

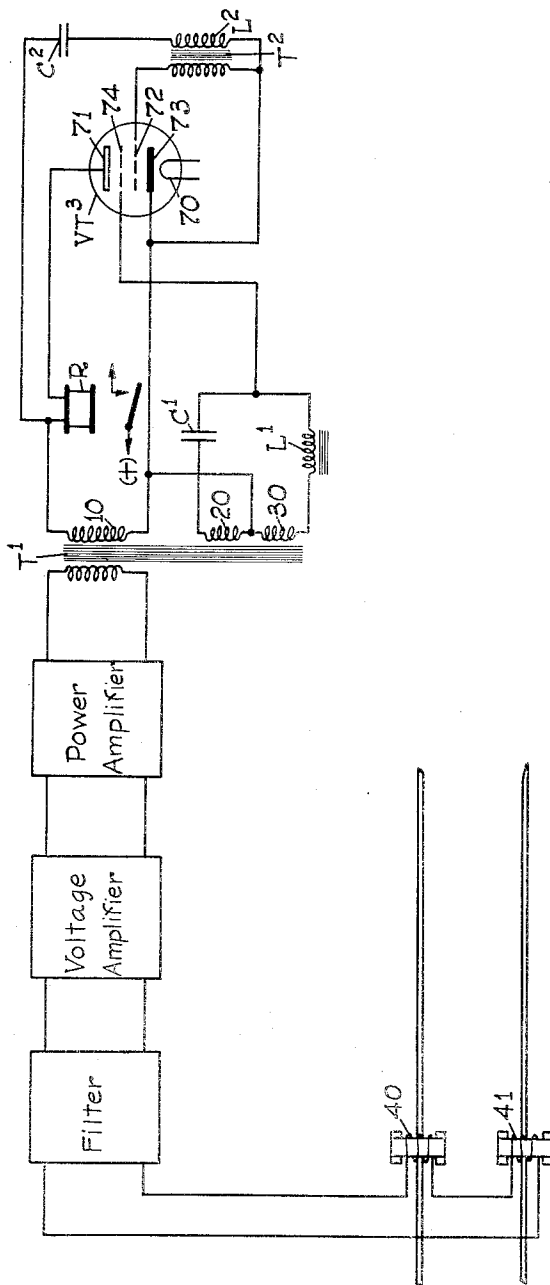
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W. H. HOPPE

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CONTINUOUS INDUCTIVE TRAIN CONTROL SYSTEM

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INVENTOR
W. H. Hoppe,
BY Neil H. Preston,
his ATTORNEY

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CONTINUOUS INDUCTIVE TRAIN CONTROL
SYSTEMWalter H. Hoppe, Rochester, N. Y., assignor to
General Railway Signal Company, Rochester,
N. Y.

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This invention relates to automatic train control systems for railroads and it more particularly pertains to systems of the type commonly known as continuous inductive train control systems.

One object of the present invention is the provision of an improved filter organization for obtaining a high degree of selectivity in the transmission of the desired frequency or frequencies collected from the track circuit, to the exclusion of undesired frequencies, parasites and the like.

Another object of the present invention is to provide, by a novel organization of parts and circuits, means whereby car carried apparatus is protected against false indications due to the presence of stray currents in the track circuits.

This invention is in the nature of an improvement over the arrangement disclosed in the prior application of W. H. Reichard, et al., Ser. No. 112,858, filed November 27, 1936.

Other objects, advantages and characteristic features of this invention will be in part apparent and in part pointed out as the description of the invention progresses.

In describing the invention, reference will be made to the accompanying drawing which shows, in a simplified and diagrammatic manner, only a sufficient portion of the receiving circuit and car carried apparatus for describing and understanding the operation of the present improvement. The parts are illustrated in a manner to facilitate in the explanation of the essential characteristics and functions of the invention, rather than to show the particular organization and construction that may be most advantageously employed in practice.

In train control or equipped territory, the track rails are divided into blocks in the usual way and an arrangement provided (not shown) for at times connecting alternating current of a relatively low frequency (anywhere from 25 to 140 cycles for example) to the track rails. The alternating current is connected to the track rails in accordance with traffic conditions and may or may not comprise coded impulses, in accordance with the particular arrangement provided. Irrespective of the particular arrangement of applying the alternating current to the track rails, it is necessary to collect energy from the rails for operating a relay or the like, for the transmission of information from the trackway to control signalling devices on the car.

