June 8, 1937. O. A. ROSS 2,083,475

AUTOMATIC BALLAST COMPENSATING MEANS FOR RAILWAY TRACK CIRCUITS

Filed March 12, 1932

FIG. 1.

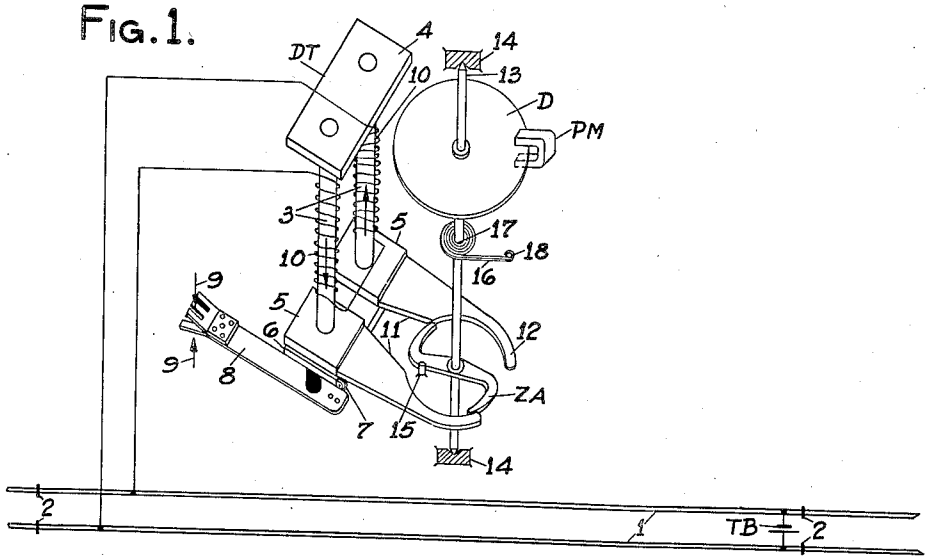


FIG. 2.

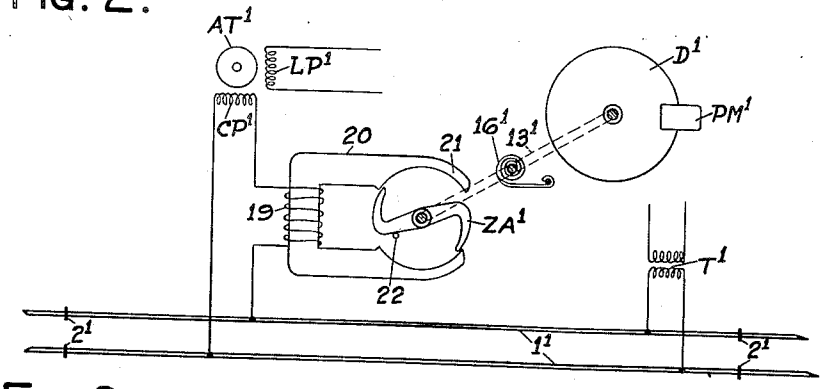
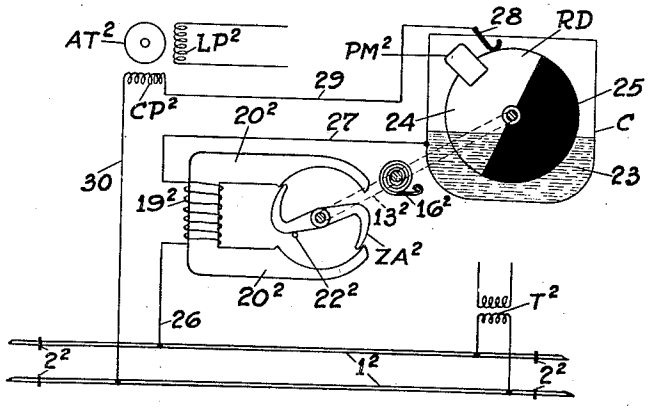


FIG. 3.



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AUTOMATIC BALLAST COMPENSATING MEANS FOR RAILWAY TRACK CIRCUITS

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16 Claims. (Cl. 246—41)

This invention relates in general to railway signalling practice, and has more particular reference to means for automatic compensating for ballast changes in track circuits, as used in railway practice, and is an improvement upon the invention disclosed in the prior application of Bodde, Ser. No. 488,897 filed October 15. 1930.

