

Oct. 21, 1924.

1,512,288

W. K. HOWE

AUTOMATIC TRAIN CONTROL SYSTEM

Filed April 11, 1919

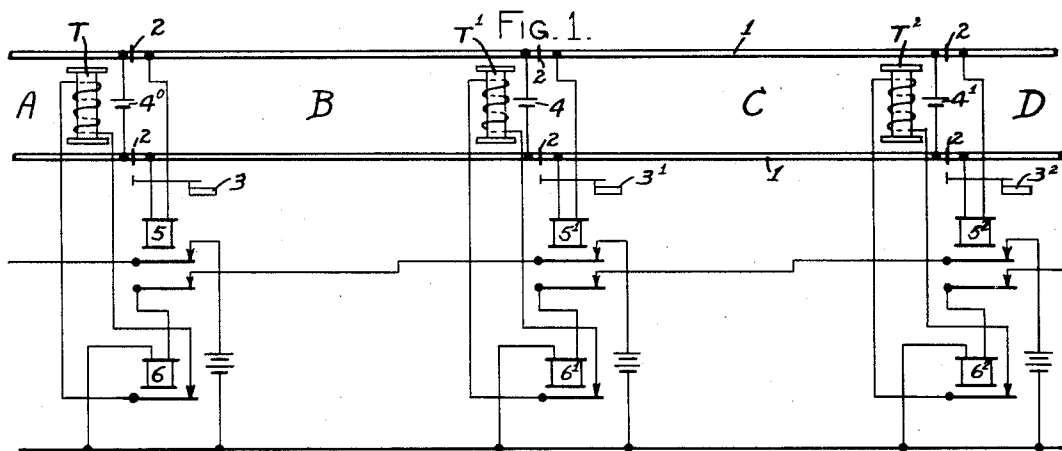


FIG. 2.

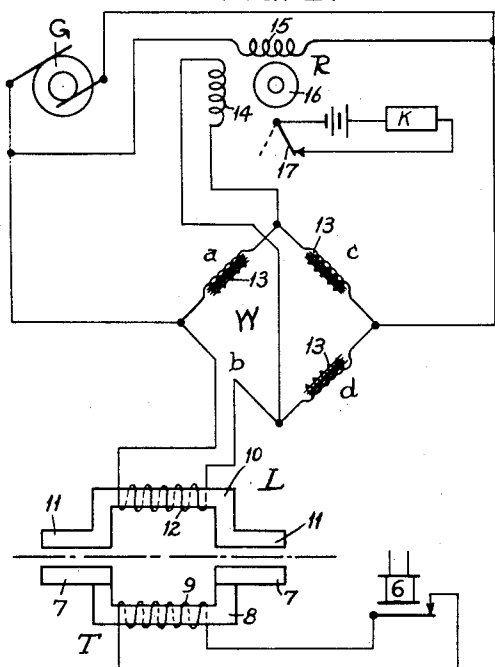


FIG. 3.

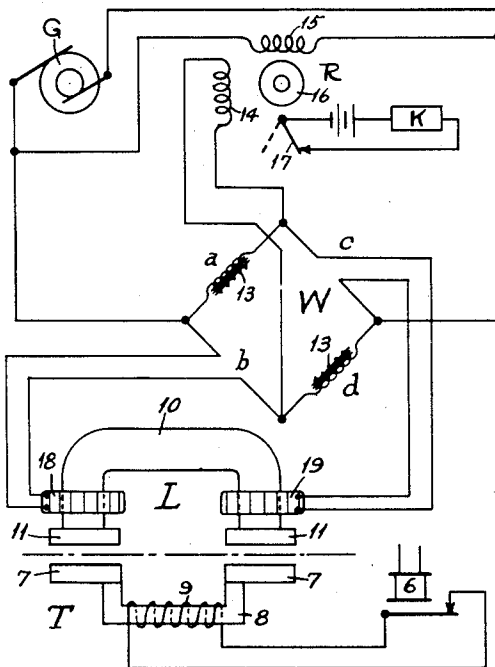


FIG. 4.

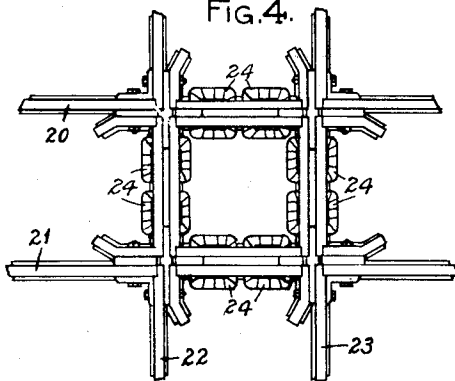
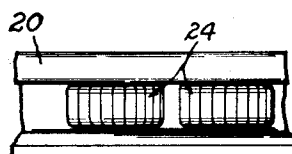


FIG. 5.



