

Nov. 9, 1937.

L. H. PETER

2,098,833

TRACK CIRCUIT SIGNALING SYSTEM FOR RAILWAYS AND THE LIKE

Filed March 16, 1935

2 Sheets-Sheet 1

Fig. 1.

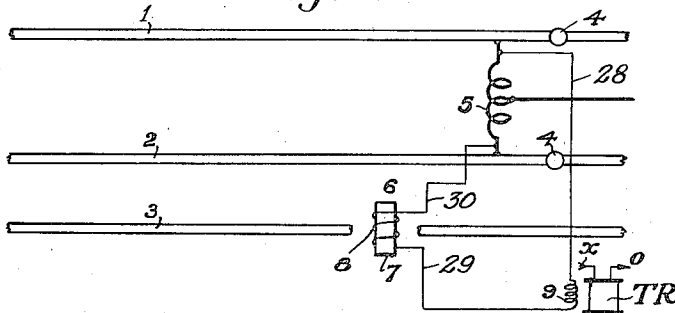


Fig. 2.

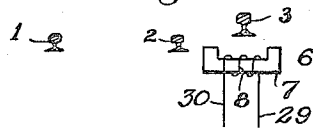


Fig. 3.

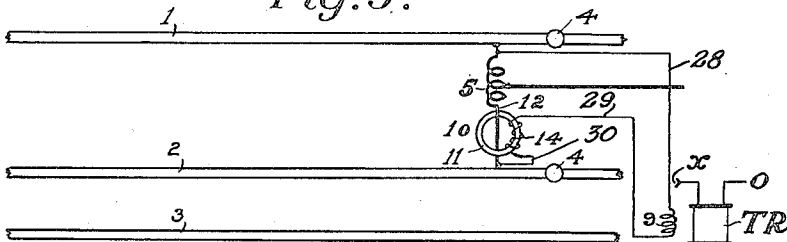
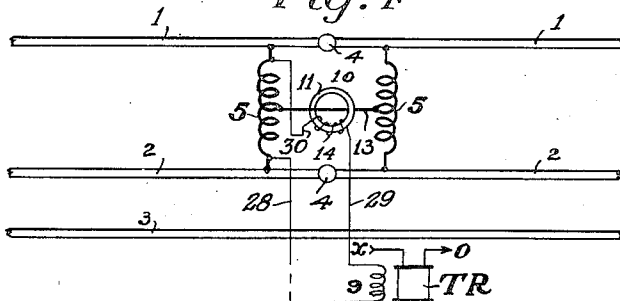


Fig.4



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2 Sheets-Sheet 2

Fig. 5.

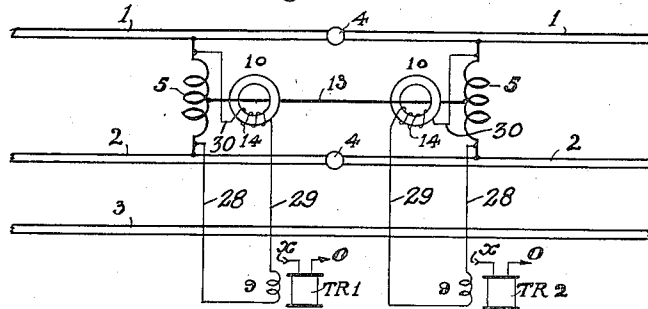


Fig. 6.

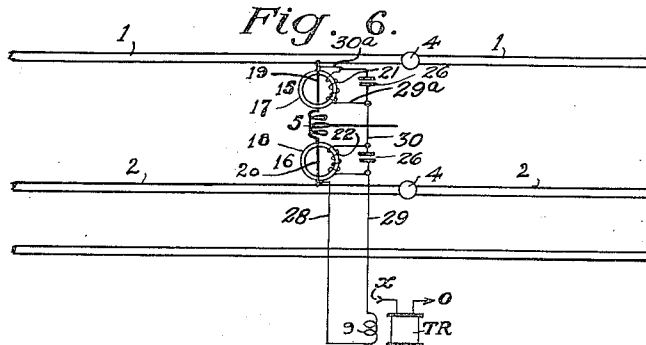


Fig. 7.

