Oct. 27, 1942. A. W. FISHER 2,300,250

TRACK CIRCUIT APPARATUS

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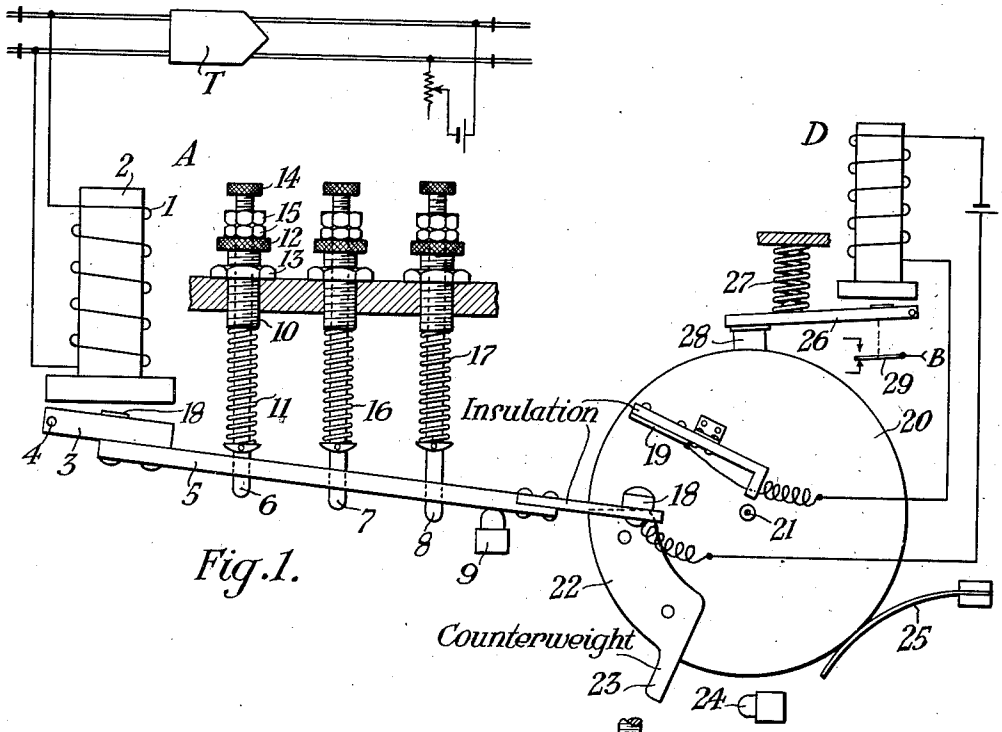


Fig. 1.

Fig. 2.

