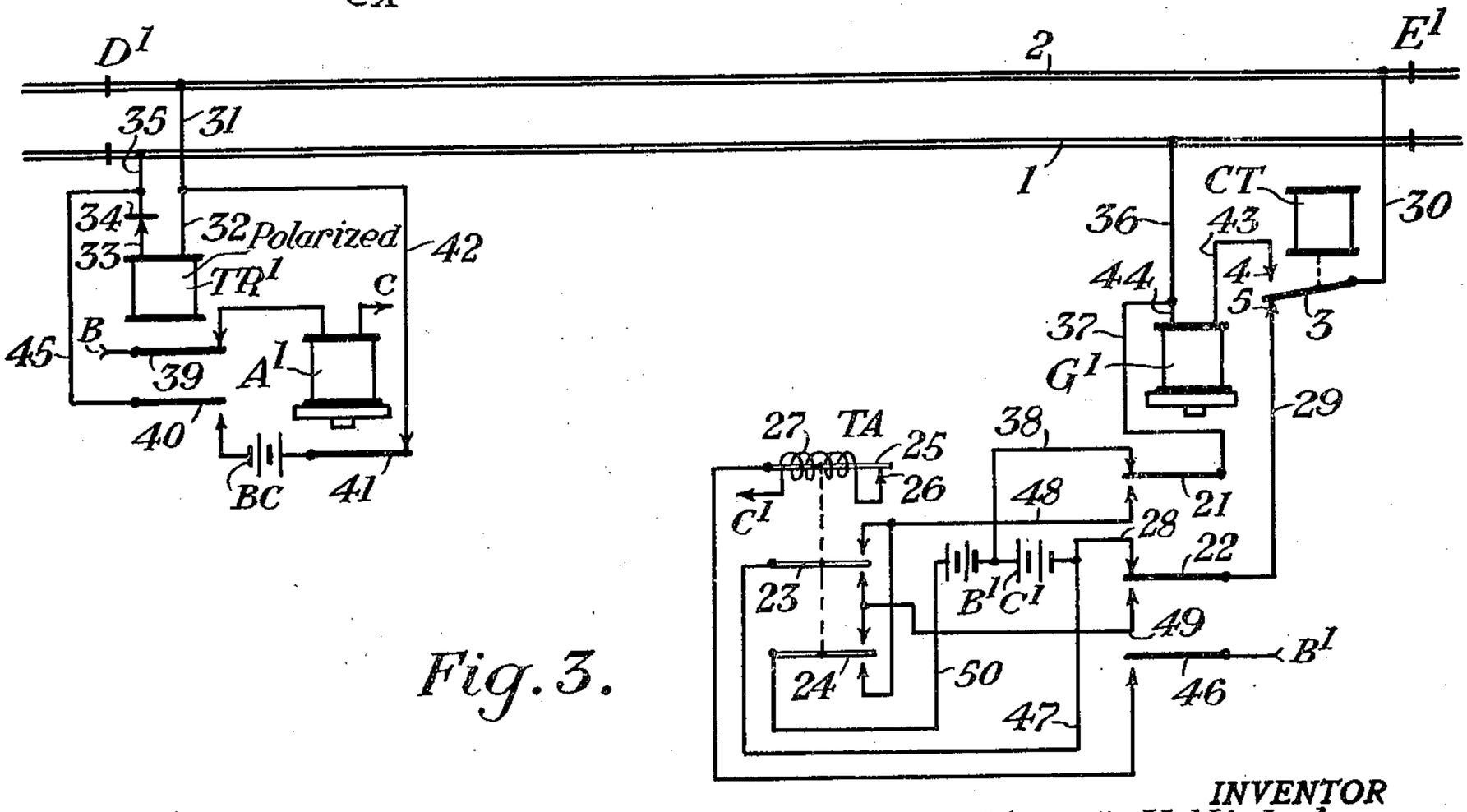


Fig. 3.