The locomotive, or other railway vehicle, carries ahead of the first or lead pair of wheels a receiver pick up coil in inductive relation to each

track rail. These coils, 40 and 41 in the drawing, are connected in a circuit including a filter to a voltage amplifier. The circuit of the receiver coils up to and including the input of the voltage amplifier is preferably tuned (by the filter) to the frequency to be received from the track rails for signalling purposes. After voltage amplification, the stepped up voltage of the above frequency is used to drive a power amplifier which has its output connected to the primary of transformers T¹. The above arrangement is not new, it having been shown in numerous patents and applications, for example, Patent No. 1,692,361 and in my prior application Ser. No. 69,618, filed March 19, 1936.

On the vehicle is a main car relay R, or other suitable electro-responsive device which, in accordance with the present invention, may be of the simple, neutral, direct current type and still be responsive only to current of the proper frequency, phase and amplitude, as is the case with the polyphase type relay in the above mentioned Patent No. 1,692,361. The contact of this relay may control other relays, light signals, a brake valve, or the like, in any required manner and, since the functions controlled by this relay are immaterial to an understanding of the present invention and form no part thereof, they have been omitted from the present disclosure.

Vacuum tube VT³ is of the gaseous, arc discharge type and has low internal plate resistance, high amplification constant and requires only moderate voltages to drive it. One device having these desirable characteristics is the Raytheon Production Corporation, RK-100 tube. This tube comprises the usual filament 70 (not shown connected since it may be activated in any well known manner), plate 71, cathanode 72, cathode 73 and control grid 74. The characteristics of this tube and its features of operation have been clearly set forth in an article beginning on page 23 of the Q. S. T. Magazine for June 1935 and need not be repeated here.

T¹ is the train control amplifier output transformer. Windings 20 and 30 of this transformer, together with condenser C¹ and inductance L¹, form an impedance bridge, resonant to the particular frequency by which relay R is to be controlled.

Transformer T² is for the purpose of controlling the "firing" of the tube, when suitable secondary voltage is provided in the series resonant circuit, including condenser C² and inductance L² comprising the primary winding of the transformer T², this circuit likewise being tuned to

resonance at the frequency by which relay R is to be controlled.

The operations previously mentioned and those now to be described, are merely typical and it is to be understood that various adjuncts and expedients may be utilized.

One important feature of this invention is the protection afforded against false operation of the car relay R by stray currents in the track rails, of the same, or some other frequency, as the regular train control current. Such stray currents may be falsely applied from the source of alternating current supply which provides the alternating current energy in the track rails themselves, due to crosses, grounds and the like, or they may come from some foreign source of the same frequency, or of a frequency so nearly like the train control frequency that the tuning and receiving coils and amplifiers are not sufficient to avoid operation of the car relay when large values of stray current are received.

In accordance with the present improvement, the chances of falsely operating relay R by such stray currents or undesired frequencies are greatly reduced. Voltage of the frequency provided in the rails for operating relay R is induced in windings 20 and 30 of transformer T¹. Voltage of the same frequency is also induced in winding 10 of this transformer. Current from winding 10 flows in the output circuit of tube VT³, including relay R, plate 71, control grid 74, cathanode 72 and cathode 73, for operating relay R, when and only when the phase angle between the voltage from winding 10 (applied to the plate circuit) and the phase angle and magnitude of the voltage from the secondary winding of transformer T² (cathanode voltage), provide a predetermined vector sum. This vector sum of voltages preferably occurring in an early part of a positive half cycle of the plate voltage, so that the firing of the tube continues through a large part of such half cycle. These values may be readily obtained by providing the proper circuit constants (such as inductance, capacity, transformer ratio and the like), for effecting current flow in the plate circuit which is at or above the pick up value of relay R, only within a very narrow frequency range. For each positive half cycle of voltage, applied by winding 10 to the plate circuit, the cathanode circuit through the secondary of transformer T², 72 and 73, fires the tube at an early part of such half cycle provided that the grid circuit through 73, 20—30, L¹—C¹ and 74 does not depress such current flow. This flow of current is automatically extinguished at the end of the positive half cycle. The current as read on an ammeter is of course large or small in accordance with what portion of each positive half cycle is permitted to flow.

