Jan. 12, 1954 B. MISHELEVICH 2,666,131

SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 1

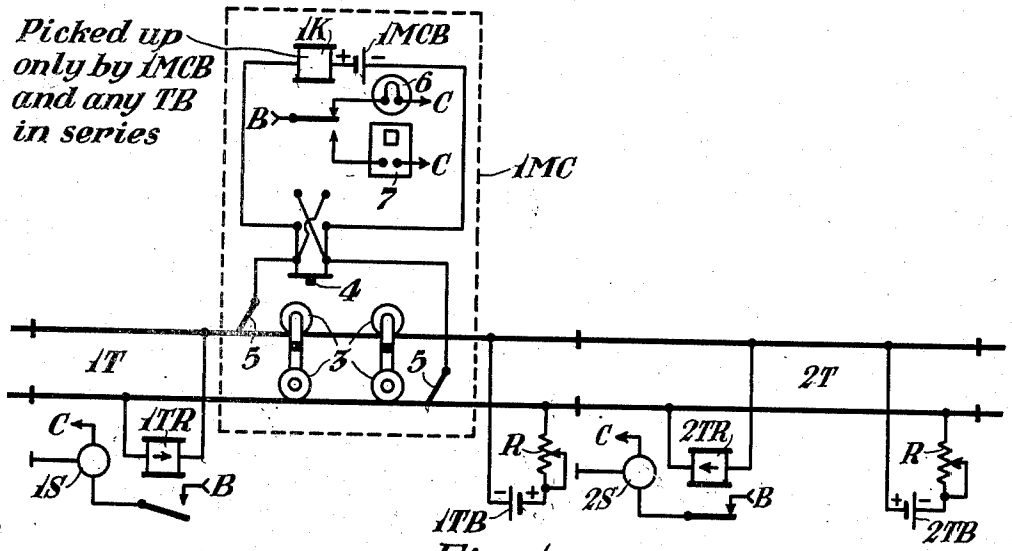


Fig. 1.

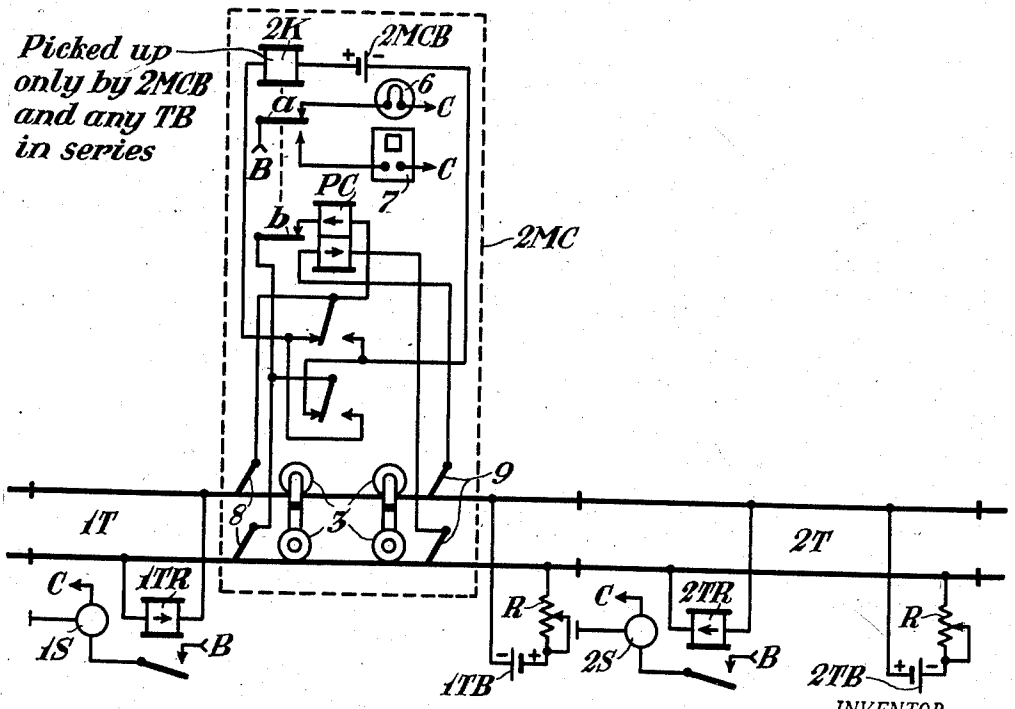


Fig. 2.

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SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 2

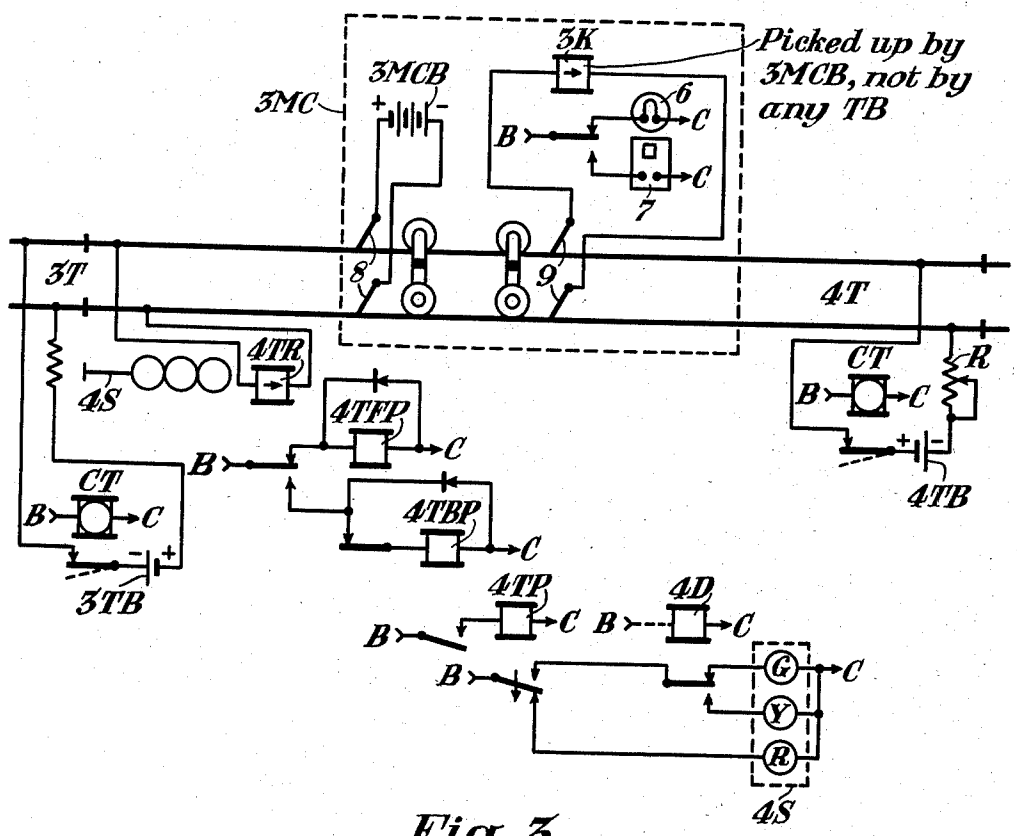


Fig. 3.

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SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 3