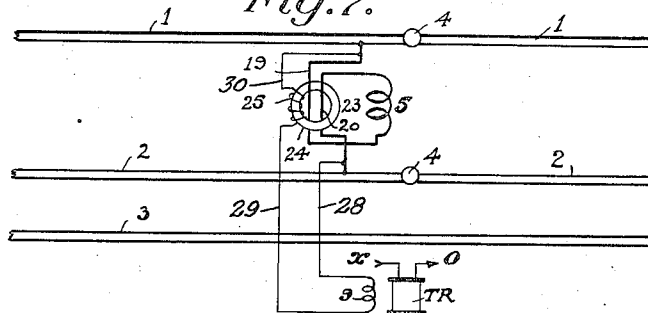


Fig. 8.

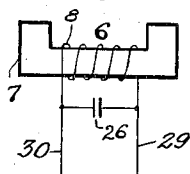


Fig. 9.

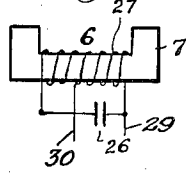


Fig. 10.

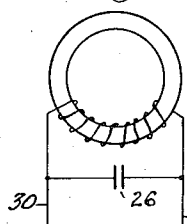
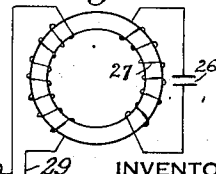


Fig. 11.



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2,098,833

TRACK CIRCUIT SIGNALING SYSTEM FOR
RAILWAYS AND THE LIKE

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Application March 16, 1935, Serial No. 11,375
In Great Britain March 17, 1934

11 Claims. (Cl. 246—37)

This invention relates to signaling systems for railways and the like of the kind in which the track rails subdivided into block sections are arranged to be supplied with signaling current and are also utilized as the return circuit for the propulsion current.

In order to avoid any appreciable difference of potential between the two track rails due to the propulsion current traversing these rails it is usual to provide inductance bonds cross-connecting the two track rails at each end of a block section the middle points of the windings of the two bonds adjacent to the joint between one block section and the next successive section being connected together so as to complete the continuity of the return path for the propulsion current from section to section throughout the system.

The propulsion current traversing the track rails as above described is a direct current which is generally derived from an alternating current supply circuit through rotary converters or rectifiers of the mercury arc type and in the latter case it is found that the rectified current has a relatively high frequency alternating component or ripple which may exert an important adverse influence upon the operation of the signaling system.

So long as the return propulsion current is equally divided between the two track rails the currents in the two halves of the winding of the inductance bond will evidently exactly neutralize each other as regards the magnetization of the core of the bond and the ripple frequency components of these currents will cause equal and opposite voltage drops in the halves of the bond winding which will thus neutralize each other as regards the voltage across the two track rails.

Owing however to the positive supply conductor or third rail for the propulsion current being usually differently inductively related to one track rail from the other, this third rail being for example located adjacent to one track rail on the side thereof remote from the other track rail, the ripple frequency component of the propulsion current tends to traverse one track rail almost entirely to the exclusion of the other. In the case of a third rail located as above described nearly 100% of the ripple frequency component of the propulsion current is found to traverse the track rail adjacent to the third rail although the direct current component of the propulsion current is substantially equally divided between the two track rails.

As a result an alternating current voltage of

ripple frequency is developed across the two track rails, which is evidently impressed upon the track relay connected across the track rails and this voltage is not only increased by the approach of a train or vehicle utilizing propulsion current to the relay but the presence of the train or vehicle does not effectively shunt or divert the current due to this voltage from the relay owing to its relatively high frequency.

It will thus be appreciated that under the conditions above described the track relay may fail to be effectively shunted or short-circuited by the presence of the train or vehicle, the relay winding being traversed by an alternating current of ripple frequency which may be of sufficient magnitude to maintain the relay energized.

The present invention has for its object to avoid this serious defect by providing arrangements for neutralizing any action of a ripple frequency component of the propulsion current upon the relay and according to the invention a compensating or correcting alternating voltage derived from the ripple component of any unbalanced propulsion current in the two track rails is arranged to be impressed upon the track relay winding in such a manner as to oppose the corresponding current of ripple frequency traversing this winding due to its connection to the track rails or otherwise.

