

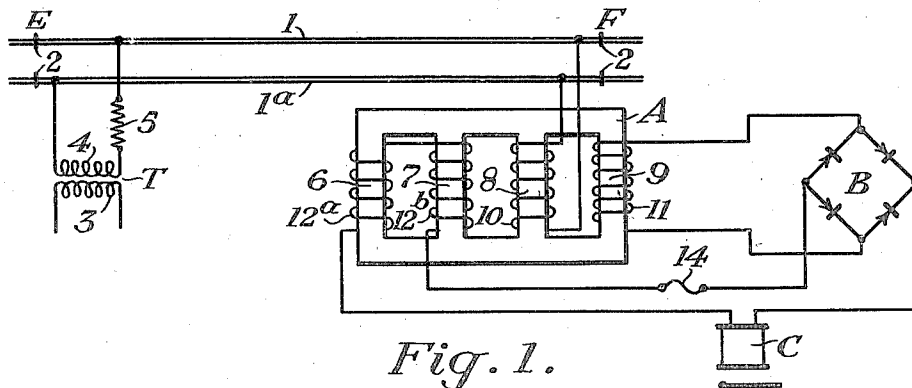
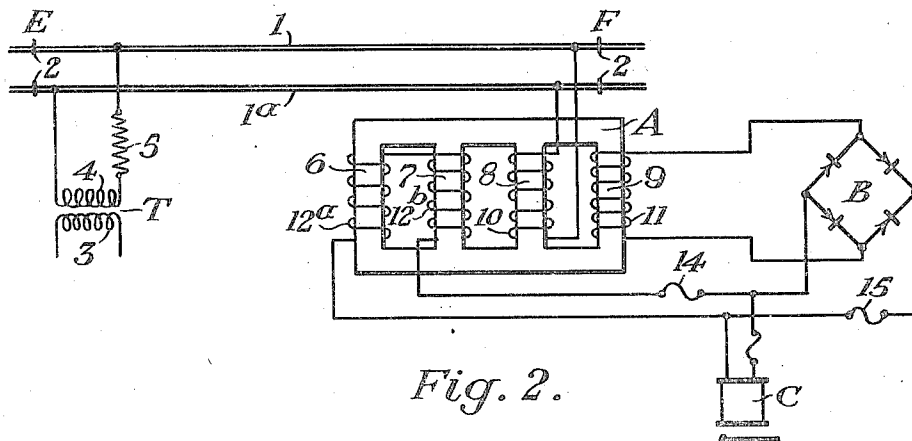
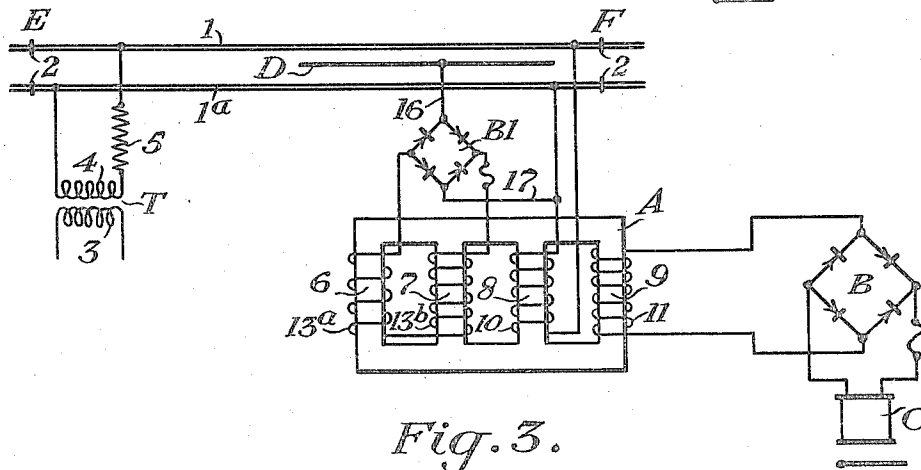
Nov. 24, 1936.