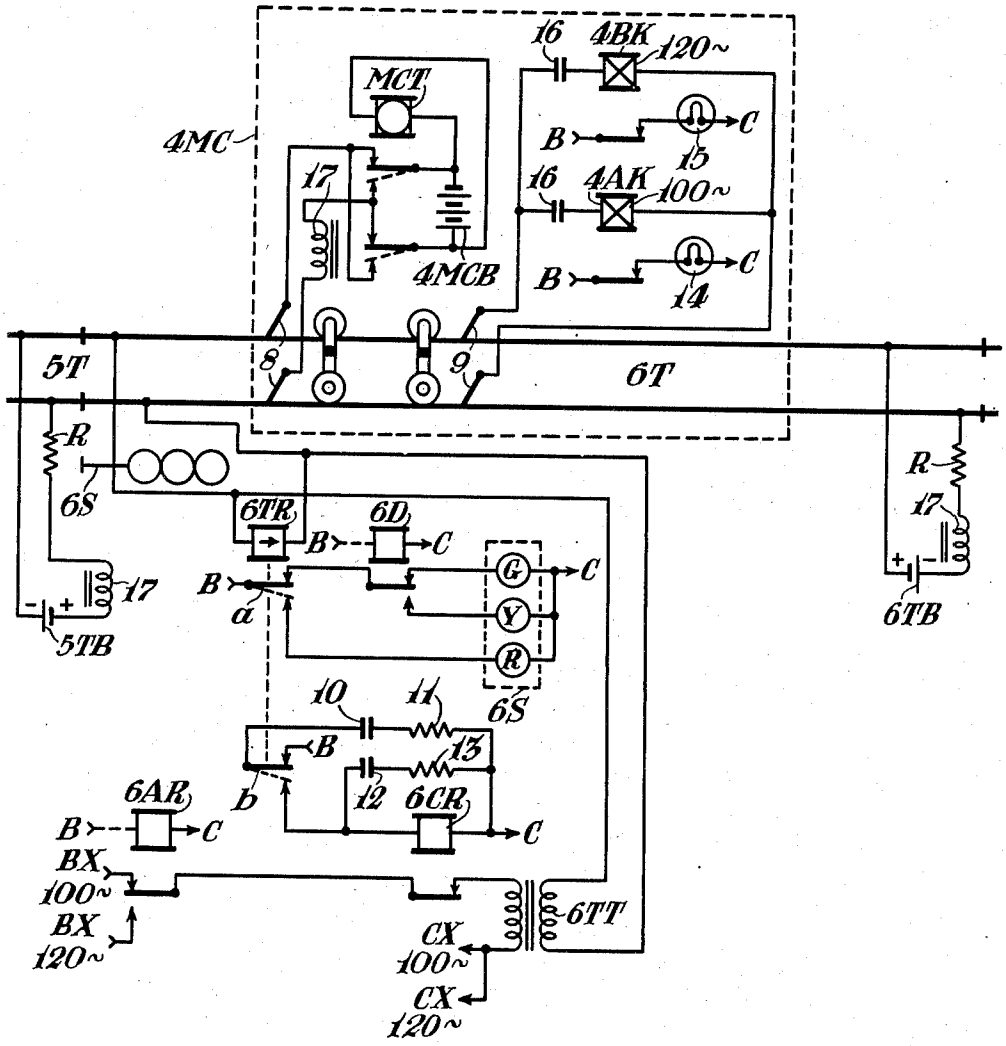


Fig. 4.

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SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 4

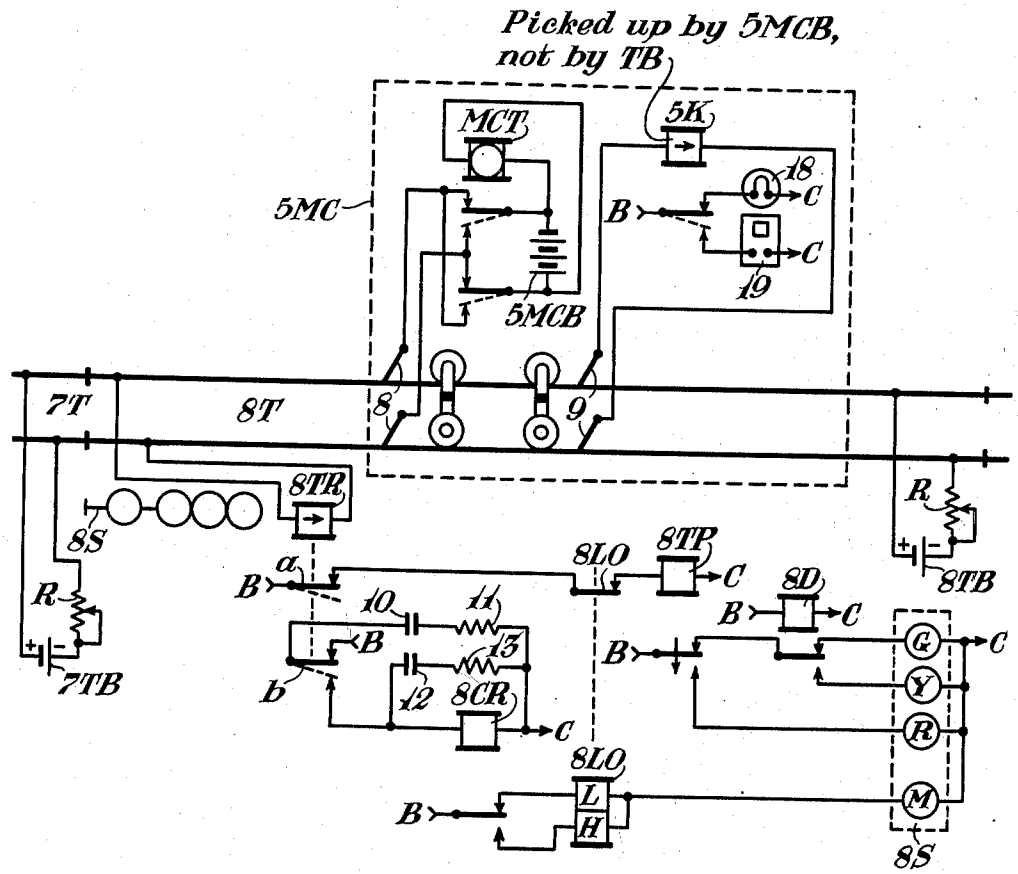


Fig. 5.

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SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 5

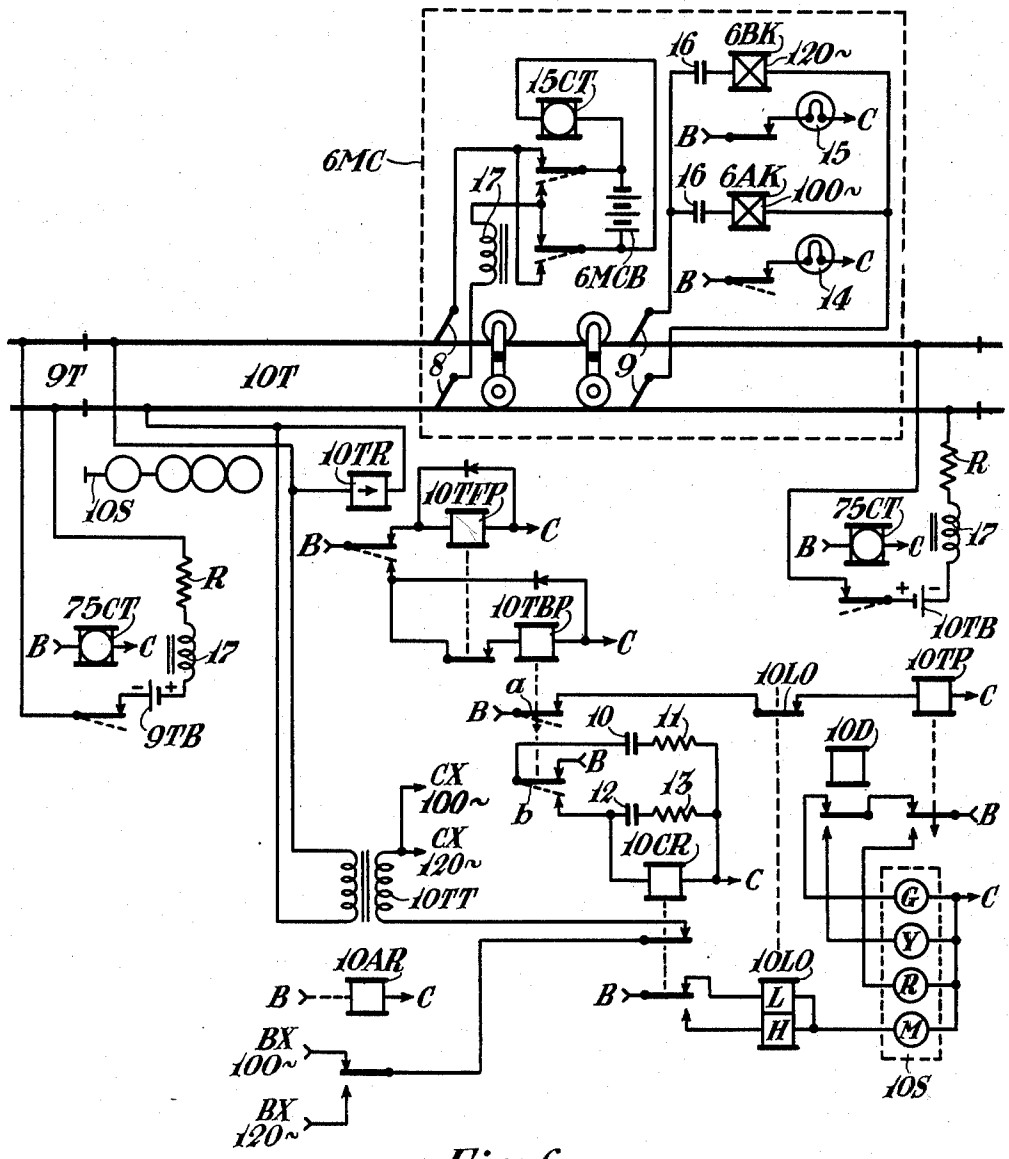


Fig. 6.