INVENTOR
Frank H. Nicholson
BY
HIS ATTORNEY

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## RAILWAY TRAFFIC CONTROLLING APPARATUS

Frank H. Nicholson, Edgewood, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application July 25, 1934, Serial No. 736,956

15 Claims. (Cl. 246—34)

My invention relates to railway traffic controlling apparatus, and more specifically to apparatus for effecting approach control of signaling functions in a signaling system employing coded track circuit current.

One feature of my invention is the provision of a system of approach control which avoids the necessity for control line wires.

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

Fig. 1 of the accompanying drawing is a diagrammatic view showing one form of approach control apparatus involving alternating current track circuits and embodying my invention. Fig. 2 is a diagrammatic view showing a modified form of a portion of the apparatus illustrated in Fig. 1, and also embodying my invention. Fig. 3 is a diagrammatic view showing a modified form of approach control apparatus involving direct current track circuits and also embodying my invention.

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

The present application is a continuation in part of my copending application Serial No. 640,208, filed October 29, 1932, for Railway traffic controlling apparatus, insofar as the subject matter common to the two is concerned.

Referring to Fig. 1, the reference characters 1 and 2 designate the track rails of a track section D—E along which traffic normally moves from left to right. Section D—E is provided at one end with a track transformer T which supplies alternating current from a source BX—CX to the track rails 1 and 2, through the current limiting reactor X. The current supplied to section D—E from transformer T is coded by a continuously operating interrupter or code transmitter CT, which periodically closes its contact 3—4 to periodically energize the primary winding 11 of transformer T.

The code transmitter CT may be energized from any suitable source, not shown, and may have a number of contact members such as 3, for providing any one of a group of distinct codes to the track section D—E, these codes being selected in accordance with traffic conditions in advance to selectively control cab signals in train control applications, or wayside signals, or both. For present purposes it is sufficient to show the use of but one such code, and to simplify the disclosure by eliminating the code-selecting apparatus. It will be understood that instead of using a code consisting of periodically interrupted current, substantially the same result can also be obtained by using current the magnitude or phase of which is periodically varied.

The reference character TR designates a code-following alternating current track relay having a track winding 6 connected with the track rails at the other end of section D—E, through a current limiting reactor $X^1$, and having a local winding 7 which is constantly energized from the same source BX—CX which feeds track transformer T. The relay TR is so designed that it will pick up on each impulse of current supplied from transformer T, that is, it will follow the code, closing front contacts 8—9 and 13—14 in step with the track current code impulses.

Associated with the track relay TR is an auxiliary relay A which receives an energizing impulse from the source BX—CX each time that front contact 8—9 of relay TR becomes closed. Relay A is sufficiently quick acting to pick up on one such energizing impulse, and is sufficiently slow releasing to remain energized for a short time interval after contact 8—9 opens and contact 8—10 closes. It must, however, release before contact 3—4 of transmitter CT closes in furnishing the succeeding code impulse, in order that reactor $X^1$ may be short-circuited in time to permit relay TR to pick up. When relay A is released, the above short circuit path around reactor $X^1$ is closed over back contact 15—16, and once relay TR picks up, this path is maintained closed over front contact 13—14 of relay TR.

It will now be apparent that following each code current impulse in the rails 1 and 2, there will exist a short time interval during which both front contact 17—18 of relay A and back contact 8—10 of relay TR will be closed completing an energizing circuit from source BX—CX for transformer $T^1$ which will supply an auxiliary current impulse to the rails 1 and 2 through the limiting resistor R. The current furnished by transformer $T^1$ is of such polarity as compared with the current in winding 7 of relay TR, as will tend to cause reverse torque in this relay, to avoid the possibility of false energization of relay TR. Reactor $X^1$ is used to prevent the track winding 6 of relay TR from by-passing an appreciable portion of the current supplied by transformer $T^1$, and it will be evident that reactor $X^1$ is short-circuited at all times when relay TR should receive current from track transformer T, the short circuit being removed each time that the transformer $T^1$ is conditioned to furnish current to the rails 1 and 2.