In connection with track circuits as employed in railway practice, ballast conditions may change radically and quickly. For example, dry ballast may become wet, or vice versa, whereby to vary the current leakage between rails and hence vary the terminal voltage across a track relay to thereby tend to vary the performance of the track relay under both shunted and unshunted conditions.

For example, should a track relay be properly adjusted for holding up in an unoccupied block under dry ballast conditions, should the ballast become wet, the resulting decreased terminal voltage across the relay may allow the relay to release its armature, even if unshunted, or what is more likely, after having released its armature due to having been shunted, the decreased terminal voltage may be insufficient to pick it up, upon its block becoming unoccupied.

With the above and other considerations in mind, it is proposed, in accordance with this invention, to provide automatic means whereby to adjust for ballast changes to thereby maintain proper operation of the track circuit at all times, regardless of changes in ballast conditions.

More specifically, it is proposed to provide, in one case, a magnetic shunt which changes in value in accordance with the ballast changes, to thereby automatically maintain the performance of the track circuit a constant one.

In another case a variable magnetic path is employed to vary the inductive reactance in one phase of a two phase alternating current track relay, to thereby maintain constant operating characteristics regardless of ballast changes.

In another case, not only is the inductance in one phase of a two element relay automatically varied in accordance with ballast conditions, but a resistance in its circuit is automatically varied, under proper conditions.

Further objects, purposes and characteristic features of this invention will appear as the description progresses, reference being made to the accompanying drawing showing, solely by way of example, and in no manner whatsoever in a limiting sense, several forms of the invention. In the drawing:—

Fig. 1 is a wholly schematic showing of one form of the invention.

Fig. 2 is a wholly schematic showing of a modified form of the invention.

Fig. 3 is a wholly schematic showing of a further modified form of the invention.

Referring now to the drawing, and first to the form of invention shown in Fig. 1, there is here shown, for the purpose of illustrating the invention, a stretch of single track constituted by track rails 1, separated into insulated track sections by insulating joints 2. The track section is supplied with a usual track battery TB, connected across one end of the section, while across the other end of the section is connected a track relay DT which, in this form of invention shown, is a direct current tractive type relay.

The relay DT includes core members 3, connected together by a back strap 4, and carrying spaced pole shoes 5, with which cooperates a tractive type armature 6, pivoted as at 7, and carrying contact fingers 8, (one only of which has been illustrated) for cooperating with fixed front and back contacts 9.

Carried on the cores 3 are windings 10, arranged to cause the fluxes produced by the windings, when energized, to be cumulative, in the usual manner, whereby to attract armature 6 toward pole shoes 5.

In the particular form of relay shown in Fig. 1, each of the pole shoes 5 has an extension 11, terminating in semi-circular hornlike members 12, between which is arranged an armature ZA, of the Z armature type. The armature ZA is mounted on a spindle 13, operating in bearings 14, and carrying a damping disc D, of aluminum or the like, for cooperating with a fixed permanent magnet PM, (which could of course if desired be an electro-magnet), for at times producing eddy currents in the disc D and damping relative movement between the disc and the magnet.

Biasing the spindle 13 to position the Z armature ZA against a fixed stop 15, is a coil spring 16, fixed at one end as at 17, to the spindle, and at the other end to a fixed anchorage 18.

From the above it can be seen that flux produced by the windings of the track relay, is shunted away from the armature 6, through a shunt path which includes the extensions 11 and the armature ZA, and as the current flowing in the windings 10 of the relay increases to thereby increase the generated flux, this magnetic shunt carries more flux and causes the

armature ZA to turn in a clockwise direction to so position the Z armature as to decrease the reluctance in the magnetic circuit afforded by this shunt path. The Z armature, in turning, must overcome the tension of the spring **16**, and must operate slowly, due to the damping effect of the aluminum disc cutting the magnetic field produced by the magnet PM.

The parts are shown in the positions and conditions assumed when the track block is unoccupied and wet ballast conditions exist, the Z armature ZA being positioned against the stop **15** by the spring **16**.