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SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Filed March 5, 1949 6 Sheets-Sheet 6

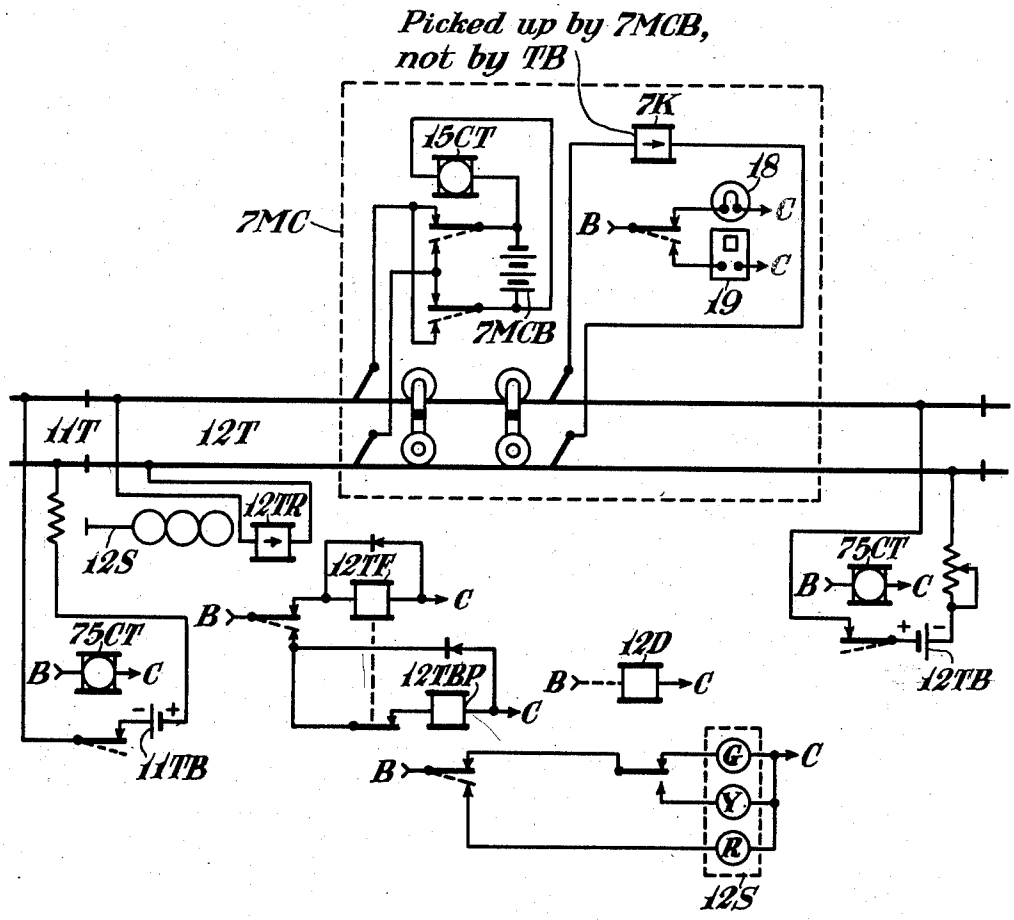


Fig. 7.

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Patented Jan. 12, 1954

2,666,131

UNITED STATES PATENT OFFICE

2,666,131

SUPPLEMENTARY APPARATUS FOR RAILWAY SIGNALING SYSTEMS

Benjamin Mishelevich, Pittsburgh, Pa., assignor to Westinghouse Air Brake Company, a corporation of Pennsylvania

Application March 5, 1949, Serial No. 79,866

21 Claims. (Cl. 246—41)

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My invention relates to railway signaling apparatus, and especially to apparatus supplementary to existing railway signaling systems for controlling the signals under special conditions.

In railway signaling systems, it is common to use track circuits to detect occupancy of the track. Such a track circuit comprises a section of track which is electrically insulated from the rails of adjoining sections. A battery is connected across the rails at one end of the section and a track relay is connected across the rails at the other end. When a train is present in the section, the relay is shunted by the wheels and axles of the train, and so releases its contacts, which control the wayside signals to indicate to approaching traffic that the section is occupied.

Lightweight vehicles such as motor cars cannot be relied upon to shunt the track rails so as to deenergize the track relays. It is therefore customary to insulate the wheels of motor cars so that they cannot shunt the rails and to take other steps to prevent collisions between motor cars and trains. Such other steps usually take the form of operating rules which restrict movements of motor cars to those authorized by a train dispatcher. Such rules not only prevent collisions but also prevent delays to train movements by motor cars.

My invention is disclosed herein in connection with apparatus for protecting a motor car or other vehicle which is incapable of shunting the track rails so as to deenergize the track relay. Certain features of my invention are also applicable to other types of emergency or supplementary signaling apparatus, for example, track gang warning systems.

Letters Patent of the United States No. 2,156,710 issued May 2, 1939, to Howard A. Thompson for Apparatus for Shunting of Track Circuits shows in Fig. 4 a signaling system whereby a motor car having insulated wheels is enabled to deenergize a track relay so as to set a wayside signal to stop.

Letters Patent of the United States No. 1,982,626, issued to George W. Baughman on December 4, 1934, for Apparatus for Controlling Highway Crossing Signals, and No. 2,019,164, issued to Paul P. Sosinski on October 29, 1935, for Apparatus for Controlling Trackway Devices from a Rail Vehicle, show systems whereby a motor car having insulated wheels is enabled to control a crossing signal located in advance of it.

One object of my invention is to provide improved apparatus for overridingly controlling the potential between the track rails in a track circuit which is at least at times connected to a normal source of electrical energy.

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Another object is to provide, in connection with apparatus of the type described, improved means for indicating that the apparatus is effective to change the potential between the track rails.

Another object of my invention is to provide improved means for modifying the energization of the track relay in a track circuit by overridingly controlling the potential between the track rails.

A further object is to provide, in connection with apparatus of the type described, improved means for indicating when the track relay energization is modified by the apparatus.

A further object is to provide apparatus of the type described which, when installed on a motor car or other vehicle which cannot shunt the track rails, is effective to modify the energization of the track relay in any section where such vehicle may be located, and which includes means for indicating that the energization of the track relay is so modified.

Another object is to provide improved apparatus for controlling a track relay in response to the presence in its track section of a motor car or other vehicle having insulated wheels.

Another object is to provide apparatus of the type described which is adapted to control the regular wayside signals in a distinctive manner, as by flashing the signals, or by causing them to display a distinctive aspect.

A further object is to provide, in connection with apparatus of the type described, improved apparatus which is adapted to cooperate with a track circuit of either polarity and with either coded or uncoded track circuits.

A further object is to provide improved means for informing the occupant of a motor car of the presence of a train within certain predetermined limits adjacent the section in which the motor car is located.

I have disclosed herein seven different supplementary signaling arrangements, each embodying certain features of my invention.

All of the several modifications of my invention disclosed herein are illustrated in connection with systems for protecting motor cars which are incapable of shunting the track circuit. In these systems, I provide supplementary apparatus which enables the motor cars to modify the energization of the track relays and thereby actuate the regular signaling systems for their own protection. In each of the several systems, the motor car is equipped with an indicator which

responds to the potential between the track rails and informs the motor car operator as to whether the supplementary apparatus is controlling the regular signaling system. In certain of the systems disclosed herein, the motor car is also equipped with another indicator which informs the operator of the presence of an approaching train.

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

In the drawings, Fig. 1 illustrates somewhat diagrammatically two sections of railway track provided with conventional wayside equipment and with motor car equipment embodying my invention. Figs. 2 to 7 are diagrammatic figures generally similar to Fig. 1 and illustrating various modifications of wayside equipment and motor car equipment embodying my invention.

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

Before proceeding with a detailed description of the drawings, the salient features of the several modifications of my invention shown herein will be briefly reviewed.