H. G. WITMER ET AL

2,061,747

RAILWAY TRACK CIRCUIT APPARATUS

Original Filed Aug. 8, 1934 2 Sheets-Sheet 1



INVENTORS
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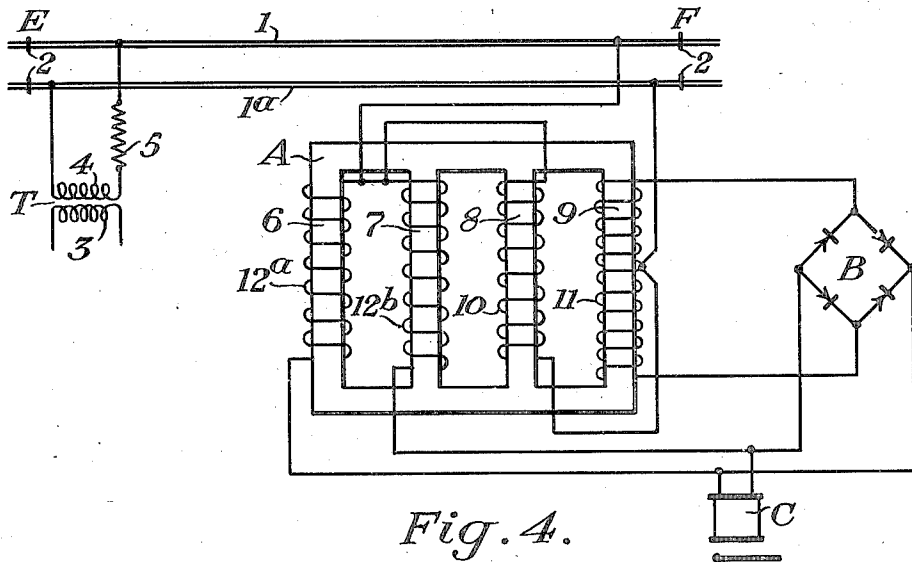
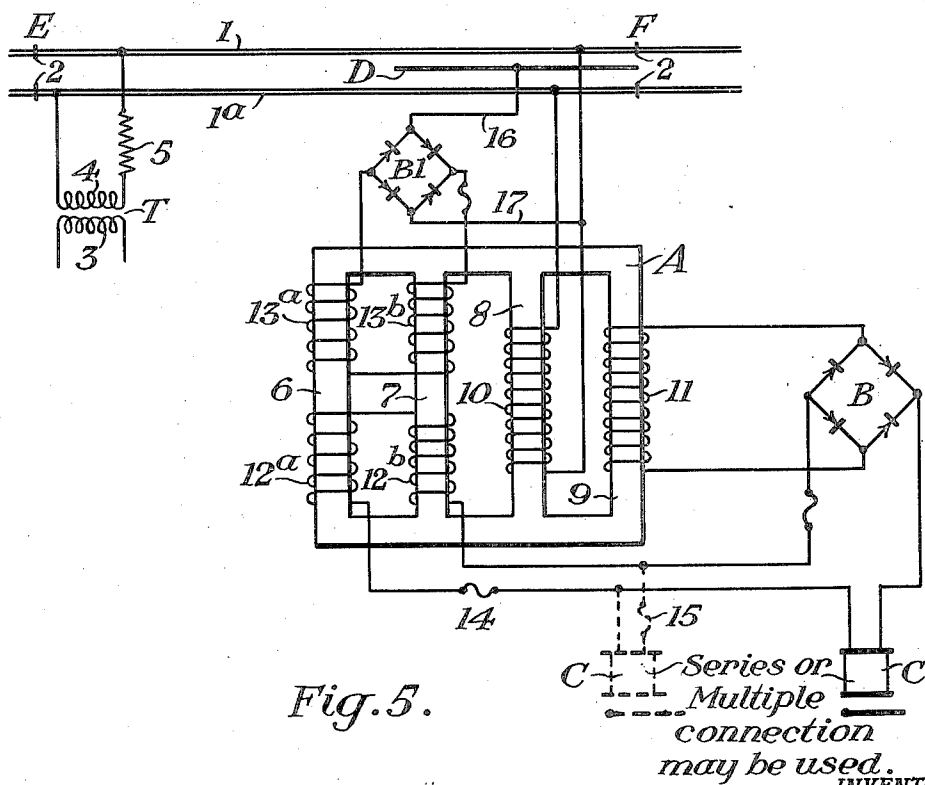
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UNITED STATES PATENT OFFICE