Although I have shown transformer $T^1$ ener-

gized from the same source BX—CX which supplies the coded track circuit energy for relay TR, it will be apparent that an auxiliary source of current of different character, as for example, a source of substantially higher frequency can be used for this purpose, in which case the reactor $X^1$ can be eliminated without danger of too great a portion of the auxiliary current being by-passed through winding 6 of relay TR. Also, if the length of section D—E is not too great, winding 7 of relay TR can be eliminated when the higher frequency source is used, without appreciable danger of false energization of the track relay by the auxiliary current, particularly if relay TR is made frequency selective.

The periodic impulses of energy from transformer $T^1$ will energize winding 12 of transformer T intermittently at a rate determined by the speed of operation of code transmitter CT, and each time that contact 3—5 of transmitter CT closes, the full-wave rectifier F will become energized and will deliver an energizing impulse to a direct current slow releasing approach relay G. The relay G is designed to be sufficiently slow releasing to maintain its picked-up position when energized at the slowest code speed of transmitter CT.

To explain the operation of the system as a whole, I shall assume that track section D—E is unoccupied, code transmitter CT is operating and track relay TR is following the code impulses being furnished from transformer T. Each time that contact 3—4 of transmitter CT closes, relay TR will pick up, closing contact 8—9, whereupon, relay A will pick up. Immediately thereafter, contact 3—4 will open, releasing relay TR, and contact 3—5 will close. For a short time interval, the following contacts will all be closed: back contact 8—10 of relay TR, front contact 17—18 of relay A, and contact 3—5 of transmitter CT. Therefore, relay G will receive an energizing impulse from transformer $T^1$, through the medium of transformer T, contact 3—5, and rectifier F. Before contact 3—4 recloses, relay A will release to short-circuit reactor $X^1$, so that relay TR will pick up upon the closing of contact 3—4, to repeat the sequence of operations previously described.

As long as the above sequence continues, relay G will remain picked up, maintaining its back contact 19—20 open so that signal S, or any other suitable traffic controlling function over which it is desired to exercise approach control, will remain deenergized.

Should a train enter section D—E, it will shunt the coded energy from both relays TR and G, so that relay A will become deenergized, releasing relay G thereby and energizing signal S over back contact 19—20 and over any other suitable selection apparatus which is not shown and which determines the proper indication to be displayed by signal S, in accordance with traffic conditions in advance.

When the train leave section D—E, relay TR will again become periodically energized, picking up relay A periodically and energizing relay G, so that signal S will become deenergized. Since the energy impulses flowing from transformer $T^1$ to relay G during the "off" code periods of transmitter CT are transmitted over the rail circuit, it will be apparent that no line wires are required for effecting approach control of signal S.

Referring to Fig. 2, the apparatus of this figure is intended to replace the apparatus at the track relay end of track section D—E of Fig. 1, eliminating auxiliary relay A and reactor $X^1$. The principle of operation of Fig. 2 is essentially the same as that of Fig. 1, in that a short energizing impulse for relay G is transmitted from the relay end of the track circuit during each "off" period of the code transmitter CT when the section is unoccupied. That is, back contact 8—10 of relay TR will close shortly after the opening of contact 3—4 of transmitter CT, and there will exist a period of time during which both contact 8—10 and contact 3—5 will be closed, permitting an energy impulse to be transmitted from transformer $T^1$, over rails 1 and 2, to energize relay G.

If desired, a slow releasing alternating current relay may be used to replace the combination of rectifier F and relay G. Also, as mentioned hereinbefore, relay TR can be of the single element type, the purpose of the local winding 7 being to economize track circuit power and to remove the danger of possible false energization of the relay by the current impulses supplied from transformer $T^1$. It will be apparent also, that although an alternating current system has been illustrated, the invention can be utilized as well on systems using direct current track circuits of the coded type and direct current relays, it being merely necessary to eliminate transformers T and $T^1$, and to substitute a direct current source for the source BX—CX, in a manner which will be obvious to those skilled in the art.