In Fig. 1, the motor car 1MC carries a battery 1MCB which is connected to the track rails through brushes 5 and a manually operable reversing switch 4. Connected in series with the motor car battery is the winding of a relay 1K having a resistance sufficiently high that it picks up its contacts only when energized by the motor car battery and one of the track batteries in series. When the motor car battery is connected to the rails with the proper polarity to oppose the track battery in its effect upon the track relay 1TR, then the two batteries aid each other in sending current through the motor car relay 1K. The motor car relay is thereby energized to pick up its contacts and complete a circuit for energizing a lamp 6 which indicates to the motor car operator that he is being protected by the usual railway signals and that it is safe to proceed. If the motor car relay is not so energized, it completes over its back contact a circuit to energize a warning signal 7 indicating that it is unsafe to proceed and that the motor car should be removed from the rails. When the motor car moves from one track circuit into an adjacent track circuit of opposite polarity, the motor car relay will be deenergized, but can be reenergized by operating the reversing switch.

The supplementary signaling apparatus shown in Fig. 2 is similar to that in Fig. 1 except that the manual reversing switch 4 is replaced by an automatic pole-changing relay PC which reverses the polarity of the motor car battery with respect to the rails as the motor car enters a new track section whose track battery is arranged with its polarity opposite to that of the track battery in the section which the motor car is leaving.

The modification of my invention disclosed in Fig. 3 may be used with direct current coded track circuits in which the polarities of adjacent track sections may or may not be staggered. This system uses a battery 3MCB on the motor car 3MC which is arranged to apply a potential to the track rails greater than twice the potential of any track battery TB. The battery 3MCB and the motor car relay 3K are connected to the rails through separate pairs of brushes 8 and 9. The winding of relay 3K has a resistance sufficiently high that it may be picked up only by the potential from the motor car battery, and cannot be picked up by any track battery. Coded track circuits of the type disclosed herein use polar relays, such as 4TR, which respond to electrical current of one polarity only. Such relays are arranged to maintain their associated signals clear as long as the relay follows code of the proper frequency. Any other mode of energization of the track relay causes the signal to assume a restrictive aspect. When this type of motor car carried apparatus is used in connection with such track circuits, then the track relay is either held continuously up or continuously down, depending upon the relative polarity of the motor car battery and the track battery. In any event, the track relay is prevented from following the usual code pattern, and the signal is therefore made to assume its restrictive aspect.

The modification of my invention illustrated in Fig. 4 is applicable to either coded or continuously energized direct current track circuits, although shown in this figure in connection with a continuously energized track circuit. This system employs a code transmitter MCT on the motor car which reverses the polarity of the motor car battery 4MCB with respect to the rails at a predetermined frequency. The motor car battery in this modification also is chosen to have a potential greater than twice that of any track battery. When a motor car carrying this system is present in a track section, the motor car battery overpowers the track battery and causes the track relay to follow the code frequency established by the motor car code transmitter. This response of the track relay causes the regular wayside signals to flash. A motor car indicator relay is provided at the wayside, which is picked up whenever the track relay follows code of the motor car frequency. This motor car indicator relay causes the application of one or another source of alternating current of distinctive frequency to the track rails, depending upon the condition of energization of an approach relay 6AR. The approach relay is in turn controlled in accordance with the occupancy of the track sections within predetermined approach limits of the section which is occupied by the motor car. The motor car is provided with two indicators 14 and 15, one responsive to each of the two alternating current frequencies. The motor car therefore receives one indication when the motor car is protected by the wayside signal and the approach section is clear, and a different indication when the motor car is protected but the approach section is occupied.

The modification of my invention disclosed in Fig. 5 is also applicable to either continuously energized or coded direct current track circuits, but is shown in Fig. 5 in connection with a direct current track circuit. The motor car 5MC in this system is also provided with a code transmitter MCT which causes the track relay to follow its code. The wayside equipment is arranged so that the code following operation of the track relay does not disturb the regular wayside signals, but instead energizes a special wayside signal M provided for the purpose of indicating the presence of a motor car. The relay 5K on the motor car which operates the motor car indicator 18 is a direct current relay having a resistance sufficiently high that it is picked up only by the motor car battery and not by any track battery.

The modification of my invention shown in Fig. 6 is similar to that shown in Fig. 4, except

that it is shown in connection with a coded track circuit. The equipment on the motor car is the same. The wayside equipment is similar to that of Fig. 4, modified to provide a coded track circuit, and to show the use of a special motor car signal M instead of flashing the wayside signals.

The system disclosed in Fig. 7 is based on that of Fig. 5 with modifications to make it suitable for use on a coded track circuit. Again the motor car equipment is the same whether the motor car is used on a coded or continuously energized track circuit. The wayside equipment in this case has been modified to flash the regular wayside signals instead of using a special signal as in Fig. 5.

In the practice of the present invention, it is contemplated that the present operating rules for motor cars will not be changed, but that the motor car movements will continue to be authorized by the train dispatcher so as not to interfere with train movements. If that is done, then although a motor car equipped according to the present invention is effective to modify the energization of the track circuit so as to operate the wayside signals, the motor car will delay train movements only when some unusual condition arises which causes a conflict between a scheduled train movement and an authorized motor car movement.

I shall now proceed with a detailed description of the apparatus shown in the drawings.

Fig. 1

There is shown in this figure a stretch of railway track divided into two insulated track sections 1T and 2T. Each of these sections is provided adjacent its exit end with a track battery such as 1TB, connected across the rails through a protective resistance R. Near its entrance end, each section has a track relay, such as 1TR, connected across the rails and normally energized by the track battery. The normal condition of energization of a track relay when its section is unoccupied is shown in the case of the track relay 2TR. The track relays 1TR and 2TR are polar relays, which pick up their contacts only when current flows through them in the direction indicated in the drawing by the arrow on the relay winding. Each track relay controls an energizing circuit for an associated wayside signal, such as 1S, which governs traffic movements into the corresponding section 1T. Only portions of these energizing circuits are shown in the drawing. The circuit for signal 1S, for example, extends from a positive battery terminal B over a front contact of relay 1TR and through signal 1S to a negative battery terminal C. When the track relay is energized, the front contact is closed, and the associated signal displays a clear or caution aspect. When the track relay is deenergized, its front contact in the signal circuit is opened, and the signal displays a more restrictive aspect.

The polarities of the track batteries and the track relays in the adjacent track sections 1T and 2T are reversed with respect to each other, so as to provide protection against broken-down insulation between track sections, in a well-known manner.

A motor car, diagrammatically indicated at 1MC, is illustrated as occupying the track section 1T. The motor car has insulated wheels 3, so that it cannot shunt the track rails and deenergize the track relays.

The motor car 1MC carries a motor car battery 1MCB, which is connected in series with the winding of a motor car indicator relay 1K, and through a manually operable reversing switch 4 and brushes 5 to the track rails.

When the reversing switch 4 is in the position shown in the drawing, the battery 1MCB is so connected to the rails that it tends to make the upper rail positive and the lower rail negative. This is opposite to the effect of the track battery 1TB. The resultant effect of the two batteries is to substantially deenergize the track relay 1TR, so that it opens its contact and causes the signal 1S to display its most restrictive aspect.

In the circuit which includes the battery 1TB, the rails up to the brushes 5, the reversing switch 4, the motor car battery 1MCB and the winding of relay 1K, the batteries 1TB and 1MCB are in series with and aiding each other. The resistance of the winding of relay 1K is chosen to that it cannot pick up its contact when its winding is energized by battery 1MCB alone or by battery 1TB alone. When the two batteries are aiding each other, as in the circuit just traced, the winding of relay 1K is then sufficiently energized so that it picks up its contact.

When the relay 1K is energized, it completes a circuit through its front contact for energizing a lamp 6, which indicates to the operator of the motor car that the potential between the track rails at the motor car is being controlled by the battery 1MCB in a sense to deenergize the track relay 1TR. Hence, the signal lamp 6 informs the motor car operator that the track relay 1TR is deenergized and that the signal 1S is at stop. The motor car operator then knows that he is being protected by the regular wayside signals of the railroad and that it is safe for the car to remain on the rails.

When the relay 1K releases its contact, it completes through its back contact an energizing circuit for a buzzer or other audible indicator 7. Energization of the buzzer 7 informs the motor car operator that he is not being protected by the wayside signal, and that it is unsafe to rely on those signals for protection.