In other words, the application of the received current to the plate circuit from winding 10, in combination with the application of the received current to the grid circuit by way of the impedance bridge, provides a very high degree of selectivity. This is because a small deviation in frequency not only reduces the magnitude of current in the tuned circuit through C¹—L¹ but it upsets the phase relations rendered critical by this tuned circuit, to such an extent that the voltage vector (sum of the voltages) from the mid-point of 20—30 to the mid-point of C¹—L¹ is reduced in magnitude and changed in phase with respect to the voltage developed in the winding 10 of transformer T¹ to depress the action of the

tube and restrict the flow of current there-through or even render it non-conducting.

Were tube VT³ of conventional thyratron or grid glow tube design, the existence of proper phase and magnitude of voltage existing in the grid circuit, namely, the voltage between the mid-point of 20—30 and mid-point of L¹—C¹, and the plate circuit voltage, namely the voltage existing between cathode 73 and the plate side of winding 10, would permit firing of tube VT³ and subsequent picking up of relay R. However, tube VT³ as described in this application, and in my prior application Ser. No. 69,618 referred to above, does not fire completely or pass its maximum plate current until a specified voltage of proper magnitude and polarity exists between the cathode 73 and the cathanode 72. As disclosed in this application, proper magnitude and phasing of the voltage applied to the cathanode circuit, that is the elements 72—73, with respect to the voltage applied to the plate circuit, and also voltage of proper phase relations within the grid circuit, namely, the voltage between mid-point of 20—30 and mid-point of C¹—L¹, is necessary to cause firing of the tube. This voltage in the cathanode circuit is dependent upon the series current that flows through the combination C²—L² of transformer T². In other words, in order that the relay R may be picked up, proper phasing and magnitude of control voltage must be established in the cathanode circuit with respect to the voltage in the plate circuit as well as proper phasing and magnitude of voltage developed in the grid circuit, all three voltages being measured by taking the cathanode 73 as zero voltage and by taking the voltage vector existing across the winding 10 of transformer T¹ as of zero phase displacement. Operation of relay R is then given by development of plate supply energy in winding 10, the magnitude of which is controlled by the voltage developed in the grid circuit, and absolutely cut off or greatly reduced in the absence of proper voltage magnitude and phase developed in the cathanode circuit, which in turn is also dependent upon the absolute value of voltage and frequency appearing in winding 10. This latter voltage develops the relay operating energy and causes the relay R to operate by sending rectified current from winding 10 through the circuit of the winding of relay R, element 71, gap in tube VT³ to cathode 73 then back to winding 10. For all frequencies other than the above mentioned predetermined frequency, the phase shift between elements of the tuned circuits will be such that substantially no current flows in the tube output circuit, in which relay R is connected. Therefore, relay R will operate in response to current of the desired frequency picked up from the track rails and will be non-responsive to strays, and the like, of practically all other frequencies, as well as being non-responsive to current of said predetermined frequency, but of insufficient amplitude.

Transformer 10 is also connected to a series resonant circuit, including winding L² of transformer T² and condenser C², with the secondary winding of this transformer T² connected to the cathanode circuit including cathode-cathanode elements 73—72 of the tube. This arrangement ionizes the tube so that a comparatively low developed voltage applied to its control grid circuit, including grid 74 and cathode 73, will modify the magnitude of current through the tube after it is made to "fire". If the voltage for "firing" tube VT³ were only that applied to its grid circuit and

due to the signal picked up by the receiver, the tube could not be fired in a strict sense since the cathanode 72 would be at cathode potential with respect to the control grid 74. The tube will fire completely only when the cathanode 72 is raised above cathode potential by at least 10 volts positive applied between 72 and 73 (73 being negative).

If the voltage between elements 72 and 73 be of sufficient magnitude to cause ionization therebetween, rectified current will flow in the plate circuit 71—73, but the magnitude of that current will be greatly reduced, unless the proper phasing of winding 10, grid voltage 74—73 and cathanode voltage 72—73 has been established by proper frequency applied to transformer T¹.

This relation holds for all voltages applied to transformer T¹ which do not exceed the flash-over voltage between elements in VT³. The excitation of T¹ is limited by the power amplifier so that no flashover could occur.