Referring to Fig. 3 of the drawing, there is shown at one end of section $D^1$—$E^1$, a direct current track relay $TR^1$ capable of following code impulses of direct current delivered to the rails at the other end of the section. The coded direct current for operating relay $TR^1$ is supplied from a direct current source $B^1C^1$, over the front points of contacts 21 and 22 of slow acting relay $G^1$, and coding contact 3—5 of the constantly operating code transmitter CT. The coded alternating current for the control of cab signaling apparatus is also furnished from the source $B^1C^1$, over the pole-changing contacts 23 and 24 of the tuned reed alternator TA, and the back points of contacts 21 and 22 of relay $G^1$ as well as coding contact 3—5.

The tuned alternator TA is of the usual "buzzer" type and comprises a reed 25 which is mechanically tuned to vibrate at the desired alternating current frequency so that this reed alternately opens and closes the energizing circuit for winding 27, over the normally closed contact 25—26. The total movement of reed 25 when operating, is sufficient to operate contacts 23 and 24 from the normally open position to the upper and lower closed positions, whereby the current applied to section $D^1$—$E^1$ from the source $B^1C^1$ becomes pole-changed at the frequency of operation of reed 25. In this manner, alternating current for the effective control of cab signaling apparatus is delivered to the rails of section $D^1$—$E^1$.

Under normal conditions, when sections $D^1$—$E^1$ is unoccupied, coded current is supplied to relay $TR^1$ over a circuit which may be traced from the right-hand terminal of battery $B^1C^1$, wire 30, front point of contact 22 of relay $G^1$, wire 29, contact 3—5 of code transmitter CT, wire 30, rail 2, wires 31 and 32, winding of relay $TR^1$, wire 33, rectifier 34, wire 35, rail 1, wires 36 and 37, front point of contact 21 of relay $G^1$, and wire 38, to the battery $B^1C^1$. Each time that contact 3—5 of transmitter CT opens to interrupt the rail current, relay $TR^1$ will release, opening its front contact 39 and closing its back con-

tact 40. Contact 39 controls the energization of the slow acting relay $A^1$, and each time that $TR^1$ picks up, relay $A^1$ will also pick up. The release time of relay $A^1$ should be sufficiently short to insure opening of contact 41, before code transmitter contact 3—5 recloses. Otherwise, the sources BC and $B^1C^1$ would be superimposed on each other, which condition is to be avoided because these sources are of opposite polarity in order that there will be no danger of source BC picking up the polarized relay $TR^1$.

It will be noted that there is a time interval during the "off" period in each code cycle when contact 3—4 of transmitter CT, back contact 40 of relay $TR^1$, and front contact 41 of relay $A^1$, are all closed. At such times, an impulse of current is delivered to the relay $G^1$, over a circuit which may be traced from one terminal of the battery BC, front contact 41 of relay $A^1$, wires 42 and 31, rail 2, wire 30, contact 3—4 of transmitter CT, wire 43, winding of relay $G^1$, wires 44 and 36, rail 1, wires 35 and 45, and back contact 40 of relay $TR^1$, to the other terminal of battery BC. Relay $G^1$ is sufficiently slow acting to bridge the time intervals between the current impulses supplied from source BC, so that normally, relay $G^1$ remains picked up, and the tuned alternator TA remains inactive. From the description given thus far, it will be apparent that energy from battery $B^1C^1$ is applied at the right-hand end of section $D^1$—$E^1$ for causing the track relay $TR^1$ to follow code, and during the "off" code intervals energy from battery BC is applied at the left-hand end of section $D^1$—$E^1$ for maintaining relay $G^1$ energized.