It should be noted that with the equipment described, any abnormal circuit conditions either on the motor car or in the track circuit can not cause the motor car indicator to produce a false safe indication. For example, an open circuit on the motor car would deenergize the relay 1K. Likewise, a short circuit on the motor car would deenergize relay 1K, because then only the motor car battery 1MCB would be effective to energize that relay. As stated above, both battery 1MCB and track battery 1TB in series are required to energize relay 1K sufficiently to pick up its contact. Likewise, a short circuit between the track rails would deenergize relay 1K, since it would remove the track battery 1TB as an energizing source. A break in the track circuit would in any event deenergize the track relay so that the signal would be at its restrictive aspect and the indication on the motor car could not be falsely safe. Depending upon the location of the break in the track circuit, the relay 1K might also be deenergized. For example, if the break were between the motor car and the track battery, then the track battery would be removed as a source of energy for the relay 1K, which would drop its contact.

When the motor car 1MC moves from section 1T into section 2T, the motor car battery 1MCB and the track battery 2TB will be aiding each other with respect to the track relay 2TR and

opposing each other with respect to the motor car relay 1K. Under these conditions, the relay 1K is deenergized, and operates the warning buzzer 7. When the motor car operator receives this warning signal, he may reverse the position of the reversing switch 4. This reverses the polarity of the motor car battery 1MCB with respect to the track rails, and makes the polarity relationship between the motor car battery and the track battery proper to pick up the relay 1K again. If at any time the motor car operator can not secure energization of the signal lamp 6 with the reversing switch 4 in either position, he is thereby informed that the motor car battery is not deenergizing the track relay and that he can not depend upon the wayside signals for protection.

Fig. 2

There is shown in this figure a modified form of motor car equipment which may be used in connection with direct current track circuits. In Fig. 2, the track sections and wayside equipment are the same as the corresponding elements of Fig. 1. Certain of the items of motor car equipment in Fig. 2 correspond to their counterparts in Fig. 1 and have either been given the same reference character, as in the case of the signal lamp 6, or have been given corresponding reference characters, as in the case of the motor car 2MC and the battery 2MCB.

The battery 2MCB and the indicator relay 2K are connected in series to the track rails through the contacts of a pole-changing relay PC and a pair of brushes 8 located at the rear of the motor car 2MC. Relay 2K has a contact *a* which controls the indicators 6 and 7, and a front contact *b* connected in the circuit of relay PC, for a purpose to be described below. The pole-changing relay PC has two windings, one of which is connected to the track rails through the brushes 8 at the rear of the motor car, and the other of which is connected to the track rails through a pair of brushes 9 located at the front of the motor car. This relay is of the polar stick type, so that its contacts remain in any position to which they are actuated until the energization of the relay is reversed. The two windings are arranged so that, after the contacts have been moved to one position, a reversal in the energization of either winding will reverse the contacts. As in the case of Fig. 1, the battery 2MCB is connected to the track rails so as to make the top rail positive, whereas the battery 2TB is connected to the rails with its polarity arranged to make the bottom rail positive. The effects of these two batteries are therefore opposed, so far as the track relay and both windings of relay PC are concerned, and hence those relays are deenergized. The signal 1S is consequently made to assume its most restrictive aspect, and the contacts of relay PC remain in position to which they were last actuated.

The batteries 2MCB and 2TB are in series with respect to the energization of the winding of relay 2K, so that the latter has picked up its contact *a* to energize the indicating lamp 6. The winding of relay 2K is similar to that of relay 1K in Fig. 1, in that its resistance is sufficiently high that the relay may be energized to pick up its contact only by both batteries 2MCB and 2TB in series.

The connections of the motor car battery 2MCB to the windings of relay PC are arranged so that it tends to cause current to flow through

the two windings in opposite directions, as indicated by the arrows on the windings in the drawing. Likewise, the track battery 1TB tends to cause current to flow through the two windings in opposite directions. Hence, any unbalance between the relative strengths of the two batteries can not cause the relay to reverse its contacts.

The polarities of the rails in sections 1T and 2T are staggered, so that the rails of section 2T are of the opposite polarity to the rails of section 1T. When the brushes 9 on the motor car pass into section 2T, the battery 2TB sends an energizing current through the lower winding of relay PC in a direction opposite to the current which had been supplied by battery 1TB. While the motor car spans the insulated joint between sections 1T and 2T, this current in the lower winding is not opposed by battery 2MCB, and hence is effective to reverse the contacts of pole-changing relay PC, thereby reversing the polarity of battery 2MCB with respect to the track rails and with respect to the upper winding of relay PC. Relay 2K is momentarily deenergized, since the battery 2MCB then opposes the effect of battery 1MCB in sending current through the winding of relay 2K. However, as soon as the motor car moves on so that the brushes 8 pass into the track section 2T, then battery 2MCB is aided by battery 2TB in sending current through the winding of relay 2K, and the latter immediately picks up its contact again to energize the indicator lamp 6. After brushes 8 pass into section 2T, then the effects of the two batteries on the windings of relay PC are again balanced, and its contacts therefore stick in the new position.

The contact *b* of relay 2K prevents improper operation of the system during conditions of unbalance between the potentials of the motor car and track batteries. To illustrate, I will assume that battery 2MCB is much stronger than battery 1TB, and consider the action which takes place when the motor car 2MC moves into section 2T. When brushes 9 pass into section 2T, current flows through the lower winding of relay PC from battery 2TB in a direction to cause relay PC to reverse its contacts. However, this action is opposed by the unbalanced current due to battery 2MCB in the upper winding of relay PC and hence the contacts of that relay do not then reverse.

When brushes 8 pass into section 2T, then battery 2TB opposes battery 2MCB in the circuit of relay 2K, and that relay drops, opening its contact *b* in the circuit of the upper winding of relay PC. At the same time, battery 2MCB is connected in parallel with battery 2TB and consequently tends to increase the current flow in the lower winding of relay PC. Relay PC is therefore strongly energized to reverse its contacts. When those contacts reverse, relay 2K is again picked up, closing its contact *b* and restoring the normal balanced conditions in the windings of relay PC. In order that these conditions will be stable, relay 2K should be made faster acting than relay PC. This prevents any tendency of relay PC to reverse its contacts because of unbalanced batteries from becoming effective until relay 2K picks up and renders relay PC insensitive to such unbalances.

It may therefore be seen that the operation of the apparatus in Fig. 2 is generally the same as that of the apparatus in Fig. 1, except that the polarity of the motor car battery 2MCB is automatically reversed with respect to the rails when-

ever the motor car enters a new track circuit whose polarity is opposite to that of the track circuit being vacated.

Fig. 3

There is shown in this figure a motor car protection system which is usable in connection with direct current coded track circuits, whether or not the polarities of the track circuits in adjacent track sections are staggered.

The track circuit and wayside equipment shown in Fig. 3 is conventional coded track circuit equipment, shown in a very simplified form, and will only be briefly described. It includes a track battery 4TB connected across the rails at the exit end of the track section through a front contact of a code transmitter CT. The code transmitter interrupts the supply of direct current from battery 4TB to the track circuit at a predetermined frequency, commonly 75 or 180 times per minute. A code following polar track relay 4TR is connected across the rails at the entrance end of the track section 4T. Under normal conditions, relay 4TR follows the code of transmitter CT, and picks up and releases its contacts at a corresponding frequency. Relay 4TR controls a front contact repeater 4TFP and a back contact repeater 4TBP, both of which are made slow releasing by the snubbing effect of asymmetric units connected across their respective windings. The energizing circuit of relay 4TBP extends over a front contact of relay 4TFP and is completed only when the relay 4TR is following code and is alternately making its front and back contacts. Relay 4TBP controls a slow release repeater relay 4TP, which governs the selection of stop or proceed aspects of signal 4S. A distant relay 4D, which commonly repeats the position of the signal next in advance of the signal 4S, governs the selection of a clear or caution aspect at the signal 4S when the slow release repeater relay 4TP is picked up.

The adjacent section 3T, only a portion of which appears in the drawing, is provided with similar equipment, including a track battery 3TB connected to the rails through the front contact of a code transmitter CT. It should be noted that the batteries 3TB and 4TB are so connected to the rails that the polarities are staggered in the adjacent sections.

The motor car 3MC carries a motor car battery 3MCB, which is connected to the rails through brushes 8 at the rear of the motor car. The motor car battery 3MCB must have a voltage greater than twice that of the track battery 4TB, and preferably three times that of the track battery. A motor car indicator relay 3K is connected to the rails through brushes 9 at the front end of the motor car. The winding of relay 3K has a resistance sufficiently high so that it can be picked up only by the motor car battery and not by any of the track batteries. Relay 3K is a polar relay which responds only to a potential whose polarity is the same as that of the motor car battery.