INVENTOR
Winthrop K. Howe,
BY
Neil R. Preston
ATTORNEY

UNITED STATES PATENT OFFICE.

WINTHROP K. HOWE, OF ROCHESTER, NEW YORK, ASSIGNOR TO GENERAL RAILWAY SIGNAL COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

AUTOMATIC TRAIN-CONTROL SYSTEM.

Application filed April 11, 1919. Serial No. 289,357.

To all whom it may concern:

Be it known that I, WINTHROP K. HOWE, a citizen of the United States, and resident of the city of Rochester, in the county of Monroe and State of New York, have invented a new and useful Automatic Train-Control System, of which the following is a specification.

This invention relates to automatic train control systems and more particularly to an improved form of impulse transmitting means which serves to transmit the necessary controlling impulses or influences required to control the operation of the train control apparatus on the vehicle, from traffic controlled devices along the track to co-operating devices on a passing vehicle.

An impulse transmitting means suitable for use on steam railroads should be preferably of a type in which the action takes place inductively, that is, without physical contact between the parts on the track and the parts on the vehicle, in order that the system may operate properly under severe weather conditions and other adverse conditions found in practice. This invention relates to such an inductive impulse transmitting means utilizing magnetic fields or flux. Unless large and expensive structures are to be used, the impulses or influences produced in this manner are momentary, on account of the high speed of the relative movement of the car-carried element and the trackway element. With such momentary impulses it is some times found difficult to cause proper operation of relays and similar electro-responsive devices. As a remedy of this difficulty, it is proposed according to this invention, to accentuate the effect of the impulse upon the relay or other electro-responsive device by producing large current variations, and where the conditions permit, cause actual reversal of the energizing current for such relay. While various expedients may be employed to obtain this end, I find the principle of the well known Wheatstone bridge particularly applicable for this purpose; and one of the principal objects of this invention is to devise a construction and arrangement of parts in which the effect of a momentary change of current upon a relay or similar device is greatly accentuated by utilization of the Wheatstone bridge principle.

Other objects and advantages of my in-

vention will appear hereinafter as the description progresses, and the novel features will be pointed out in the appended claims.

In order to make clear the nature, functions and mode of operation of my invention, I have illustrated in the accompanying drawing some specific embodiments of the invention, this illustration being diagrammatic in its nature and being selected more with a view of making it easy to understand the invention, than with the idea of showing the particular constructions of the parts which would be preferably employed in practice.

In describing the embodiments of the invention illustrated, reference will be made to the accompanying drawing, in which like reference characters designate corresponding parts in the several views, and in which:

Figure 1 illustrates one arrangement of trackway circuits suitable for use with the impulse transmitting means embodying the invention;

Fig. 2 shows in a diagrammatic way one form of the car-carried apparatus, together with its relation to the trackway element;

Fig. 3 illustrates a modified construction of the car-carried apparatus; and

Figs. 4 and 5 illustrate a way in which the track rails of a crossing may be made ineffective to cause improper operation of the train control equipment on a passing vehicle.

Referring first to the trackway circuits shown in Figure 1, the track rails 1 of the track are divided by insulated joints 2 into blocks, in the usual and well known way employed in block signal systems. Two of such blocks B and C are shown, together with the adjacent ends of two other blocks A and D. My system of train control may be used with or without the usual fixed signals of the block signal system; and in Fig. 1 I have shown in a conventional way the usual fixed signal 3 associated with the blocks B, C and D. The controlling circuits and devices for these signals, however, being well known, have not been illustrated in order to avoid confusion, although in practice such controlling circuits will include in part the relays illustrated. The parts and circuits associated with the blocks A to D are the same, and for convenience these parts will be given like reference characters with distinctive exponents added. Each of the blocks is provided with the usual track bat-

tery 4 and track relay 5; and associated with each block is a line relay 6, the controlling circuit of which includes front contacts of the track relays of the corresponding block and the next block in advance. For example, the line relay 6 for the block B is energized when neither the block B nor the block C is occupied, and is deenergized when either of said blocks is occupied. The line relays 6 of the several blocks govern the controlling condition of the corresponding trackway elements T, by opening and closing a control circuit for said trackway elements, so as to produce the desired different effects upon the car equipment for caution and clear, as explained hereinafter.