Let us take as an example one set of related constants under which this invention may operate. Let us assume that alternating current of the proper frequency is applied to the transformer T¹ under which condition positive and negative voltage waves are applied to the plate 71 of the tube VT³. Since the frequency under consideration is the proper frequency a tuned circuit is connected across this winding 10 of transformer T¹ so that the current flowing through the condenser C² and the inductance L² is substantially of unity power factor, that is it neither leads nor lags the voltage impressed on this circuit. Since the transformer T² in fact constitutes a current transformer the voltage delivered by secondary winding is substantially in quadrature with respect to the current flowing in the primary winding L² of this transformer T², and the turns in this transformer are so related that the voltage applied to the cathanode 72 lags almost 90 degrees behind the voltage applied to the plate 71. This relation of voltage vectors would result in a tendency for the tube VT³ to fire just before the positive voltage on the plate circuit becomes a maximum. The tube VT³ may, however, not fire at this point in the positive half cycle of the plate voltage because there is a possibility that the grid voltage applied to grid 74 is at this instant of insufficient value or of such negative value as to prevent firing of the tube. Since, however, we have assumed that the frequency is the correct frequency the voltage applied to the grid 74 is of such phase relation as to allow firing of the tube. This is true because for normal frequency the impedance bridge 20—30, C¹—L¹ is in resonance and the voltage existent between the mid-point of 20—30 and the mid-point of C¹—L¹ is substantially in quadrature with the voltage impressed on the plate circuit and is of the same polarity as the voltage applied to the cathanode circuit by the secondary winding of transformer T². In other words, under the substantially ideal conditions assumed the voltages impressed upon the grid circuit and the cathanode circuit are substantially in phase and lag substantially 90 degrees behind the voltage applied to the plate circuit.

Having described a train control system as particularly adapted for the continuous inductive type as one specific embodiment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume. It is further to be

understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention, except as limited by the appended claims.

What I claim is:—

1. A train control system of the continuous inductive type in which alternating current of a predetermined frequency is applied to the track rails under certain operating conditions; car carried receiving coils disposed over the track rails in inductive relation thereto; a relay on the car; a transformer on the car having a plurality of secondary windings; means including said receiving coils for receiving and transmitting single phase alternating current to said transformer to induce in said secondary windings voltages of said predetermined frequency; and selectively responsive means controlled by the currents in a plurality of said secondary windings and in accordance with the phase relation between those currents for actuating said relay.

2. A train control system of the continuous inductive type in which alternating current of substantially a predetermined frequency is applied to the track rails under certain operating conditions; car carried receiving coils disposed over the track rails in inductive relation thereto; a relay on the car; transformer means on the car having a plurality of secondary windings; means including said receiving coils for receiving and transmitting alternating current to said transformer, whereby said secondary windings have voltages of said frequency impressed therein and having currents flowing therein having a phase relation depending upon the constants of the circuits in which they are included and the frequency of said currents, and selectively responsive means controlled by the phase relation of the currents in said secondary windings for actuating said relay.

3. A train control system of the continuous inductive type in which alternating current of substantially a predetermined frequency is applied to the track rails under certain operating conditions; car carried receiving coils disposed over the track rails in inductive relation thereto and conductively connected in series; a relay on the car; transformer structure on the car having a plurality of secondary windings; means including said receiving coils for receiving and transmitting alternating current of the frequency of the current applied to the track rails to said transformer, whereby said secondary windings have voltages of said frequency impressed therein and will have currents flowing therein having a phase relation depending on the electrical characteristics of the circuits in which they are included; and selectively responsive means controlled by the phase relation and the magnitude of the currents in said secondary windings for actuating said relay.

4. A train control system of the continuous inductive type in which alternating current of a predetermined frequency is applied to the track rails under certain operating conditions; car carried receiving coils disposed over the track rails in inductive relation thereto; a relay on the car; a transformer on the car having a plurality of secondary windings; means including said receiving coils for receiving and transmitting alternating current of said predetermined frequency to said transformer, whereby said secondary windings have currents of said predetermined fre-

quency impressed therein; a first circuit connected to a first one of said transformer windings and including said relay; an impedance bridge including other windings of said transformer; and means responsive to the combination of the currents of said predetermined frequency in said first transformer winding and in said impedance bridge for actuating said relay.

5. A train control system of the continuous inductive type in which alternating current of a predetermined frequency is applied to the track rails under certain operating conditions; car carried receiving coils disposed over the track rails in inductive relation thereto; a relay on the car; a transformer on the car having a plurality of secondary windings; means including said receiving coils for receiving and transmitting alternating current of said predetermined frequency to said transformer, whereby said secondary windings have currents of said predetermined frequency impressed therein; a first circuit connected to a first one of said transformer windings and including said relay; an impedance bridge including another winding of said transformer, a condenser and an inductance in series, said bridge being tuned to said predetermined frequency; and means responsive to the combination of the currents of said predetermined frequency and their phase relation in said first transformer winding and in said impedance bridge for actuating said relay.