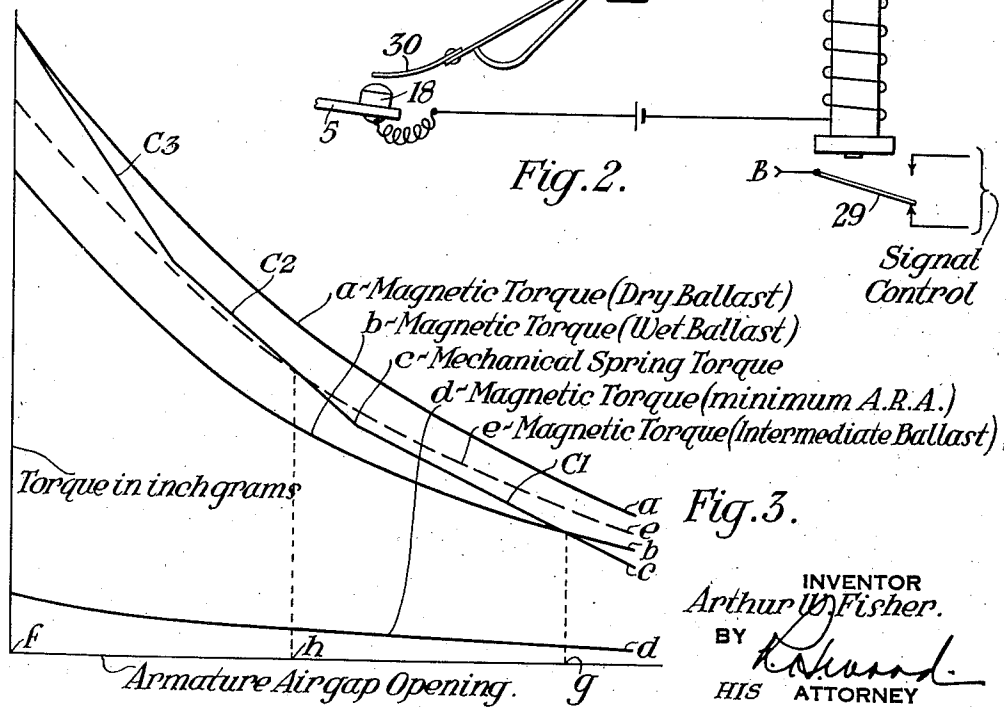


Fig. 3.

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TRACK CIRCUIT APPARATUS

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3 Claims. (Cl. 246—41)

My invention relates to track circuit apparatus and particularly to apparatus of this character for improving the shunting sensitivity of railway track circuits. More specifically, my invention relates to the track relay portion of such apparatus, and may be considered an improvement of the so-called primary-secondary combination which is in quite general use.

In the ordinary primary-secondary relay combination using conventional relays, the maximum release can be no higher than the pick-up which is used for the track circuit adjustment in wet weather with minimum ballast resistance. It is obvious that the maximum train shunt resistance value to release the relay is established by this adjustment and will become less as the energy level increases due to dry track ballast, because this release point cannot change to compensate for the higher saturation due to the working current.

An object of my invention is to improve the shunting sensitivity of a track relay by bringing the working and release points close together, and maintaining the close relationship between the two automatically throughout the full range of change in energy level incident to changes in track ballast resistance from wet weather to dry weather.

In my relay, the train shunt is required to make only a small change in relay current to obtain release and this desirable characteristic will not change even for energy levels corresponding to high saturation. This is just the reverse of conditions obtaining in conventional relays. Accordingly, the relay herein disclosed will release with train shunts of much higher resistance, and this value will not be lowered by an increase in saturation due to dry track. Other objects, purposes, and characteristic features of my invention will become apparent from the description which follows.

I accomplish these objects by providing the primary relay with a graduated mechanical torque which opposes the magnetic torque of the relay armature and which approximates the shape of the magnetic torque curves, throughout the range from pick-up energy to the maximum saturation obtainable on a given track, thus causing the release characteristic of the track relay to coincide substantially with the working characteristic corresponding to the energy level just prior to track occupancy. I also provide an inertia type of contact operated by the track relay armature which adjusts the pick-up point of the relay in accordance with the degree of energization received by the relay from the track just prior to release.

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

Fig. 1 of the accompanying drawing is a diagrammatic view showing one form of apparatus embodying my invention. Fig. 2 is a diagrammatic view, also embodying my invention, showing a modified form of a portion of the apparatus of Fig. 1, in which the inertia contact is dispensed with. Fig. 3 is an explanatory diagram showing certain torque curves of the apparatus.

Referring to Fig. 1 of the drawing, I have shown a sensitive track relay designated generally by the reference character A and receiving energy from the usual direct current track circuit which is shown occupied by the train T. Relay A is provided with the usual energizing winding 1, magnetic core 2, and armature 3 pivoted at 4 in the usual manner. It will be understood that the magnetic circuit of relay A may be of the usual two-core form employed in track relays but is shown diagrammatically as a single core having a single winding for purposes of simplicity.

Affixed to the armature 3 is an arm 5 the function of which is to engage progressively the spring biased pins or plungers 6, 7, and 8, as the armature air gap becomes progressively closed during the full stroke operation of the relay. The construction of these spring pins need not be described in detail, it being understood that as the relay picks up and after the arm 5 has left the backstop 9, this arm will first engage the pin 6 and if the relay energization is sufficient, this pin will move upwardly in the sleeve 10, compressing the spring 11. The sleeve 10 is adjustable by means of the knurled knob 12 which is integral therewith and the lock nut 13. Similarly, the pressure of the spring is adjustable by means of the knurled knob 14 which is integral with the pin 6, and the two lock nuts 15 threaded thereon. As the armature air gap closes still further during pick-up, the arm 5 will engage pin 7, compressing spring 16, and if the energization is sufficient, pin 8 will also be engaged to compress spring 17 before movement of the armature is finally stopped by the non-magnetic core pin 18.