When motor car 3MC occupies a track section, as it is occupying section 4T in the drawing, the potential of motor car battery 3MCB predominates over that of the track battery 4TB. If the battery 3MCB is of the same polarity as the track battery 4TB, then battery 3MCB is effective to maintain the contacts of polar relay 4TR continuously picked up, regardless of the coding action of transmitter CT. This is the case in section 4T. On the other hand, if battery 3MCB is of the opposite polarity to battery 4TB, then battery 3MCB maintains the contacts of the polar relay 4TR continuously down. In any event, the code following action of relay 4TR is stopped by the presence of battery 3MCB. As a result of the cessation of that code following action, relay 4TBP is deenergized, thereby deenergizing relay 4TP and causing signal 4S to display a stop aspect.

Track battery 4TB has no effect on the motor car indicator relay 3K, since its potential is not great enough to pick up the relay 3K. Furthermore, the potential of motor car battery 3MCB is sufficiently greater than that of track battery 4TB that battery 3MCB can always pick up the relay 3K, even when opposed by battery 4TB. Indicator relay 3K therefore checks that the battery 3MCB is connected to the rails and is effective to modify the potential between the rails in a manner which causes relay 4TR to stop its code following action.

Fig. 4

There is illustrated in this figure a modified form of motor car protection apparatus which is suitable for use with either coded or continuously energized direct current track circuits, although shown in Fig. 4 in connection with continuously energized track circuits. In this system, provision is made for a special flashing aspect of the wayside signals whenever a motor car occupies the track section. Furthermore, the motor car operator is informed not only as to whether he is protected by the wayside signals, but also as to the presence of a train within predetermined approach limits.

The track circuit includes the usual track battery 6TB, a polar track relay 6TR, and the rails of the track section 6T. Contact *a* of relay 6TR cooperates with a distant relay 6D to control the signal 6S in a conventional manner.

The motor car 4MC carries a battery 4MCB which has a potential substantially greater than that of the track battery 6TB. Battery 4MCB is connected to the rails through brushes 8 and through the pole-changing contacts of a code transmitter MCT, which is effective to periodically reverse the polarity of the potential supplied to the track rails through the brushes 8 by the battery 4MCB. This coding action of the transmitter CT is effective to cause the track relay 6TR to alternately pick up and release its contacts, regardless of the particular polarity of relay 6TR. This code following action of relay 6TR causes the signal 6S to have a flashing aspect. That is, the signal alternately displays its stop and clear aspects or its stop and caution aspects, depending upon the condition of energization of the distant relay 6D.

The track relay 6TR is also provided with a contact *b* which controls a code responsive relay 6CR. When relay 6TR is picked up, contact *b* completes an obvious charging circuit for a condenser 10, which circuit includes a resistance 11. When contact *b* engages its associated back contact, condenser 10 discharges through a circuit including the winding of code responsive relay 6CR in parallel with a branch circuit including a condenser 12 and a resistance 13. The time constant of the circuit including condenser 10 and resistance 11 and that of the circuit including condenser 12 and resistor 13 are so chosen with relation to the frequency of operation of the code transmitter MCT on the motor car 4MC that code responsive relay 6CR is continuously

energized only when relay 6TR is following code whose frequency is that of transmitter MCT.

When relay 6CR is energized, its front contact completes an energizing circuit for the primary winding of a track transformer 6TT. This energizing circuit supplies the transformer 6TT selectively with 100 cycle or 120 cycle alternating current, depending upon the condition of energization of an approach relay 6AR. Relay 6AR is controlled by the condition of occupancy of the approach limits of section 6T, which approach limits may include one or more track sections. The energizing circuit for relay 6AR is not completely shown in the drawing. Reference is made to the copending application for Letters Patent of the United States, of Howard A. Thompson, Serial No. 51,276, filed September 25, 1948, now U. S. Patent No. 2,617,922, issued November 11, 1952, entitled Supplemental Signaling Systems for Special Railway Vehicles, for a complete showing of such an energizing circuit. If no train is within the approach limits, relay 6AR is energized and closes its front contact, thereby supplying 100 cycle current to the primary of transformer 6TT. If a train is within the approach limits, relay 6AR is deenergized, and 120 cycle alternating current is supplied over its back contact to the primary winding of transformer 6TT. The secondary winding of transformer 6TT is connected across the rails of section 6T at its entrance end, and the alternating current induced in the secondary winding of transformer 6TT flows through the track rails to brushes 9 at the front end of the motor car, to which are connected a pair of resonant indicator relays 4AK and 4BK, which are arranged to respond to alternating current of 100 cycle and 120 cycle frequencies, respectively. A front contact of relay 4AK controls an energizing circuit for an indicator lamp 14, and a front contact of relay 4BK controls an energizing circuit for an indicator lamp 15. Filter condensers 16 are connected in series with the relays 4AK and 4BK to prevent direct current from flowing through them. Choke coils 17 are connected in series with the motor car battery 4MCB and the respective track batteries to prevent alternating current from flowing through those paths.

It will be seen that the energization of the signal lamp 14 informs the motor car operator that the motor car battery 4MCB and code transmitter CT are causing code following operation of track relay 6TR, hence that the signal 6S is being flashed to inform approaching trains of the presence of the motor car, and also that no train is approaching within the control limits of approach relay 6AR. Signal 15 on the other hand informs the motor car operator that track relay 6TR is following the motor car code and the wayside signal 6S has its flashing aspect, but that a train is approaching within the approach limits of relay 6AR. If neither signal lamp 14 nor 15 is energized, the motor car operator knows either that the system is not operating or that the track rails of section 6T are shunted. If desired, a third indicator, either audible or visual, could be added to the motor car to inform the operator that both the lamps 14 and 15 are deenergized.

With the system of Fig. 4, the motor car operator is continuously informed as to whether he is being protected by the wayside signals, and is also continuously informed as to whether a train is aproaching. With this system, it is not so essential as in the case of the systems of Figs. 1 to 3 that the motor car be operated under the orders of the train dispatcher. With this system, the motor car operator can operate his motor car so as not to interfere with or delay the movement of trains. In other words, the system warns the motor car operator of the approach of a train in sufficient time so that he can proceed to the nearest convenient point and remove his car from the rails before the train reaches him. Furthermore, the motor car is protected by the wayside signals so that a collision with the motor car will be avoided even if the operator does not remove it from the rails.

Fig. 5

The system shown in this figure is applicable either to continuously energized or coded direct current track circuits, although shown in connection with a continuously energized track circuit. The system is generally similar to that of Fig. 4, and only those features which differ from Fig. 4 will be specifically mentioned. The wayside apparatus has been modified to omit the approach control and the transmission of alternating current to the track rails to operate the motor car indicator. The track relay controls the wayside signal through a slow release repeater relay 8TP so that the normal aspects of the signal are not disturbed by the presence of the motor car. Instead of changing the normal signal aspect, a special signal arm or lamp M is provided, which is energized only when a motor car is present in the track section. The motor car indicator relay 5K follows the motor car code transmitter MCT and provides an intermittent signal when the motor car is being protected by the wayside signals.

Referring to the changes in the wayside equipment in detail, it may be seen that front contact *a* of track relay 8TR controls an energizing circuit for track repeater relay 8TP, which circuit also includes a front contact of a lightout relay 8LO. The slow release track repeater relay 8TP controls the aspects of the signal 8S in a conventional manner.

The code responsive relay 8CR is arranged to be energized when relay 8TR follows code of the frequency produced by the motor car code transmitter MCT. This relay 8CR controls an energizing circuit for the special signal lamp M. This energizing circuit includes a low resistance winding L of the lightout relay 8LO. The latter relay is also provided with a high resistance winding H, which is connected in series with the lamp M over a back contact of code responsive relay 8CR. The lightout relay 8LO is required in order to protect the motor car in case the filament of the lamp M fails. It will be seen that if the circuit through the lamp M is opened for any reason, whether the lamp is lighted or not, relay 8LO is thereby deenergized, and the signal 8S immediately assumes its most restrictive aspect.

Motor car battery 5MCB has a potential considerably higher than that of track battery 8TB, and the motor car relay 5K has a resistance sufficiently high that it can be picked up only by the motor car battery 5MCB and not by any track battery such as 8TB. The relay 5K will follow the coding action of transmitter MCT unless for some reason the potential of battery 5MCB is not being transmitted to the rails or unless the track section 8T is shunted. Hence relay 5K will intermittently energize the signal lamp 18 and the

buzzer 19 whenever the motor car 5MC is being protected by the wayside signals.