2,061,747

RAILWAY TRACK CIRCUIT APPARATUS

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17 Claims. (Cl. 246—34)

Our invention relates to railway track circuit apparatus, and has for an object the provision of novel and improved means for increasing the shunting sensitivity of apparatus of this character.

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

In the accompanying drawings, Figs. 1 to 5, inclusive, are diagrammatic views showing various forms of apparatus each embodying our invention.

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

Referring first to Fig. 1, the reference characters 1 and 1^a designate the track rails of a stretch of railway track, which rails are divided by insulated joints 2 to form a track section E—F. Located adjacent one end of this section is a transformer T, the primary 3 of which is supplied with alternating current from a source which is not shown in the drawings, and the secondary 4 of which is connected across the track rails 1 and 1^a through the usual current-limiting impedance 5. Located at the other end of the section is a transformer A, the magnetizable core of which is made up of four parallel legs 6, 7, 8, and 9. A primary coil 10 is wound on one of these legs 8, and is connected across the rails of the section E—F. A secondary coil 11 is wound on leg 9. Mounted on the legs 6 and 7 are two oppositely wound controlling coils 12^a and 12^b. A full wave rectifier B has its input terminals connected with the secondary coil 11, and this rectifier is provided with an output circuit which includes the two controlling coils 12^a and 12^b and the operating winding of a track relay C all connected in series.

The direct current furnished by the rectifier B tends to saturate the legs 6 and 7 of the transformer A, and variations in the value of this current will therefore vary the reactance of the transformer; and the variations in the reactance serve in turn to regulate the output of the rectifier B. As the voltage received by the primary coil 10 from the track rails increases, the voltage delivered by the secondary coil 11 increases, and this in turn increases the direct current supplied to the controlling coils 12^a and 12^b by the rectifier B. The consequent increase in the saturation of the leakage paths reduces the reactance in series with the rectifier B, so that the current delivered by the rectifier is still further increased. Thus a small increase in the alternating voltage received from the track rails will cause a large increase in the rectifier current supplied to the track relay C, and conversely, a small decrease in the alternating voltage received from the rails will cause a relatively large decrease in the current supplied to the relay C. If the apparatus is so adjusted

that under minimum ballast resistance condition the current supplied to the relay C is the normal value, then when the ballast resistance is infinite, a large current will flow through relay C, but any shunt across the track rails of a lower resistance than the total minimum ballast resistance will cause a large decrease in the current supplied to the relay C below the normal value. It follows that the track circuit apparatus has high shunting sensitivity.

The alternating magnetic fluxes created in the core legs 6 and 7 by current in the primary coil 8 will induce practically equal and opposite alternating voltages in the two oppositely wound coils 12^a and 12^b, and so these fluxes will create substantially no alternating voltage in the circuit for relay C.

Referring to Fig. 2, the apparatus shown in this view is the same as that shown in Fig. 1, except that the output circuit for the rectifier B has two multiple branches, one of which includes the track relay C and the other of which includes the controlling coils 12^a and 12^b connected in series. The operation of the apparatus shown in Fig. 2 will be understood from the foregoing discussion of Fig. 1.