When a train enters section $D^1$—$E^1$, relay $TR^1$ will be shunted, opening contact 39, and thereby permanently deenergizing relay $A^1$. The opening of contact 41 of relay $A^1$ disconnects battery BC from the rails, thereby insuring the release of relay $G^1$ at the other end of the section. Even before battery BC is disconnected, the shunting action of the train deprives relay $G^1$ of energy, so that a moment after the train enters section $D^1$—$E^1$, relay $G^1$ releases, closing its back contact 46 as well as the back points of contacts 21 and 22. Back contact 46 closes the energizing circuit for winding 27 of the tuned alternator TA, thus initiating the pole-changing action of contact fingers 23 and 24.

As soon as the front points of contacts 23 and 24 become closed, the train will begin to receive cab signal controlling current over a circuit which may be traced from the right-hand terminal of battery $B^1C^1$, wire 47, front point of contact 23, wire 48, back point of contact 21, wires 37 and 36, rails 1 and 2, wire 30, contact 3—5, wire 29, back point of contact 22, wire 49, front point of contact 24, and wire 50, to the other terminal of battery $B^1C^1$. When the back points of contacts 23 and 24 are closed, the track feed circuit is the same as just traced, with the exception that wires 48 and 49 are now connected to the opposite terminals of the battery $B^1C^1$, so that the instantaneous polarity of the rail current is opposite to that existing at the previous instant. It will be apparent therefore, that during the "on" code interval when contact 3—5 of transmitter CT is closed, the section $D^1$—$E^1$ is supplied with alternating current, originating in the battery $B^1C^1$.

When the train leaves the section $D^1$—$E^1$, relay $TR^1$ will pick up on the half-waves of the alternating current which pass through the rectifier 34, and relay $A^1$ will pick up, in turn. As soon as relay $TR^1$ releases during the next "off" code impulse, relay $G^1$ will receive a pickup impulse, as previously explained, and the system will be restored to its normal condition in which relay $G^1$ is energized and the tuned alternator TA is deenergized.

By shifting the position of wire 38 with respect to the cells of the battery $B^1C^1$, an adjustment of the coded direct current level for wayside control can be obtained, independently of the level of the coded alternating current which provides cab signal control. Although contact finger 3 has been described as operating at but one speed, to simplify the disclosure, it will be obvious that the code transmitter CT can be made to operate finger 3 at different speeds which are selected in accordance with traffic conditions in advance. When this is done, the rail current will be coded at different frequencies, for selectively controlling multiple aspect wayside and cab signals in the usual and well-known manner.

It is not essential that the track relay $TR^1$ be of the polarized type, because the rectifier 34 is poled in such a direction as to prevent an appreciable amount of current supplied by source BC from entering the relay. However, from the standpoint of broken down insulated rail joint protection, the polarized track relay is to be preferred, as protection can be obtained by staggering the polarities of adjoining track circuits, in the usual manner.

Since the coded alternating current is supplied to the rails only upon the entry of a train into the section, and since this current is supplied without the use of rotating equipment, or other apparatus, such as transformers supplied with interrupted direct current which consume considerable power in performing the direct current to alternating current transformation, therefore, the system disclosed has the advantage of requiring a relatively low output from the battery $B^1C^1$. Furthermore, this advantage is obtained with apparatus which is relatively simple and inexpensive, and which embodies all of the usual safety features required by systems of this character.

Although I have herein shown and described only three forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a section of railway track, means for supplying periodically interrupted track current to the rails at one end of said section, a track relay connected with the rails at the other end of said section and responsive to the periodic interruptions of said track current, means controlled by said track relay for supplying an impulse of current to the rails at said other end of the section during each periodic interruption of said track current, and traffic governing apparatus at said one end of the section controlled by said current impulses.

2. In combination, a section of railway track, a source of current for the rails of said section, a coding device for periodically interrupting the track current supplied from said source, a track relay receiving energy from said rails and arranged to release during each interruption of the track current while said coding device is in operation, means controlled by said track relay effective each time said track relay is released for supplying an impulse of auxiliary current to the

rails of said section, an approach relay connected with the rails of said section and governed by said auxiliary current impulses, and traffic controlling apparatus governed by said approach relay.