Fig. 6

The system illustrated in Fig. 6 is similar to that of Fig. 4, except that it is shown as used in connection with a coded track circuit rather than a continuously energized track circuit. Furthermore, the wayside equipment has been modified so that the presence of a motor car causes the illumination of a special signal lamp, instead of causing a flashing aspect of the regular wayside signals.

The wayside coded track circuit is substantially the same as that of Fig. 3, except that the code transmitter has been designated 75CT to indicate that it interrupts the track circuit at a frequency of 75 times per minute. The motor car equipment is the same as that of Fig. 4, except that the motor car code transmitter has been designated 15CT to indicate that it reverses the polarity of the motor car battery 6MCB with respect to the rails at a frequency of 15 cycles per minute.

The particular frequencies mentioned for the wayside code transmitter 75CT and the motor car code transmitter 15CT are selected for example only. It is only necessary that the two code transmitters operate at frequencies sufficiently different so that the wayside apparatus can distinguish between them. With the wayside equipment shown, the frequency of the motor car transmitter must be sufficiently slow so that when the track relay 10TR is following the low frequency code, the back contact repeater relay 10TBP will become deenergized once during each code cycle.

The arrangement is such that when the track relay 10TR is following the normal code whose frequency is controlled by the transmitter 75CT, then the relay 10TBP is continuously picked up. However, when the track relay 10TR is following the lower frequency code established by the motor car battery 6MCB and code transmitter 15CT, then the relay 10TBP will follow the lower frequency code. Motor car battery 6MCB has a potential at least twice as high as the potential of battery 10TB, so that battery 6MCB may always predominate over the track battery.

Contact *a* of relay 10TBP controls an energizing circuit for a slow release relay 10TP, which cooperates with distant relay 10D to control the signal 10S in a conventional manner.

Contact *b* of relay 10TBP controls a code responsive relay 10CR which is comparable to the relay 6CR of Fig. 4. Relay 10CR controls an energizing circuit for the primary winding of a transformer 10TT which corresponds to the transformer 6TT of Fig. 4. Relay 10CR also controls an energizing circuit for the special indication lamp M of signal 10S in a manner corresponding to the control of special indication lamp M of signal 8S by relay 8CR in Fig. 5.

Fig. 7

The system illustrated in Fig. 7 corresponds generally to that of Fig. 5, but is shown in connection with a coded track circuit rather than a continuously energized track circuit. Furthermore, the wayside equipment is modified so that the presence of a motor car causes a flashing aspect of the normal wayside signals, instead of energizing a special signal.

As in the case of Fig. 6, a wayside code transmitter is operated at a frequency of 75 times per minute, while the motor car transmitter is operated at a frequency of 15 times per minute. The motor car battery 7MCB is made more than twice the potential of track battery 12TB, and preferably three times that potential, so that the motor car battery will always be able to override the effect of the track battery on the track relay 12TR and cause the track relay to follow the frequency of the motor car transmitter. The difference between the frequencies of the two transmitters is sufficiently great so that when the track relay 12TR is following the high frequency code, the back contact repeater 12TBP is picked up continuously, but when the track relay 12TR is following the lower code from the motor car, the relay 12TBP follows that code, periodically dropping its contacts. Relay 12TBP cooperates with a distant relay 12D to control the wayside signal 12S in the conventional manner. It may therefore be seen that when the track section 12T is occupied by the motor car 7MC, the wayside signal 12S is flashed.

The motor car indicator relay 7K is of sufficiently high resistance that it cannot be picked up by any track battery such as 12TB, but can be picked up by the motor car battery 7MCB. Therefore, when the motor car battery 7MCB is controlling the potential between the track rails, the relay 7K follows the code transmitter 15CT, thereby flashing the lamp 18 and intermittently energizing the buzzer 19. The relay 7K distinguishes between high potential energy received from the motor car battery 7MCB and low potential energy received from track battery 12TB, and does not distinguish between the code frequencies, as such.

Although I have herein shown and described only seven forms of supplementary signaling apparatus for railway signaling systems 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. Apparatus for controlling the electrical potential between track rails having a first source of electrical energy at times connected thereto, comprising a second source of electrical energy having a potential greater than twice that of said first source, means for connecting said second source to the rails so as to modify the potential between the rails in a manner distinctively different from any modification imparted thereto by said first source, means for indicating whether the potential is so distinctively modified, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

2. Apparatus for controlling the electrical potential between track rails having a first source of electrical energy intermittently connected thereto, comprising a second source of electrical energy having a potential greater than twice that of said first source, means for continuously connecting said second source to the rails, means for indicating whether said second source is connected to the rails, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

3. Apparatus for controlling the electrical potential between track rails having a first source of direct electrical energy alternately connected thereto and disconnected therefrom at a predetermined rate, comprising a second source of

electrical energy having a potential greater than twice that of said first source, means for connecting said second source to the rails, pole-changing means in said connecting means for alternately reversing the polarity of the second source with respect to the rails, means for indicating whether said second source is connected to the rails, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

4. Apparatus for controlling the electrical potential between track rails having a first source of direct electrical energy alternately connected thereto and disconnected therefrom at a predetermined rate, comprising a second source of electrical energy having a potential greater than twice that of said first source, means for connecting said second source to the rails, pole-changing means in said connecting means for alternately reversing the polarity of the second source with respect to the rails at a rate different from that at which the connections of said first source are changed, means for indicating whether said second source is connected to the rails, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

5. Apparatus for controlling the electrical potential between track rails having a first source of direct electrical energy alternately connected thereto and disconnected therefrom at a predetermined rate, comprising a second source of electrical energy having a potential greater than twice that of said first source, means for connecting said second source to the rails, pole-changing means in said connecting means for alternately reversing the polarity of the second source with respect to the rails at a rate substantially slower than that at which the connections of said first source are changed, means for indicating whether said second source is connected to the rails, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

6. Apparatus for controlling the electrical potential between track rails having a first source of direct electrical energy continuously connected thereto, comprising a second source of electrical energy having a potential greater than twice that of said first source, means for connecting said second source to the rails, pole-changing means in said connecting means for alternately reversing the polarity of the second source with respect to the rails, means for indicating whether said second source is connected to the rails, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

7. Apparatus for controlling the electrical potential between track rails having a first source of direct electrical energy connected thereto, comprising a second source of direct electrical energy having a potential sufficient to at least balance said first source, means for connecting said second source to the rails so as to oppose said first source and thereby reduce the potential between the rails while aiding said first source in sending current through said connecting means, and means connected in series with said connecting means and responsive only to a potential greater than that of either of said sources for indicating that said connecting means is effective.

8. In combination with railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy, the rails of the section and a track relay, and a signal controlled by the track relay and governing traffic movements into the section, said relay being effective when deenergized by the shunting action of the wheels and axles of a passing train to cause said signal to display a restrictive aspect, the polarity of the rails in adjacent sections being staggered; emergency apparatus for controlling said signal comprising a second source of electrical energy having a potential sufficient to at least balance that of said first source, means for connecting said second source to the rails so as to modify the potential between the rails and thereby the energization of said track relay in a manner distinctively different from any modification imparted thereto by said first source, means including said track relay and effective upon such a modification in the energization thereof to cause said signal to display a restrictive aspect, and means located adjacent the connecting means and rendered effective as a result of such a distinctive modification of the potential across the rails for indicating whether the potential is so distinctively modified.

9. In railway signaling apparatus comprising a normally energized track relay connected to the track rails so as to be deenergized by the shunting action of the wheels and axles of a passing train; improved means for protecting a special vehicle whose wheels are ineffective to shunt said relay comprising a source of electrical energy on said vehicle, means for connecting said source to the rails to modify the energization of said track relay, means including said track relay and responsive to such a modification in the energization thereof to supply an electrical potential of a distinctive character to the track rails, and an indicator on the vehicle responsive to said distinctive potential to indicate the condition of energization of said track relay.

10. In railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy; the rails of the section and a track relay, said section being subject to occupancy by normal vehicles which electrically shunt the rails and special vehicles which do not shunt the rails; improved apparatus for deenergizing the track relay when such a special vehicle occupies the section comprising a second source of electrical energy carried by said vehicle, means for connecting said second source to the rails to oppose said first source and thereby deenergize said track relay, said sources being effective when so connected to aid each other in sending current through said connecting means, and means connected in series with said connecting means and responsive only to a potential greater than that of either of said sources for indicating that said connecting means is effective and said track relay is deenergized.