The impulse transmitting means, generally speaking, comprises a trackway element T, and a car-carried element L. The trackway element T comprises two side bars or pole pieces 7 which are connected by a U-shaped core 8, said pole pieces and core being made of iron or other magnetic material, laminated or solid as conditions require. In the construction illustrated, the pole pieces 7 extend a short distance parallel with the track rails, this distance being selected so as to produce a duration of influence upon the car-carried element sufficient to cause operation of the car equipment with ample margin. In this connection it should be noted that two or more cores 8 for connecting said pole pieces, may be used as desired. The core 8, or each of such cores, if there be more than one, carries a winding or coil 9, which is arranged so as to be included in a closed circuit of low resistance when the corresponding line relay 6 is energized, and to be open-circuited when that line relay is deenergized. In other words, the coil 9 of the trackway element T is in closed circuit under safe traffic conditions, but is open-circuited under dangerous traffic conditions.

The car-carried element L comprises an inverted U-shaped yoke or core 10, with pole pieces 11, these parts being also made of laminated or solid iron, and being arranged on the vehicle in such a way that the pole pieces 11 will pass over the pole pieces 7 of the trackway element T. The core 10 of the car-carried element L is surrounded by a coil or winding 12.

In the arrangement shown in Fig. 2, this coil 12 is included in one arm *b* of an arrangement of conductors and current limiting devices constituting a Wheatstone bridge W. Each of the other arms *a*, *c* and *d* of this Wheatstone bridge W include impedances 13, which may be adjustable, if desired; but obviously, resistances or combinations of inductive or non-inductive resistance may be used for the same purpose. The Wheatstone bridge W is supplied with alternating current from a generator G, which is located on the car and is constantly

driven by any suitable means, such as a steam turbine. In the embodiments of the invention illustrated, the relay or electro-responsive device is a two-element alternating current relay R of the rotor type, having two field coils or windings 14 and 15, a rotor 16, and a contact element or finger 17, these parts being illustrated conventionally. One field winding 15 of the control relay R is directly connected to the generator G and is constantly energized. The other winding 14 is connected across the arms of the bridge W in the manner illustrated.

The operation of the type of relay R illustrated will be readily understood by those skilled in the art with only a brief explanation. The contact finger 17 is biased to the middle or neutral position; and when both field windings 14 and 15 are energized by alternating current of proper strength and phase displacement, the rotor 16 is turned in one direction, thereby causing movement of the contact finger 17 to one extreme position in opposition to its bias. If the strength of the current in the field winding 14 is decreased, the torque developed by the rotor 16 is likewise decreased; and when the current falls to a certain value, the contact element 17 returns to its middle position in response to its bias. If the phase displacement of the currents in the two field windings 14 and 15 is reversed, the rotor 16 is turned in the opposite direction, and the contact finger 17 is moved to its opposite extreme position.

The impedances 13 in the arms *a* and *d* of the bridge W are selected or adjusted so that, when the car-carried element L is not over a trackway element T, the strength and the phase displacement of the currents in the field windings 14 and 15 of the relay R are such as to cause the contact finger 17 to move to one extreme position, for example, to the right as shown in Fig. 2. The contact finger 17 in this normal position closes a circuit through a train control device, or a controlling means thereof, which is illustrated conventionally and designated K. The device K may be of any suitable construction, capable of controlling the brakes, giving a signal, or the like. For example, the device K may be the E. P. V. of the train control apparatus disclosed in my application, Serial No. 287,132, filed April 3, 1919. It should be noted, however, that the device K, or its controlling means, should be adapted to be responsive to a temporary interruption of its controlling circuit, since the contact 17 is only momentarily opened.

The operation is as follows: While the vehicle is traveling between signaling points, that is, the points where the trackway elements T are located, the relay R is energized in such a way that its movable

element is shifted to one of its extreme positions, that is, the relay may be said to be picked up on one side, thus maintaining the control device K energized. When a signaling point is reached, and dangerous traffic conditions exist, the line relay 6 is deenergized and the coil 9 of the trackway element T is open-circuited. Consequently, the trackway element T presents a magnetic bridge for the pole pieces 11 of the car-carried element L; and in accordance with well known principles, the impedance of the coil 12 is thereby increased due to the decrease in the reluctance of its magnetic circuit. This change in the impedance of the coil 12 inserts added impedance in arm b, and causes the current in the field winding 14 of the relay R to decrease, and in some cases, depending upon the design and proportion of the parts, to actually reverse. In any event, the contact finger 17 is opened, and the train control device K set into operation. When the car-carried element L passes beyond the influence of the trackway element T, the normal balance of the bridge W is restored and the contact finger 17 moved back to its normal position.