As an example of the conditions to which the invention is applicable it may be stated that when the propulsion current of an electric railway is derived from a hexa-phase connected mercury arc rectifier supplied from a 50 cycle alternating current circuit it is found that the rectified current contains a ripple or alternating current component of 300 cycle frequency which may have a root-mean-square or effective value of 4% to 6% of the direct current component, this ripple being present not only in the return propulsion current in the track rails but also in the feed wires supplying signaling current to the system in cases in which this latter current is derived directly or indirectly from the alternating current source from which the rectifier is supplied. There may thus be present in the track winding of a track relay or in both the track and local windings of a two element track relay an alternating current having a frequency of 300 cycles per second and when the track rails are traversed by a relatively large unbalanced return current due to the approach of a train to the relay, the track winding of the relay may be traversed by a 300 cycle alternating current which is sufficient to energize the relay in spite of the presence of the train.

The invention is illustrated by way of example in the accompanying drawings of which Figure 1 is a diagrammatic plan view of a portion of a track circuit for an electric railway provided with arrangements for neutralizing the action of the ripple frequency of the propulsion current upon the track relay in accordance with one form of the invention, Figure 2 being a transverse view of the track shown in Figure 1. Figures 3, 4, 5, 6, and 7 are views similar to Figure 1 illustrating various modified arrangements embodying the invention, Figures 8, 9, 10, and 11 being detail views of portions of the apparatus illustrated in the preceding figures.

Referring now first to Figures 1 and 2, it will be seen that the track rails of an electric railway are indicated at 1, 2, the third rail of the propulsion circuit for the supply of propulsion current being indicated at 3. Each of the track rails 1, 2 is subdivided into sections by insulated joints 4 to form track circuits, each of which is energized in the usual manner so as to cause alternating signaling current to flow in the track winding of a track relay TR connected across rails 1, 2 at one end of the track section and the two track rails are cross-connected by an inductance bond 5 at each end of the section in the usual manner so as to permit both track rails to serve as a path for the return current of the propulsion circuit.

A compensating inductor 6 is provided comprising a magnetic core 7 inductively related to the positive propulsion current conductor or third rail 3 as shown in Figure 2, the core 7 being provided with a winding 8 connected in series with the track winding 9 of the usual two element track relay TR across the track rails 1, 2. The path of the signaling current in the portion of the track circuit shown in Fig. 1 may be traced from rail 1 to wire 28, track winding 9 of track relay TR, wire 29, winding 8 of the compensating inductor 6, wire 30 to rail 2. The local winding of track relay TR is connected in the usual manner to terminals x and o of a local source of signaling current, which, it is to be understood, is of the same frequency and of the proper phase with respect to the signaling current derived from the track rails. It will be understood that the ripple component of the propulsion current traversing the third rail 3 will induce in the inductor winding 8 an alternating voltage which is arranged to be opposite in phase to the corresponding ripple voltage impressed upon the track winding 9 of the relay TR from the track rails 1, 2 due to the unbalanced return propulsion current and thus effects the desired neutralization as regards the current traversing the relay winding 9.

If desired the inductor 6 may be arranged to be inductively related to the track rail 2 adjacent to the third rail 3 for the same purpose.

In another form of the invention illustrated in Figures 3, 4, and 5 an inductor 10 comprising a closed or substantially closed magnetic core 11 is utilized, the core 11 surrounding the conductor carrying the return propulsion current or a portion thereof. This conductor may for example as shown in Figure 3, be the conductor 12 connecting the winding of the inductance bond 5 to the track rail 2 adjacent to the third rail 3 or as shown in Figure 4 the conductor may be the conductor 13 connecting the middle points of the windings of adjacent bonds 5. The core 11 of the inductor 10 is provided with a winding

14 connected in series with the winding 9 of the track relay across the track rails and the voltage induced in the winding 14 by the ripple component of the current traversing the conductor 12 or 13 is impressed upon the track relay TR and effects the required compensation as already explained.

Figure 5 illustrates an arrangement similar to that of Figure 4 as applied to the track relays TR1 and TR2 of two adjacent track sections.

It will be understood that in all the arrangements above described the compensation or neutralization of the ripple by the action of the inductor 6 or 10 is based upon an assumed constant extent of unbalancing in the distribution of the return propulsion current between the two track rails 1, 2 but in cases in which this unbalancing is variable modified arrangements enabling the desired compensation to be effected for all degrees of unbalancing may be adopted.