Referring for the moment to Fig. 3, the curves *a*, *b*, and *d* of this figure show the manner in which the armature torque of the relay A varies with armature air gap opening, for different

values of relay energization, without the effect of the opposing torque which is provided by the spring pins 6, 7, and 8. For example, it may be assumed that relay A is a 4 ohm relay and is energized from a typical track circuit about 3,000 feet long having a minimum (wet) ballast resistance of about 2.5 ohms per 1,000 feet. Normally, this track circuit will be so adjusted as to provide a relay energization of about 70 milliamperes which value will increase to about 150 milliamperes under the condition of infinite (dry) ballast resistance. The torque curves developed for different armature openings at these two levels of energization are shown as *b* and *a*, respectively. Curve *d* shows the torque developed at a current level of 15 milliamperes which represents the minimum release value for a 4 ohm track relay, without contact spring pressure, as established by the American Association of Railroads. Curve *c* represents an adjustment of the opposing mechanical torque due to the spring pins acting alone, for different armature air gaps, this curve consisting of three portions C1, C2, and C3, which correspond to engagement with pin 6, pins 6 and 7, and pins 6, 7, and 8, respectively.

Looking at the curves *a* and *c*, it will be noted that these curves intersect at the point of minimum armature opening *f* or full stroke point of the relay. This means that with a current of 150 milliamperes, relay A will just go to full stroke since the magnetic torque of the relay will be greater than the opposing mechanical spring torque at all points of the armature travel except at full stroke where the two forces will balance one another. It is obvious that the spring torque curve may be adjusted to reach higher values at point *f* and thus be made equal to the magnetic torque for any predetermined maximum value to which the relay current may go with infinite ballast resistance. Similarly, at a current of 70 milliamperes, the magnetic torque curve *b* intersects the spring torque curve *c* at an air gap opening *g* which shows that at this energization the armature will not close beyond an air gap opening *g* since beyond this point the opposing spring torque is greater than the magnetic torque. At some intermediate value of current represented by the dotted torque curve *e*, the armature will move up to an air gap opening *h* at which the forces will again balance one another. From the foregoing, it will be clear that at any value of current in excess of the minimum required to cause engagement with pin 6 (and below the full stroke value) the armature will be near the point of release since any decrease in current will cause a downward movement of the armature, away from the core 2.

The mechanical spring torque curve *c* is designed to provide as closely as possible a balance between the mechanical torque and the magnetic torque throughout the full range of energizaiton of relay A from the pick-up point *g* under wet ballast conditions to the saturation or full stroke point *f* when the ballast resistance is infinite. By increasing the number of spring pins or by otherwise graduating the opposing mechanical torque, an approach as close as desired to the magnetic relay torque can be obtained. In practice, three such spring pins are deemed sufficient.

From the foregoing it will be obvious that the arm 5 will assume various positions depending upon the amount of energy in the relay coil and that the presence of a shunt on the track will result in an immediate response and release of the armature. Thus, the apparatus described approaches an ideal track relay in which the working level and release are always together regardless of the increased saturation due to the increase of this level above the level adjusted for pick-up with wet track. Conventional contacts cannot, however, be used with this apparatus because of the variation in position of the contact arm 5. In order to take care of this condition, I have provided a special type of contact which follows the movement of the arm 5 except when a track shunt is applied.

Referring again to Fig. 1, the arm 5 carries a contact 18 which normally engages the contact 19, thus closing an energizing circuit for the auxiliary or secondary track relay D. Contact 19 is mounted on the rotatable disc 20 which is supported on the shaft 21 and is biased by the counterweight 22 to a position in which the arm 23 may engage the back-stop 24. The friction member 25 provides a slight retarding force in order to slow up the movement of the disc 20, but this force is insufficient to overcome the return torque of the counterweight when the disc is otherwise free.

The secondary relay D is of the quick acting type and has an armature 26 which is biased by a spring 27 to open quickly upon deenergization of the relay caused by separation of the contacts 18 and 19. The armature 26 also carries a brake pad 28 which engages the periphery of the disc 20 upon release, thus fixing the position of contact member 19 and thereby fixing the pick-up point of relay A in relation to the value of track energization existing just prior to the application of the train shunt. Armature 26 operates a contact finger 29 which can be used to perform the usual control functions which are performed by track relay contacts.