If traffic conditions ahead are clear, the line relay 6 is energized and the coil 9 of the trackway element T is in a closed circuit of low resistance. Consequently, the trackway element does not produce the increase in the impedance of the coil 12 as before; and the parts are so proportioned that said trackway element, having its coil 9 in closed circuit, will not change the impedance of the coil 12 sufficiently to permit the relay R to operate.

In the modification shown in Fig. 3, the U-shaped yoke 10 is provided with two separate coils 18 and 19 which are included in the opposite arms b, c of the bridge W. This modified construction operates in the same manner already described, the two coils 18 and 19 merely serving to increase the unbalancing of the bridge W and produce a greater controlling effect upon the relay R.

From the foregoing, it will be observed that the car-carried element will be influenced by any magnetic body affording a path for the passage of flux between the pole pieces 11 of the car-carried element L. Such magnetic bodies occur at various places along the railroads, such as the track rails of crossings, cross-overs and the like. Obviously, some provision should be made so that such track rails will not cause an improper operation of the system. For one thing, the parts may be constructed and proportioned so that the trackway element T will produce a sufficient change in the reluctance of the magnetic circuit of the coil 12 as to cause operation of the relay R, while the track rails of crossings and other

magnetic bodies encountered along the track, will not affect the car-carried element to such an extent. Also, closed-circuited coils may be associated with the track rails of crossings, or with the other foreign magnetic bodies, so as to produce the same effect as putting the coil 9 of the trackway element T in a closed circuit. In Fig. 4, I have illustrated track rails 20 and 21 of one track intersected by the track rails 22 and 23 of another track, the crossing construction shown being conventional. Coils 24 of low resistance connected upon themselves are passed through the web of the track rails at the crossing, preferably as close to the head of the rail as possible, (see Fig. 5); and these coils are located at the points over which the car-carried element passes. Obviously, these coils 24 reduce the effect of the track rails on the impedance of the coil 12 on the passing vehicle; and the parts may be proportioned so that the change in the impedance of said coil, which may be produced, will not be sufficient to cause operation of the relay R. Instead of coils 24, suitable bonds, such as shown in my application above mentioned, may be used.

It will be observed that my invention provides a simple and reliable impulse transmitting means of the inductive type which will not be affected by weather conditions and which does not involve complicated or expensive apparatus along the track or along the train. The important feature of this system is the manner in which the increase in the impedance of the coil 12 on the vehicle is utilized to produce a positive opening of the contacts of the control relay of simple and substantial construction. This control relay R, being a two-element relay, may have the greater part of its operating energy derived from the constantly energized field winding 15, so that the small current in the other field winding 14 needed to pick up the relay, can be more readily reduced in amount or changed in phase relation by an increase in the impedance of the coil 12. The impedances and power factors of these field windings 14 and 15 of the relay R, together with the impedances 13 in the arms of the bridge, will be, of course, properly designed and selected with regard to the electrical and magnetic characteristics of the various parts of the system, so as to produce the greatest effect on the relay R. The way in which this should be done will be readily apparent to those skilled in the art, it being observed that the object is to obtain the maximum tendency for the relay R to open its contacts when the impedance in the coil 12 is increased by a trackway element T having its coil 9 open circuited.

In describing my invention, I have dis-

closed simplified forms of construction, it being understood that various additions and modifications would be made in practicing my invention so as to conform to good design and engineering practice. For example, the parts on the train and along the track would be protected by suitable casings of wood or other non-magnetic material, and would be located between the track rails, or on one side thereof, according as the particular circumstances requires. Also, while the trackway element T has been shown as located at the entrance to a block, it may be located at any signaling point where it is desired to transmit an impulse from the track to the train; and the trackway elements T and the car-carried element L may be positioned lengthwise of the track, instead of crosswise as shown, if clearances and other conditions on a particular railroad may make such arrangement preferable. Various additions and modifications obvious to those skilled in the art may be made in the particular construction shown and described, without departing from my invention; and I desire to have it understood that the specific embodiments herein disclosed are merely illustrative and do not exhaust the various modifications of the idea of means constituting my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In an automatic train control system, in combination: impulse receiving means on a vehicle comprising the elements of a Wheatstone bridge, a source of alternating current, electro-responsive means connected across said bridge, and a coil included in one arm of the bridge, and a traffic controlled trackway element adapted to increase the impedance of said coil if in the active stopping condition and thereby vary the current supplied to said electro-responsive means.