In the arrangement shown in Figure 6 the propulsion current traversing each of the track rails 1, 2 is caused to influence a separate inductor the windings of the two inductors being connected in series with one another and with the track relay across the track rails in such a manner that the ripple frequency voltages induced in the two inductor windings are opposed to each other and the compensating voltage impressed upon the relay thus corresponds to the unbalanced ripple current component.

In the arrangement of Figure 6 the two inductors are indicated at 15, 16, the magnetic cores 17, 18 of these inductors surrounding the conductors 19, 20 connecting the inductance bond 5 to the track rails 1, 2 respectively. The path of the signaling current in Fig. 6 may be traced from rail 2, wire 28, track winding 9 of relay TR, wire 29, winding 22 of inductor 16, wire 30, wire 29a, winding 21 of inductor 15, wire 30a to rail 1. The windings 21, 22 of the inductors 15, 16 are oppositely connected with respect to the propulsion current and are in series with each other in the circuit of the winding 9 of the track relay TR.

In the modified arrangement shown in Figure 7 only a single inductor 23 is provided the magnetic core 24 of which surrounds both of the conductors 19, 20 connecting the inductance bond 5 to the track rails 1, 2, the winding 25 of the inductor 23 being connected in the circuit of the relay winding 9 of the track relay TR.

In order to increase the sensitivity of the inductors employed in any of the arrangements above described the circuit of the winding of the inductor may be tuned by providing a condenser connected either directly across the winding or across an auxiliary winding on the inductor, the capacity of the condenser being so determined that the inductor circuit is resonant at the ripple frequency.

As shown in Figure 8, the inductor 6 utilized in the system shown in Figure 1 is provided with a condenser directly connected across the terminals of the inductor winding 8 to which wires 29 and 30 are connected, while in Figure 9 the condenser 26 is shown as connected across the terminals of a winding 27 on the core 7 of the inductor 6, a portion of this winding being connected to wires 29 and 30 in the circuit of the relay winding 9.

Similar arrangements may be provided for the inductors utilized in the system of Figures 3, 4, 5, 6, and 7, the condenser 26 being either directly connected across the winding of the in-

ductor as shown in Figures 6 and 10 or across an auxiliary winding 27 on the magnetic core of the inductor as shown in Figure 11.

The invention is evidently not limited to any particular construction or connection of the inductor or its equivalent employed and variations in these and other respects may obviously be made without exceeding the scope of the invention.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a signaling system for electric railways employing the track rails as conductors of alternating signaling current and as the return conductor of the propulsion current circuit, a track relay having a winding connected across the track rails to render said relay responsive to alternating signaling current in the track rails, and means for preventing the response of the track relay to alternating current derived from the propulsion current circuit due to the connection of said winding to the track rails comprising an inductor having a winding electromagnetically coupled with the propulsion circuit and connected across the track rails in series with said track relay winding.

2. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor of the propulsion current circuit, a track relay having a winding connected to the track rails to render said relay responsive to a signaling current potential difference impressed across the track rails, and means for preventing the response of said track relay to a potential difference across the track rails due to an inequality in the propulsion current in the two track rails, comprising means for deriving inductively a compensating potential difference from a part of the propulsion circuit which does not include the track rails, and means for impressing said compensating potential difference upon said track relay winding in such a direction as to oppose the flow of propulsion current in said winding.

3. In a signaling system for electric railways employing the track rails as the return conductor of the propulsion current circuit, a track relay having a winding connected across the track rails, and means for opposing the flow of the alternating current component of the propulsion current from one track rail to the other through said winding comprising a magnetic core, for inducing a flux in said core in proportion to the alternating current component of the propulsion current in one or both of the track rails, and a winding on said core included in series with said track relay winding.

4. In a signaling system for electric railways in which the propulsion current circuit includes a positive conductor and a return conductor comprising the track rails, a track relay having a winding connected across the track rails to render said relay responsive to alternating signaling current in the track rails, a magnetic core located in inductive relation to one or more of said conductors of propulsion current, and a winding on said core included in series with said track relay winding connected in such direction that the voltage induced by the propulsion current therein opposes the flow of the propulsion current from one track rail to the other through said windings.