3. In combination, a section of railway track, a source of current connected with the rails at one end of said section, a coding device for periodically interrupting the track current supplied from said source, a track relay connected with the rails at the other end of said section and arranged to follow the interruptions of said track current, an approach relay at said one end of the section; means for energizing said approach relay including an auxiliary source of current, a back contact of said track relay, and the rails of said section; and traffic governing apparatus controlled by said approach relay.

4. In combination, a section of railway track, a source of current for the rails of said section; a coding device having a first and a second contact which close alternately, said first contact acting to interrupt the track current supplied from said source; a track relay receiving energy from said rails and arranged to release during each interruption of the track current while said coding device is in operation, means controlled by said track relay effective each time the track relay is released for supplying an impulse of current to the rails of said section; an approach relay connected with the rails of said section through said second contact and energized by said current impulses, said approach relay being sufficiently slow releasing to bridge the open circuit interval of said second contact while said coding device is in operation, and traffic controlling apparatus governed by said approach relay.

5. In combination, a section of railway track, a source of current connected with the rails at one end of said section; a coding device having a first and a second contact which close alternately, said first contact acting to periodically interrupt the track current supplied from said source; a two element track relay one element of which is connected with the rails at the other end of said section and the other element of which is constantly energized from said source, said relay being arranged to follow the interruptions of said track current; an approach relay connected with the rails at said one end of the section, means including a back contact of said track relay for supplying current from said source to the rails at said other end of the section for controlling said approach relay over said second contact, the polarity of said current being so chosen as to oppose the energization of said track relay, and traffic governing apparatus controlled by said approach relay.

6. In combination, a section of railway track, a source of current connected with the rails at one end of said section; a coding device having a first and a second contact which close alternately, said first contact acting to periodically interrupt the track current supplied from said source; a track relay connected with the rails at the other end of said section and arranged to follow the interruptions of said track current; an auxiliary relay controlled by a front contact of said track relay, said auxiliary relay being so designed as to remain energized for a brief interval following the opening of said front contact; an approach relay connected with the rails at said one end of the section over said second contact; a circuit for supplying current to the rails at said other end of the section for controlling said approach relay which circuit includes a source of current, a back contact of said track relay, and a front contact of said auxiliary relay; and traffic governing apparatus controlled by said approach relay.

7. In combination, a section of railway track, a source of current connected with the rails at one end of said section; a coding device having a first and a second contact which close alternately, said first contact acting to periodically interrupt the track current supplied from said source; a track relay connected with the rails at the other end of said section through a current limiting impedance and arranged to follow the interruptions of said track current; an auxiliary relay controlled by a front contact of said track relay, said auxiliary relay being so designed as to remain energized for a brief interval following the opening of said front contact; an approach relay connected with the rails at said one end of the section over said second contact; a circuit for supplying current to the rails at said other end of the section for controlling said approach relay which circuit includes a source of current, a back contact of said track relay, and a front contact of said auxiliary relay; two short-circuiting paths around said current limiting impedance one of which includes a back contact of said auxiliary relay and the other of which includes a second front contact of said track relay, and traffic governing apparatus controlled by said approach relay.

8. In combination, a section of railway track, means for supplying periodically coded unidirectional track current to the rails at one end of said section, a code-following track relay receiving energy from the rails at the other end of said section, means controlled by said track relay for supplying an impulse of current to the rails at said other end of the section during each code cycle of said track current, an approach relay receiving energy from the rails at said one end of the section and energized by the continuing succession of said current impulses, and means effective when said approach relay becomes de-energized for supplying alternating current to the rails at said one end of the section.