2. In an automatic train control system, impulse receiving means on a vehicle, comprising a Wheatstone bridge, an electro-responsive device connected across said bridge, a source of current for said bridge, and a magnetic yoke having a coil included in circuit in one arm of said bridge, said bridge being adjusted to cause a predetermined amount of current to flow through the electro-responsive device normally, and a trackway element adapted to reduce the reluctance of the magnetic circuit of said core, said trackway element comprising a core of magnetic material and a winding thereon which is closed in a deenergized circuit of low resistance under clear traffic conditions and which is open-circuited under danger traffic conditions.

3. In an automatic train control system, in combination: a core and a coil on the vehicle, means including a source of alternating current, an electro-responsive device

and impedances arranged in the form of a bridge for detecting variation in the impedance of said coil, and traffic controlled trackway elements adapted to influence said coil inductively and increase its impedance under danger traffic conditions but not under clear traffic conditions.

4. In an automatic train control system, the combination with a magnetic yoke on a vehicle, of means including a source of current, an electro-responsive device, a coil on the yoke, and a bridge for detecting a change in the reluctance of the magnetic circuit through said yoke, and traffic controlled elements along the track for decreasing the reluctance of said magnetic circuit under danger traffic conditions but not under clear traffic conditions.

5. In an automatic train control system, means constituting a magnetic circuit on a vehicle partly of iron, means including the elements of a bridge for detecting a change in the reluctance of said magnetic circuit, and traffic controlled means on the track for decreasing the reluctance of the magnetic circuit on a passing vehicle under danger traffic conditions but not under clear traffic conditions.

6. In an automatic train control system, impulse receiving means on a vehicle comprising, impedances arranged in the form of a bridge, a source of alternating current, a two-element alternating current relay having one field winding connected across said bridge and the other energized from said source, and a coil included in one arm of the bridge and adapted to have its impedance varied by trackway elements.

7. In an automatic train control system, impulse receiving means on a vehicle comprising, in combination with a source of alternating current, a two element alternating current relay having both windings constantly energized from said source, and means including a coil adapted to be influenced from the trackway and an inductive reactance in multiple with said coil for determining the degree of energization and phase relation of the current in one of said windings.

8. In an automatic train control system, impulse receiving means on a vehicle comprising a two element alternating current relay having one winding constantly energized, a coil and a partial magnetic circuit therefor on the vehicle, and means for changing both the phase relation and the amount of current in the other winding of said relay as the impedance of the coil is increased.

9. In an automatic train control system, in combination, a track element having a magnetic core and a coil thereon, traffic controlled means for controlling the circuit of said coil, and car carried means including

a constantly energized two element alternating current relay adapted to be influenced by the track element when its circuit is open.

10. In a train control system, a car equipment comprising a normally energized brake control device adapted whenever deenergized to cause an automatic brake application, a two-element alternating current relay of the induction type acting so long as effectively energized to maintain energization of the brake control device, a magnetic core and a winding thereon, a source of alternating current constantly energizing one field element of said relay, the other field element of the relay and said winding being also connected to said source so as to effectively energized said relay, a track device comprising a magnetic core and a coil therein for cooperating with said car-carried core to vary its reluctance, a deenergized circuit of low resistance through said trackway coil, and track circuit controlled means for closing said circuit under clear traffic conditions and for opening it under danger traffic conditions.

11. Car equipment for automatic train control systems comprising a normally energized two element alternating current relay, a coil and a partial circuit therefor, and means acting to produce an amplified change in the phase relation of the currents in the windings of said relay when the impedance of said coil is changed.

12. Car equipment for automatic train control systems comprising a two element alternating current relay, a coil and a partial magnetic circuit therefor, and an arrangement of multiple circuits, one of which includes said coil, for causing reversal of the phase relation of the currents in the windings of said relay when the impedance of said coil is changed.

13. In an automatic train control system, automatic train control apparatus on a vehicle, a normally closed circuit for maintaining said apparatus inactive, a two element alternating current relay having a contact finger controlling said circuit, a car-carried element including a core and a coil thereon normally developing a torque in one direction in said relay, means whereby an increase in the impedance of said coil causes reversal of the torque set up in the relay and opening of the contact finger of said relay, and a track element cooperating with said car carried element and acting to increase the impedance of said coil under dangerous traffic conditions.