11. In railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy, the rails of the section and a track relay, said section being subject to occupancy by normal vehicles which electrically shunt the rails and special vehicles which do not shunt the rails; improved apparatus for deenergizing the track relay when such a special vehicle occupies the section comprising a second source of electrical energy carried by said vehicle and having a potential greater than twice that of said first source, means for connecting said second source to the rails so as to modify the potential between the rails and hence the en-

ergization of said track relay in a manner distinctively different from any modification imparted thereto by said first source, means on the vehicle for indicating whether the energization of the track relay is so distinctively modified, and means responsive only to a potential between the rails greater than that of said first source for operating said indicating means.

12. In railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy, the rails of the section and a track relay, and a signal controlled by the track relay and governing traffic movements into the section, said relay being effective when deenergized to cause said signal to display a restrictive aspect, said section being subject to occupancy by normal vehicles which electrically shunt the rails and thereby deenergize the relay, and by special vehicles which do not shunt the rails; improved apparatus for protecting such a special vehicle comprising a second source of electrical energy carried by said vehicle, relay means for connecting said second source to the rails so as to modify the potential between the rails and thereby the energization of said track relay, contacts controlled by said relay means for cyclically changing said connections, a second signal for conveying information to vehicles approaching said section, and means including said track relay and effective in response to such cyclical changes in the energization thereof to cause said second signal to display an aspect informing approaching vehicles of the presence of the special vehicle in said section.

13. In railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy, the rails of the section and a track relay, and a signal controlled by the track relay and governing traffic movements into the section, said relay being effective when deenergized to cause said signal to display a restrictive aspect, said section being subject to occupancy by normal vehicles which electrically shunt the rails and thereby deenergize the relay, and by special vehicles which do not shunt the rails; improved apparatus for protecting such a special vehicle comprising a second source of electrical energy carried by said vehicle, relay means for connecting said second source to the rails so as to modify the potential between the rails and thereby the energization of said track relay, contacts controlled by said relay means for cyclically changing said connections, means including said track relay and effective in response to such cyclical changes in the energization thereof to cause said signal to display a different restrictive aspect, and means on said vehicle rendered effective as the result of the modification of the potential across the rails for indicating whether the rail potential and the track relay energization are so modified.

14. In railway signaling apparatus comprising a stretch of railway track divided into a plurality of sections, each section having a track circuit including a polar code following track relay, the rails of the section, a first source of direct electrical energy, and means for coding the current supplied by said source, said sections having their sources of energy staggered with respect to the track rails so that the respective track rails in successive sections are of opposite polarities, said stretch being subject to occupancy by normal vehicles which electrically shunt the rails and thereby deenergize the respective track relays and by special vehicles which do not shunt the rails; improved apparatus for controlling the track relays from such a special vehicle, comprising a second source of electrical energy carried by said vehicle and having a potential greater than twice that of said first source, means for continuously connecting said second source to the rails to continuously energize or deenergize said code following track relay, and means on said vehicle responsive only to a potential greater than that of said first source for indicating whether said track relay is following code.

15. In railway signaling apparatus comprising a normally energized track relay connected to the track rails so as to be deenergized by the shunting action of the wheels and axles of a passing train; improved means for protecting a special vehicle whose wheels are ineffective to shunt said relay comprising a first source of electrical energy on said vehicle, means for connecting said source to the rails to modify the energization of said track relay, a second source of electrical energy having a character distinctively different from said first source, means including said track relay and responsive to such a modification in the energization thereof to connect said second source to the track rails to supply a potential of said distinctive character thereto, means responsive to the approach of a train toward said section to cut off said supply of distinctive electrical potential, and an indicator on the vehicle responsive to said distinctive potential to indicate that it is safe for said vehicle to proceed.

16. In railway signaling apparatus comprising a normally energized track relay connected to the track rails so as to be deenergized by the shunting action of the wheels and axles of a passing train; improved means for protecting a special vehicle whose wheels are ineffective to shunt said relay comprising a first source of electrical energy on said vehicle, means for connecting said source to the rails to modify the energization of said track relay, a second source of electrical energy having a character distinctively different from said first source, means including said track relay and responsive to such a modification in the energization thereof to connect said second source to the track rails to supply a potential of said distinctive character thereto, a third source of electrical energy having a character distinctively different from said first and second sources, means responsive to the approach of a train toward said section to connect said third source to the track rails provided the energization of said track relay is modified by said first source, and a pair of indicating means on the vehicle respectively responsive to said second and third sources.

17. In railway signaling apparatus comprising a normally energized track relay connected to the track rails so as to be deenergized by the shunting action of the wheels and axles of a passing train; improved means for protecting a special vehicle whose wheels are ineffective to shunt said relay comprising a first source of electrical energy on said vehicle, means for connecting said source to the rails to modify the energization of said track relay, a second source of electrical energy having a character distinctively different from said first source, means including said track relay and responsive to such a modification in the energization thereof to connect said second source to the track rails to supply a potential of said distinctive character thereto, a third source of electrical energy having a character distinctively different from said

first and second sources, means responsive to the approach of a train toward said section to cut off the connection of said second source to the track rails and to connect said third source to the track rails provided the energization of said track relay is modified by said first source, and a pair of indicating means on the vehicle respectively responsive to said second and third sources.

18. Railway signaling apparatus comprising a track section, a signal governing traffic movements into the section, a relay electrically connected to the track rails and responsive to electrical potentials therein for controlling said signal, portable means for controlling said relay including a first source of electrical energy, means for connecting said first source to the rails to modify the condition of energization of said relay, second and third sources of electrical energy each having characteristics distinct from the characteristics of the other and from the characteristics of said first source, means including said relay and effective upon modification of the energization thereof by said first source to cause said signal to display a restrictive aspect and to connect said second source to the rails, means responsive to the approach of a train toward said section, means including said approach responsive means for connecting said third source to the rails when a train approaches, and first and second indicating means associated with said portable means and connected to the rails, said first and second indicating means being respectively responsive only to potentials from said second and third sources.

19. Railway signaling apparatus comprising a track section, a signal governing traffic movements into the section, a relay electrically connected to the track rails and responsive to electrical potentials therein for controlling said signal, portable means for controlling said relay including a first source of electrical energy, means for connecting said first source to the rails to modify the condition of energization of said relay, second and third sources of electrical energy each having characteristics distinct from the characteristics of the other and from the characteristics of said first source, means including said relay and effective upon modification of the energization thereof by said first source to cause said signal to display a restrictive aspect and to connect said second source to the rails, means responsive to the approach of a train toward said section, means including said approach responsive means for connecting said third source to the rails and simultaneously cutting off said second source from the rails when a train approaches, and first and second indicating means associated with said portable means and connected to the rails, said first and second indicating means being respectively responsive only to potentials from said second and third sources.

20. In combination with railway signaling apparatus comprising a track section having a track circuit including a first source of electrical energy, the rails of said section and a track relay, and a signal controlled by the track relay and governing traffic movements into the section, said relay being effective when deenergized by the shunting action of the wheels and axles of a passing train to cause said signal to display a restrictive aspect; emergency apparatus for controlling said signal comprising a second source of electrical energy having a potential sufficient to at least balance that of said first source, means for connecting said second source to the rails so as to modify the potential between the rails and thereby the energization of the track relay in a manner distinctively different from any modification imparted thereto by said first source, means including said track relay and effective upon such a modification in the energization thereof to cause said signal to display a restrictive aspect, means responsive to the approach of a train toward said section, a third source of electrical energy having characteristics distinctively different from those of said first and second sources, and means including said track relay and said approach responsive means for connecting said third source to the rails when the energization of said track relay is so distinctively modified and a train approaches, and indicating means associated with said emergency apparatus and responsive only to potential from said third source.

21. Railway signaling apparatus comprising a track section, a signal governing traffic movements into the section, a relay electrically connected to the track rails and responsive to electrical potentials therein for controlling said signal, portable means for controlling said relay including a first source of electrical energy, means for connecting said first source to the rails to modify the condition of energization of said relay, a second source of electrical energy having characteristics distinct from those of said first source, means including said relay and effective upon modification of the energization thereof by said first source to cause said signal to display a restrictive aspect and to connect said second source to the rails, means responsive to the approach of a train toward said section, means including said approach responsive means for disconnecting said second source from the rails when a train approaches, and indicating means associated with said portable means and connected to the rails, said indicating means being responsive only to potential from said second source.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,982,626	Baughman	Dec. 4, 1934
2,024,845	Bourdon	Dec. 17, 1935
2,069,870	Baughman	Feb. 9, 1937
2,081,555	O'Hagen	May 25, 1937
2,156,710	Thompson	May 2, 1939
2,176,616	Thompson	Oct. 17, 1939