Referring now to Fig. 3, the apparatus shown in this view is the same as that shown in Fig. 1, except as to the means for supplying direct current to the controlling coils on the transformer legs 6 and 7. These controlling coils, which are here designated 13^a and 13^b, are connected in series in the output circuit of a second rectifier B1. One input terminal of this rectifier is connected with one of the track rails 1^a through a conductor 17, and the other input terminal is connected through a conductor 16 with an auxiliary conductor D, which is in contact with the track ballast. The output circuit for rectifier B includes only the operating winding of the track relay C.

When the track ballast resistance is infinite, no direct current will be supplied to the controlling coils 13^a and 13^b, and the apparatus should be so adjusted that under this condition just enough current flows in the track relay C to energize this relay. As the ballast resistance decreases, an alternating voltage will be applied to the rectifier B1, and this rectifier will in turn supply direct current to the coils 13^a and 13^b, thereby reducing the effective reactance of the transformer by an amount sufficient to compensate for the decrease in track voltage produced by the ballast leakage current. Under all conditions of track ballast, therefore, the current supplied to relay C will remain substantially constant at the value required to energize this relay, and so the shunting sensitivity of the apparatus will be relatively high.

With apparatus of the character shown in

Figs. 1, 2, and 3, any fault which results in a reduction of transformer reactance will cause an increase in the current supplied to the track relay with a resultant loss in the shunting sensitivity. Such a condition might arise, for example, if part or all of one of the controlling coils should become short-circuited. Such a failure would cause a large increase in the current supplied to the relay, and with the apparatus shown in Figs. 1 and 2 it would cause a large increase in the current supplied to the controlling coils. Fuses 14 and 15 may be provided in the apparatus shown in Figs. 1 and 2 to furnish protection whenever a large part of either of the controlling coils become short-circuited. Another means for providing the desired protection is illustrated in Fig. 4. The apparatus shown in this view is the same as that shown in Fig. 2, except that a center tap in the secondary coil 11 is connected with a center tap between the controlling coils 12^a and 12^b through the primary coil 10. The relationship between the relative polarity of the alternating current in the primary coil 10 and the relative polarity of the alternating currents induced in the controlling coils is such that no net alternating voltage is produced in the connection between these two center taps. With the apparatus constructed in this manner, a short-circuit of any magnitude in the controlling coils will reduce the current supplied to the relay C and a total short-circuit of either controlling coil will cause the relay to release. By connecting the track rails with these two center taps, and by connecting the primary coil 10 across the center taps, complete protection is provided against false operation due to a break in any of the wires of the apparatus.

Referring now to Fig. 5, the apparatus shown in this view is a combination of the two forms shown in Figs. 1 and 3. In Fig. 5 the transformer legs 6 and 7 are provided with two controlling coils 12^a and 12^b, which are energized from rectifier B in the manner shown in Fig. 1; and these legs are provided with auxiliary controlling coils 13^a and 13^b which are energized in accordance with ballast resistance as in Fig. 3. The advantage of the low relay energization of Fig. 3 is thus amplified by the high shunting sensitivity of Fig. 1, and so the shunting sensitivity of the apparatus shown in Fig. 5 will be higher than in any of the other views. As indicated by the dash lines in Fig. 5, the output circuit of rectifier B may be the same as that shown in Fig. 2, instead of the same as that shown in Fig. 1.

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

Having thus described our invention, what we claim is:

1. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, and an output circuit for said rectifier including said

controlling coils connected in series and the operating winding of a track relay.

2. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, and an output circuit for said rectifier including said controlling coils and the operating winding of a track relay all connected in series.

3. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, and an output circuit for said rectifier having two multiple branches one of which includes said regulating coils in series and the other of which includes the operating winding of a track relay.

4. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core and connected in series, a connection from one rail of said section to a center tap in said secondary coil, a connection from the other rail of said section to a center tap between said regulating coils, means for connecting said primary coil across said two center taps, and an output circuit for said rectifier including said regulating coils and the operating winding of a track relay.

5. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, an auxiliary conductor in contact with the track ballast, a second rectifier having its input terminals connected with said conductor and one of the track rails, respectively, an output circuit for said second rectifier including said two controlling coils in series, and an output circuit for said first rectifier including the operating winding of a track relay.

6. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, an output

circuit for said rectifier including said controlling coils connected in series and the operating winding of a track relay, two auxiliary controlling coils oppositely wound on said two remaining legs, respectively, an auxiliary conductor in contact with the track ballast, a second rectifier having its input terminals connected with said conductor and one of the track rails, respectively, and an output circuit for said second rectifier including said auxiliary controlling coils connected in series.

7. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and receiving current from the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core and connected in series, means for supplying said controlling coils with direct current the value of which varies in response to variations in the resistance of the track ballast, and an output circuit for said rectifier including the operating winding of a track relay.

8. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and receiving current from the rails of said section, a secondary coil wound on another of said legs, two controlling coils oppositely wound on the two remaining legs of said core, respectively, and connected in series, means for supplying said controlling coils with direct current the value of which varies in accordance with variations in the resistance of the track ballast, and a track relay receiving current from said secondary coil.

9. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and receiving current from the rails of said section, a secondary coil wound on another of said legs, two controlling coils oppositely wound on the two remaining legs of said core, respectively, and connected in series, an auxiliary conductor in contact with the track ballast, a rectifier having its input terminals connected with said conductor and one of the track rails, respectively, and its output terminals connected with said controlling coils, and a track relay receiving current from said secondary coil.

10. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a core made up of four parallel legs, a primary coil wound on one of said legs and connected across the rails of said section, a secondary coil wound on another of said legs, a rectifier having its input terminals connected with said secondary coil, two controlling coils oppositely wound on the two remaining legs, respectively, of said core, and means for supplying said auxiliary controlling coils with direct current the value of which varies in accordance with variations in the resistance of the track ballast.

11. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having a primary coil receiving current from the rails of said section, a rectifier having its input ter-

minals connected with the secondary of said transformer and its output terminals connected with a track relay, and means for varying the reactance of said transformer in response to variations in the output current of said rectifier.

12. In combination, a stretch of railway track, a source of alternating current connected across the rails of said section, a transformer the primary of which receives current from said rails, a track relay receiving current from the secondary of said transformer, and means for varying the reactance of said transformer in response to variations in the resistance of the track ballast.

13. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having an input winding receiving current from the rails of said section, a rectifier receiving current from the output winding of said transformer, a track relay energized from the output of said rectifier, and means for varying the reactance of said transformer in response to variations in the output current of said rectifier.

14. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having an input winding receiving current from the rails of said section, a track relay receiving current from the output winding of said transformer, and means including an auxiliary winding of said transformer for varying the reactance of the transformer in response to variations in the resistance of the track ballast.

15. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having an input winding receiving current from the rails of said section, a rectifier receiving current from the output winding of said transformer, an auxiliary winding on said transformer, an auxiliary conductor in contact with the track ballast, a second rectifier having its input terminals connected with said conductor and one of the track rails, respectively, an output circuit for said second rectifier including said auxiliary conductor, and a track relay governed by the output current of said first rectifier.

16. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having an input winding receiving current from the rails of said section, a rectifier receiving current from the output winding of said transformer, an auxiliary winding for said transformer, means for supplying said auxiliary winding with direct current the value of which varies in response to variations in the resistance of the track ballast, and an output circuit for said rectifier including the operating winding of a track relay.

17. In combination, a section of railway track, a source of alternating current connected across the rails of said section, a transformer having an input winding receiving current from the rails of said section, a rectifier receiving current from the output winding of said transformer, an auxiliary winding for said transformer, and means including said rectifier for supplying said auxiliary winding with direct current the value of which varies in accordance with variations in the resistance of the track ballast.

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