14. In an automatic train control system, automatic train control apparatus on a vehicle, a normally closed circuit for maintaining said apparatus inactive, a three position electro-responsive means controlling said circuit, a car-carried element comprising a coil and a partial magnetic circuit therefor,

a source of alternating current on the vehicle for energizing said coil and normally maintaining a torque in a certain direction in said electro-responsive device, means whereby a change in the impedance of said coil causes reversal of the torque of said electro-responsive device to interrupt the normally closed circuit and set said train control apparatus into operation, trackway means for increasing the impedance of said coil, and a winding on said trackway means for making it ineffectual if said winding is in a closed deenergized circuit.

15. In an automatic train control system, electro-responsive means on a vehicle, conductors and impedances arranged in the form of a Wheatstone bridge for energizing said means, a pair of coils and a partial magnetic circuit therefor included in opposite arms of the bridge, a track element constituting a partial magnetic circuit and having a coil thereon, and traffic controlled means for including said coil of the track element in a closed circuit of low resistance under clear traffic conditions.

16. In an automatic train control system, the combination with a track element constituting a mass of iron when in the active stopping condition, of car-carried means cooperating with said track element and comprising multiple circuits with current limiting devices therein, arranged in the form of a bridge, a source of alternating current connected to said bridge, a two-element alternating current relay having one field winding connected across the bridge and the other energized from said source, and a coil in one arm of the bridge adapted to have its impedance increased by said track element.

17. In an automatic train control system, a track element comprising a U-shaped core with a coil thereon, a circuit of low resistance including said coil, traffic controlled means for opening and closing said circuit, a car element comprising a U-shaped magnetic yoke arranged to pass over the track element, a winding associated with said yoke, a two-element alternating current relay with one field winding constantly energized, a source of alternating current and current limiting means arranged in the form of a bridge for causing operation of said relay when the impedance of the coil of the car element is increased as it passes over a track element having its controlling circuit open.

18. In an automatic train control system, train control apparatus on a vehicle, a normally closed circuit for maintaining said apparatus inactive, a two-element alternating current relay adapted to open said circuit when deenergized or reversed, a car element comprising a U-shaped magnetic core having a coil thereon, multiple circuits with current limiting means therein ar-

ranged in the form of a bridge, the coil of the car element being connected in one arm of said bridge, a source of alternating current on the vehicle energizing said bridge, 5 said relay having one field winding energized from said source and the other connected across said bridge, and a track element for cooperating with said car element and comprising a U-shaped core with a coil 10 thereon, and traffic controlled means for including the coil of the track element in a closed circuit of low resistance under clear traffic conditions.

19. In an automatic train control system, 15 the combination with a track element constituting a mass of iron when in the active stopping condition, of car-carried means influenced by said track element and comprising a coil, multiple circuits arranged in the 20 form of a bridge, said coil being connected in one arm of the bridge, a two-element alternating current relay having one field winding connected across the bridge, and a source of alternating current for energizing 25 the bridge and the other field winding of said relay.

20. Car apparatus for automatic train control systems comprising a U-shaped magnetic core, a coil on said core, a source of 30 alternating current, a two-element alternating current relay having one field winding energized from said source, and means including a reactance in multiple with said coil for connecting the other field winding of the

relay to said coil and for causing operation 35 of the relay when the impedance of the coil is increased.

21. Car apparatus for automatic train control systems comprising a core, a coil thereon, a source of alternating current, a 40 two-element alternating current relay having one field winding energized from said source, an impedance, a circuit energized from said source including the impedance and said coil in multiple, and means for sup- 45 plying current from the source to the other field winding of the relay by the difference in the drop in potential through said impedance and coil.

22. In an automatic train control system, 50 the combination with a track element constituting a mass of iron in the active stopping condition, of car apparatus inductively influenced by the track element and comprising a magnetic yoke, a coil on the yoke, 55 a source of alternating current, a two-element alternating current relay having one field winding energized from said source, multiple circuits arranged in the form of a bridge and energized from said source, said 60 coil being connected in one arm of the bridge, the other field winding of said relay being connected across the bridge, said bridge being normally unbalanced to cause operation of the relay in one direction and 65 being thrown into balance or reversed by the influence of the track element.

WINTHROP K. HOWE.