Assume now that the ballast dries up, for example, to thereby decrease leakage between the track rails **1** and hence increase the terminal voltage across the track relay. The increased current in the windings **10** increases the resulting flux produced thereby, to thereby cause the Z armature to turn clockwise against the tension of spring **16** and increase the shunting effect around the armature **6**, and hence maintain the holding effect on the armature **6** substantially constant regardless of the change in terminal voltage applied to the relay.

Upon the block being occupied, as by a train, the relay is shunted out in the usual manner to release its armature **6**. This decrease in terminal voltage due to the train shunt allows the spring **16** to move the armature ZA towards its stop **15**. This movement however, is slow, due to the damping effect of the magnet PM on the disc D, and the parts can be proportioned so as to cause this action to consume any desired amount of time.

It is preferably arranged so that the damping effect is sufficient to cause the Z armature to require substantially the full time of the occupancy of the block by a train proceeding at maximum speed, before it reaches its stop **15**.

In this manner, the magnetic shunt around the tractive armature **6** is maintained during occupancy and effectually insures against pick-up of the track relay during occupancy.

The damping means, however, can be differently proportioned, if desired, and can be so proportioned that the Z armature returns against its stop **15** shortly after occupancy, whereby to remove a large part of the magnetic shunt around the tractive armature **6** so that the track relay will have additional assurance of picking up with certainty and promptness upon its block becoming unoccupied.

Referring now to Fig. 2, there is here shown a second form of the invention, wherein a track relay AT^1 of the two-element alternating current type is employed, and the track section is supplied with alternating current track circuit energy as by a track transformer T^1.

The track relay, in this form of invention, has a local phase winding LP^1, and a control phase winding CP^1, and the relay can be, for example, of the usual induction motor type, the phases of the currents in the two windings being suitably displaced in any desired manner for producing a rotating field.

The control phase CP^1, includes in series therewith a winding **19**, placed on a core member **20**, having semi-circular extending spaced ends **21**, within which is positioned a Z armature ZA^1, mounted on a spindle 13^1, and spring biased by spring 16^1 to at times position the Z armature against a fixed stop **22**. The spindle 13^1 carries a damping disc D^1, cooperating with a magnet PM^1.

The form of invention shown in Fig. 2 operates, in general, as set forth above in connection with the form shown in Fig. 1, the Z armature automatically varying the reluctance of the magnetic circuit on which the choke winding **19** is placed, whereby, on ballast conditions changing from wet to dry, the terminal voltage across the control phase CP^1 of the track relay increases to increase the flux produced by the winding **19**. This increase in flux causes the Z armature ZA^1 to rotate clockwise against the tension of spring 16^1 and the damping effect of the disc D^1, to thereby decrease the reluctance of the magnetic path through the members **20**, whereby to increase the inductive reactance or choking effect on the control phase of the track relay. Thus the track relay is energized no more strongly under dry ballast conditions than under wet ballast conditions.

Advantage can also be taken of the change in the phase relationship of the currents in the two phase windings of the track relay, produced by the Z armature movement if desired. For example, the movement of the Z armature can shift the phase of the current in the control phase so as to either increase or decrease the resulting torque on the armature of the track relay, according as the result of the movement of the Z armature is to bring the two winding phases nearer to a 90° displacement, or further from a 90° displacement.

While the relay has been shown with the spindle 13^1 shown in a generally horizontal position, it is contemplated placing this spindle vertically if desired in order to minimize frictional losses. Furthermore, this variable induction means can be made relatively small and readily included within the usual relay casing to make a very compact and economical unit both with regard to manufacturing costs and with regard to space consumed.

Referring now to Fig. 3, the form of invention shown herein is very similar to that shown in Fig. 2, the Z armature ZA^2 automatically varying the reluctance of the magnetic circuit through the members 20^2, to thereby vary the inductive reactance or choking effect on the control phase winding CP^2, of the track relay AT^2, in the same manner as explained above in connection with Fig. 2.