9. In combination, a section of railway track, means for supplying periodically coded unidirectional track current to the rails at one end of said section, a code-following track relay receiving energy from the rails at the other end of said section, means controlled by said track relay for supplying an impulse of current to the rails at said other end of the section during each code cycle of said track current, an approach relay receiving energy form the rails at said one end of the section and energized by the continuing succession of said current impulses, and means controlled by said approach relay effective upon the entry of a train into said section for supplying coded alternating current to the rails at said one end of the section.

10. In combination, a section of railway track, a source of direct current, a code-following track relay for said section, a coding device having a normal and a reverse contact, an approach relay, means including a front contact of said approach relay and said reverse contact for supplying the rails of said section with periodically coded unidirectional track current from said source, means controlled by said track relay for supplying an impulse of current to the rails of said section during each code cycle of said track current, a

circuit including said normal contact for maintaining said approach relay energized by the continuing succession of said current impulses, a tuned alternator, and means governed by said alternator and including a back contact of said approach relay as well as said reverse contact for supplying coded alternating current to the rails of said section.

11. In combination, a section of railway track, a source of direct current, a code-following track relay for said section, a coding device having a normal and a reverse contact, an approach relay, means including a front contact of said approach relay and said reverse contact for supplying the rails of said section with periodically coded unidirectional track current from said source, means controlled by said track relay for supplying an impulse of current to the rails of said section during each code cycle of said track current, a circuit including said normal contact for maintaining said approach relay energized by the continuing succession of said current impulses, a normally deenergized tuned alternator, means effective when said approach relay is deenergized for energizing said tuned alternator, and means for supplying current from said alternator to the rails of said section.

12. In combination, a section of railway track, a first source of direct current, a direct current code-following track relay for said section, a coding device having a normal and a reverse contact, an approach relay, means including a front contact of said approach relay and said reverse contact for supplying the rails of said section with coded unidirectional current from said first source, a slow acting relay energized over a front contact of said track relay, a second source of direct current, means including a back contact of said track relay and a front contact of said slow acting relay for supplying current from said second source to the rails of said section, a circuit including said normal contact for maintaining said approach relay energized with rail current supplied from said second source, a tuned alternator having pole-changing contacts, and means effective when said approach relay is deenergized for causing said tuned alternator to supply alternating current from said first source over said pole-changing contacts to the rails of said section.

13. In combination, a section of railway track, means for supplying periodically coded unidirectional track current to the rails at one end of said section, a direct current code-following track relay receiving energy from the rails at the other end of said section, a slow acting relay energized over a front contact of said track relay and having a release time sufficiently short to release during each code cycle of said track current, means controlled by said track relay and said slow acting relay for supplying an impulse of current to the rails at said other end of the section during each code cycle of said track current, an approach relay receiving energy from the rails at said one end of the section and energized by the continuing succession of said current impulses, a tuned alternator having pole-changing contacts, and a circuit including said pole-changing contacts as well as a back contact of said approach relay for supplying periodically pole-changed current from said source to the rails at said one end of the section.

14. In combination, a section of railway track, a source of direct current, means for supplying periodically coded unidirectional track current to the rails at one end of said section, a code-following track relay receiving energy from the rails at the other end of said section, means controlled by said track relay for supplying an impulse of current to the rails at said other end of the section during each code cycle of said track current, an approach relay receiving energy from the rails at said one end of the section and energized by the continuing succession of said current impulses, and means effective when said approach relay becomes deenergized for supplying periodically pole-changed current from said source to the rails at said one end of the section.

15. In combination, a section of railway track, a first source of direct current, a polarized direct current code-following track relay for said section, said track relay being responsive to current of normal relative polarity only, means for supplying the rails of said section with coded unidirectional track current of normal polarity from said first source, an approach relay receiving energy from the rails of said section, a second source of direct current, means effective when said track relay is deenergized for supplying direct current of reverse polarity from said second source for maintaining said approach relay in the energized condition, a tuned alternator having pole-changing contacts, and a circuit including said pole-changing contacts as well as a back contact of said approach relay for supplying periodically pole-changed current from said first source to the rails of said section.

FRANK H. NICHOLSON.