5. In a signaling system for electric railways

employing the track rails as conductors of signaling current and as the return conductor for the propulsion current circuit, insulated joints dividing the track rails into block sections, inductance bonds connected across the track rails on each side of the insulated joints having their mid-points connected together to provide a path for the propulsion current from the rails of one block section to the rails of the adjacent block section, a track relay having a winding connected across the track rails adjacent one of said inductance bonds to render said relay responsive to signaling current in the track rails, and means for neutralizing the effect of the propulsion current upon the track relay due to the connection of said winding to the track rails, comprising a compensating coil inductively coupled to the propulsion circuit and connected across the track rails in series with said track relay winding.

6. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor for the propulsion current circuit, insulated joints dividing the track rails into block sections, inductance bonds connected across the track rails on each side of the insulated joints having their mid-points connected together to provide a path for the propulsion current from the rails of one block section to the rails of the adjacent block section, a track relay having a winding connected across the track rails adjacent one of said inductance bonds to render said relay responsive to signaling current in the track rails, and means for neutralizing the effect of the propulsion current upon the track relay due to the connection of said winding to the track rails, comprising a magnetic core inductively coupled to the conductor connecting a track rail to one end of the inductance bond adjacent the track relay, and a winding on said core connected across the track rails in series with said relay winding.

7. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor for the propulsion current circuit, insulated joints dividing the track rails into block sections, inductance bonds connected across the track rails on each side of the insulated joints having their mid-points connected together to provide a path for the propulsion current from the rails of one block section to the rails of the adjacent block section, a track relay having a winding connected across the track rails adjacent one of said inductance bonds to render said relay responsive to signaling current in the track rails, and means for neutralizing the effect of the propulsion current upon the track relay due to the connection of said winding to the track rails, comprising a magnetic core inductively coupled to the conductor connecting the mid-points of said inductance bonds, and a winding on said core connected across the track rails in series with said track relay winding.

8. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor for the propulsion current circuit, insulated joints dividing the track rails into block sections, inductance bonds connected across the track rails on each side of the insulated joints having their mid-points connected together to provide a path for the propulsion current from the rails of one block section to the rails of the adjacent block section, a track relay having a winding connected across the track rails adjacent one of said in-

ductance bonds to render said relay responsive to signaling current in the track rails, and means for neutralizing the effect of the propulsion current upon the track relay due to the connection of said winding to the track rails, comprising a magnetic core inductively coupled to the propulsion circuit, an inductor winding on said core connected across the track rails in series with said track relay winding, and a condenser so associated with said inductor winding as to render it selectively responsive to the frequency of the propulsion current.

9. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor for the propulsion current circuit, insulated joints dividing the track rails into block sections, inductance bonds connected across the track rails on each side of the insulated joints having their mid-points connected together to provide a path for the propulsion current from the rails of one block section to the rails of the adjacent block section, a track relay having a winding connected across the track rails adjacent one of said inductance bonds to render said relay responsive to signaling current in the track rails, and means for neutralizing the effect of the propulsion current upon the track relay due to the connection of said winding to the track rails, comprising windings magnetically coupled to the conductors connecting the track rails to the ends of the inductance bond adjacent the track relay, said windings being connected across the track rails in series with said track relay winding, and condensers so associated with said windings as to render them selectively responsive to the frequency of the propulsion current.

10. In a signaling system for electric railways in which the propulsion current circuit includes a positive conductor and a return conductor comprising the track rails, a track relay having a winding connected across the track rails to render said relay responsive to signaling current in the track rails, and means for compensating for the effect of alternating current in the propulsion circuit upon the track relay due to the connection of said winding to the track rails comprising an inductor winding tuned to resonance at the frequency of said alternating current and connected in series with said track relay winding, said inductor winding being coupled magnetically to at least one conductor of the propulsion circuit.

11. In a signaling system for electric railways employing the track rails as conductors of signaling current and as the return conductor of the propulsion current circuit, a track relay having a winding connected across the track rails to render said relay responsive to alternating signaling current in the track rails, and means for preventing the response of the track relay to alternating current flowing in the propulsion circuit due to an unbalance in such alternating current in the two rails, comprising an inductor having a winding tuned to the frequency of said alternating current and connected across the track rails in series with said track relay winding, said inductor winding being electromagnetically coupled to the propulsion circuit in such a direction that the voltage induced therein opposes the flow of current from one track rail to the other through said windings.

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