In addition, however, to this automatic regulation, there is an adjustable resistance means automatically controlled, in the circuit of the control phase of the relay. This resistance means includes a container C, in the form shown made of conducting material, within which is a body of mercury **23**, or the like conducting liquid, the spindle 13^2 carrying a resistance disc RD having a conducting portion **24**, and a balancing non-conducting portion **25**. The circuit for the control phase winding CP^2 of the track relay can be traced from one track rail, wire **26**, winding 19^2, wire **27**, container C, mercury **23**, conducting disc portion **24**, brush or the like **28**, wire **29**, control phase winding CP^2, and wire **30** to the other track rail.

The position and condition of parts as shown in Fig. 3, are those existing when the track section is unoccupied and there is a maximum of ballast leakage, as for example, when the ballast is very wet.

Should the ballast dry up to increase the terminal voltage across the control phase winding of the track relay, the Z armature is driven in a clockwise direction against the tension of its

spring to increase the inductive reactance in the control phase winding circuit.

Movement of the spindle 13² in a clockwise direction also rotates the resistance disc RD in a clockwise direction to decrease the amount of the conducting portion 24 of the disc which is immersed in the mercury 23 to thereby increase the resistance in the energizing circuit for the control phase winding. The proportions of the various parts can be varied in accordance with requirements, it being contemplated that the maximum movement of the Z armature rotates the disc RD so as to withdraw all but a very small part of the conducting portion 24, from the mercury, to thereby materially increase the resistance in the energizing circuit for the relay.

Thus, in the form of invention shown in Fig. 3, not only is the energizing circuit for the control phase choked down but resistance is cut into the circuit, and in this form, as well as explained above in connection with Fig. 2, advantage can be taken of the phase shift due to movement of the Z armature, if desired. If it is not desired to take advantage of this phase shift, the parts can be readily proportioned so that any phase shift occurring is relatively so small and unimportant as to permit it to be completely ignored.

In connection with the forms shown in Figs. 2 and 3, the damping arrangement of magnet and disc can be proportioned and adjusted either to prevent the Z armature from returning to a position against its stop until after a train proceeding at maximum speed has vacated a block, or it can be adjusted to return more quickly. It is contemplated that the parts should preferably be so arranged as to maintain the magnetic shunt in force during the major portion of the occupancy of a track block by a train proceeding at medium or high speed, to thereby additionally safeguard against a track relay picking up back of a train in an occupied block.

The above rather specific description of several forms of the invention, has been given solely by way of example, and is not intended, in any manner whatsoever, in a limiting sense. Obviously, this invention can assume many different physical forms, and is susceptible of numerous modifications, and all such forms and modifications, are intended to be covered by this application, as come within the scope of the appended claims.

Having described my invention, I now claim:—

1. In combination, in a track circuit, a track relay having an armature and a field, an automatically variable magnetic shunt for affecting the magnetic force of the field operating on the armature, and means for retarding the rapidity of action of said variable magnetic shunt.

2. In combination, in a track circuit, a track relay, having an armature and a field, and an automatically variable magnetic shunt, varying in reluctance in accordance with ballast conditions to assume at least three different reluctances, for maintaining the magnetic force of the field operating on said armature substantially constant in amount regardless of ballast conditions.

3. In combination, in a track circuit, a track relay having an armature and a field, and an automatically variable magnetic shunt varying in accordance with ballast conditions for maintaining the magnetic force of the field operating on the armature substantially constant in amount regardless of ballast conditions, the magnetic shunt including a rotary motor member movable to numerous stationary positions to vary the reluctance of the magnetic shunt.

4. In combination, in a track circuit, a track relay having an armature and a field, and an automatically variable magnetic shunt in multiple with said armature and varied to any one of numerous reluctances in accordance with ballast conditions, for maintaining the magnetic force of the field operating on the armature substantially constant in amount regardless of ballast conditions, the magnetic shunt comprising a Z armature cooperating with field pieces and movable to vary the reluctance of the magnetic shunt.

5. In combination, in a track circuit, a track relay having an armature and a field, an automatically variable magnetic shunt varying in accordance with ballast conditions, for maintaining the magnetic force of the field operating on the armature substantially constant in amount under various ballast conditions, the magnetic shunt comprising a Z armature cooperating with field pieces and movable to vary the reluctance of the magnetic shunt, and damping means for retarding movement of the Z armature.