Depending upon weather conditions which affect the track ballast resistance and so affect the degree of energization of relay A, the arm 5 will assume different positions and will cause contact 19 to follow and to assume corresponding positions. Accordingly, relay D will be maintained energized during the slow changes in energization of relay A which are caused by weather conditions. When a train enters the section, however, the resulting quick change in energization will cause contact arm 5 to fall quickly so that contacts 18—19 will separate, whereupon armature 26 will release and apply the brake pad to the disc 20 to hold contact 19 in an open position such as that illustrated in the drawing. When the train vacates the section, arm 5 will pick up, closing contacts 18—19 to thereby energize relay D, and again restoring the apparatus to the condition in which arm 5 and disc 20 are free to adjust their position in accordance with the degree of energization of relay A, thus constantly maintaining the apparatus in its most sensitive condition for release by a train.

It will be apparent that the friction spring 25 can be replaced by magnetic or other suitable damping means, if desired. Also, contacts 18—19 can control a simple repeater relay of the usual type, without the added feature of the rotatable disc 20 and the brake 28. The use of the latter feature is advantageous, however, because it provides additional contact opening at the contacts 18—19 when the track becomes occupied, thereby decreasing possible difficulties due to intermittent shunting, and also provides compensation for track ballast resistance changes, thus

further increasing the shunting sensitivity of the apparatus.

Referring now to Fig. 2, I have shown in this figure a modified form of the apparatus of Fig. 1, in which the auxiliary relay D is replaced by an ordinary repeater relay C, without the rotatable disc feature. The arm **5** of relay A engages a flexible front contact **30** which is fastened to a rigid supporting member **31**, but which has sufficient compression or follow to permit full stroke movement of the armature of relay A. As shown, arm **5** occupies the fully released position in which contacts **18—30** are open so that relay C is de-energized. When the train vacates the section, contacts **18—30** will close, thereby energizing relay C and restoring the apparatus to its normal condition.

From the foregoing, it will be apparent that I have provided a highly sensitive track relay in which the working and release points are substantially together throughout the working range of the relay. I have also provided a track relay combination in which, in addition, compensation for track ballast resistance variation is automatically provided. Moreover, these objects and advantages are attained in apparatus which is comparatively simple, rugged, and reliable in operation. It will be apparent that although I have shown my invention applied to a relay combination of the primary-secondary type, the secondary relay is not an indispensable element and the improvement in the release characteristic can be applied to a primary relay alone, if desired.

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

Having thus described my invention, what I claim is:

1. In combination with a section of railway track and a source of track circuit current connected across the rails of said section, a track relay receiving energy from said source over the rails of said section, said relay having a movable armature which develops a magnetic torque varying along a first predetermined curve with change in position of the armature for the maximum energization of the relay corresponding to maximum ballast resistance in said section, said armature developing a magnetic torque which varies along a second predetermined curve with change in position of the armature for pick-up energization of the relay corresponding to minimum ballast resistance in said section, and means for establishing a torque which opposes the magnetic torque of the relay, said opposing torque varying along a curve which falls between said second and said first curves and which intersects said second and said first curves at substantially the pick-up and full stroke armature positions respectively.

2. In combination with a section of railway track and a source of track circuit current connected across the rails of said section, a track relay receiving energy from said source over the rails of said section, said relay having a movable armature which develops a magnetic torque varying along a first predetermined curve with change in position of the armature for the maximum energization of the relay corresponding to maximum ballast resistance in said section, said armature developing a magnetic torque which varies along a second predetermined curve with change in position of the armature for pick-up energization of the relay corresponding to minimum ballast resistance in said section, and means for establishing a mechanical torque which opposes the magnetic torque of the relay, said mechanical torque varying along a curve which falls between said second and said first curves and which intersects said second and said first curves at substantially the pick-up and full stroke armature positions respectively.

3. In combination with a section of railway track and a source of track circuit current connected across the rails of said section, a track relay receiving energy from said source over the rails of said section, said relay having a movable armature which develops a magnetic torque varying along a first predetermined curve with change in position of the armature for the maximum track energization, said armature developing a magnetic torque which varies along a second predetermined curve with change in position of the armature for pick-up energization of the relay, and means for establishing a progressively increasing force as the armature moves between its pick-up and full stroke positions for opposing the magnetic torque of the armature and for balancing said magnetic torque at a predetermined point on each of said second and said first magnetic torque curves.

ARTHUR W. FISHER.