6. In a track circuit, a direct current track relay including spaced pole shoes and a cooperating armature, a partial magnetic path interconnecting the pole shoes through an air gap including a Z armature, said Z armature varying the air gap in accordance with ballast conditions, a spindle carrying the Z armature, means biasing the spindle to give a minimum shunt, and electromagnetic retarding means acting on the spindle.

7. In a track circuit, in combination, an alternating current relay having a field winding, an inductance including a magnetic circuit having an air gap associated with the field winding, a Z armature operable in the air gap for automatically varying the said inductance in accordance with ballast conditions, a resistance in series with the field winding, and means for automatically varying the resistance in accordance with ballast conditions.

8. In a track circuit, in combination, an alternating current relay having a field winding, an inductance including a magnetic circuit having an air gap associated with the field winding, a Z armature operable in the air gap for automatically varying the said inductance in accordance with ballast conditions, a resistance in series with the field winding, means for automatically varying the resistance in accordance with ballast conditions, a spindle carrying the Z armature, said resistance including a sector of conducting material mounted on the spindle, and a cup of conducting liquid in which the sector dips to variable degrees in accordance with the position assumed by the spindle, to thereby vary the resistance in series with the field winding.

9. In combination, in a track circuit, a track relay having an armature and a field, an automatically variable magnetic path varying in accordance with ballast conditions, for maintaining the magnetic force operating on the armature substantially constant in amount under various ballast conditions, the magnetic path comprising a Z armature cooperating with field pieces and movable to vary the reluctance of the magnetic path, and damping means for retarding movement of the Z armature.

10. In combination, a railway track section limited in its length by insulating joints, a source of current connected across the rails at one end of said section, a track relay connected across

the rails at the other end of said section, regulating means including a variable magnetic path for varying in small increments the sensitivity of said relay in accordance with gradual changes of voltage across the rails at the relay end of said track section; and separate means for retarding the rapidity of action of said regulating means.

11. In combination, a railway track section limited in its length by insulating joints, a source of current connected across the rails at one end of said section, a track relay connected across the rails at the other end of said section, regulating means including a variable resistance consisting of conducting material having a variable area thereof in contact with conducting fluid and connected in series with said relay for varying in small increments the sensitivity of said relay in accordance with ballast resistance changes, and means making said regulating means slow acting.

12. In combination, a railway track section limited in its length by insulating joints, a source of current connected across the rails at one end of said section, a track relay connected across the rails at the other end of said section, regulating means including a variable inductance and a variable resistance both acting to vary in small increments the sensitivity of said relay in accordance with ballast resistance changes, and means for retarding the rapidity of action of said regulating means.

13. In combination with a section of railway track provided with a track circuit including a source of energy, a track relay connected across said track rails, contacts for said relay, and means for rendering said relay responsive differently to sudden and gradual changes in the current supplied to said relay, said means including a permanent magnet and a disc of conducting material movable in an air-gap of said permanent magnet.

14. In a track circuit for railroads, means responding differently to gradual and sudden changes of potential across the track rails and comprising, an electro-responsive device having a coil energized by the potential across the track rails and a movable element and a spring biasing said movable element in one direction, and means for regulating the rate of movement of said element including a permanent magnet and a disc of conducting material movable in an air gap of said magnet.

15. A track circuit for railroads comprising, a source of current connected across the track rails at one end of a track section; relay means at the other end of said track section for operating contacts in response to the presence of a train in the track section; and electro-responsive means energized by the potential across the track rails at the other end of said section for governing the energization of said relay means; said electro-responsive means including a movable element and a spring biasing said element in one direction, and means regulating the rate of movement of said element; whereby said electro-responsive means responds differently to gradual and sudden changes of potential across the track rails.

16. A track circuit for railroads comprising, a source of current connected across the track rails at one end of a track section, relay means at the other end of said section for operating contacts in response to the presence of a train, and a changeable device including a rotatable element and energized by the potential across the track rails at the other end of said track section for controlling the energization of said relay means, said rotatable element automatically tending to assume different positions in response to changes in the potential across the track rails and including means opposing rotation of said element due to a relatively sudden change in the condition of said device.

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