6. A train control system of the type in which car carried receiving coils receive alternating current of a predetermined frequency from the trackway; a relay on the car; a transformer on the car having a plurality of secondary windings; means for transmitting the alternating current received by said receiving coils to said transformer, whereby said secondary windings have currents of said predetermined frequency impressed therein; a vacuum tube having said relay and one of said transformer windings connected in its output circuit, whereby said relay is operated when said tube has its plate circuit rendered conductive; and an input circuit for said tube including a control element of said tube and other windings of said transformer, the voltages applied to said output and input circuits if of a predetermined phase relation rendering said plate circuit conductive.

7. A train control system of the type in which car carried receiving coils receive alternating current of a predetermined frequency from the trackway; a relay on the car; a transformer on the car having a plurality of secondary windings; means for transmitting the alternating current received by said receiving coils to said transformer, whereby said secondary windings have voltages of said predetermined frequency induced therein; a vacuum tube having said relay and one of said transformer windings connected in its output circuit, whereby said relay is operated when said tube has its plate circuit rendered conductive; and an input circuit for said tube including an impedance bridge and a control element of said tube and other windings of said transformer, the voltages applied to said output and said input circuits if of the proper phase relation and magnitude rendering said plate circuit conductive.

8. A train control system of the type in which car carried receiving coils receive alternating current of substantially a predetermined frequency from the trackway; a relay on the car; a transformer on the car having a plurality of secondary

windings; means for transmitting the alternating current received by said receiving coils to said transformer, whereby said secondary windings have voltages of the frequency of the current induced in said receiving coils impressed therein; a vacuum tube having said relay and one of said transformer windings connected in its output circuit, whereby said relay is operated when said tube has its plate circuit rendered conductive; an input circuit for said tube including a control element of said tube and other windings of said transformer, the voltages applied to said output and said input circuits having a predetermined phase relation therebetween only if the frequency of the alternating current received is very nearly said predetermined frequency, and said voltages if of said predetermined phase relation rendering said plate circuit conductive; and an additional control circuit for said tube connected to another secondary winding of said transformer for increasing the sensitivity of said tube to said voltages only if the transmitted current is substantially of said predetermined frequency.

9. A train control system of the type in which car carried receiving coils receive alternating current from the trackway; a relay on the car; a transformer on the car having a plurality of secondary windings; means for transmitting the alternating current received by said receiving coils to said transformer, whereby said secondary windings have voltages of the same frequency as that flowing in the trackway induced therein; a vacuum tube having said relay and one of said transformer windings connected in its output circuit, whereby said relay is operated when said tube has its plate circuit rendered conductive; an input circuit for said tube including a first control element of said tube and other windings of said transformer, the voltages applied to said output and said input circuits having a predetermined phase relation therebetween only if the frequency of the voltages induced in said windings is of a predetermined value, and said voltages if of said phase relation rendering said plate circuit conductive; and an additional circuit for said tube including a second control element of said tube connected to said transformer for increasing the sensitivity of said tube to said voltage.

10. In a cab signal system of the continuous inductive type in which favorable traffic conditions are manifested on the car by the inductive transmission of current from the track rails to the car; the combination with receiving coils on the car in inductive relation to the track rails; a transformer on the car having a plurality of secondary windings; means for energizing said transformer in accordance with voltages induced in said receiving coils by current flowing in the track rails; a relay; a vacuum tube having said relay and one of said windings included in series in its output circuit, whereby said relay is picked up when said tube has its output circuit rendered conductive in time phase with the voltage induced in said one winding; resonating means for producing a voltage from alternating current derived from another of said windings which voltage has a phase relation with respect to the voltage induced in said one winding in accordance with the frequency and is in predetermined phase relation therewith when the currents are of predetermined frequency; and means for applying the voltage produced by said resonating means to the grid of said tube; whereby said relay

will be picked up only if the frequency of the current applied to the track rails is substantially said predetermined frequency.

11. In a cab signal system of the continuous inductive type, the combination with receiving coils on the car in inductive relation to the track rails; a transformer on the car having a primary winding energized in accordance with the voltage induced in said receiving coils by current flowing in the track rails and having a plurality of secondary windings; a relay; a vacuum tube having a plate circuit, and a grid circuit; said plate circuit including in series one secondary winding of said transformer and said relay, whereby said relay is picked up when said plate circuit is rendered conductive in time phase with the voltage induced in said one winding; a circuit including a condenser and an inductance in series energized by another of said secondary windings, said inductance and condenser having constants such that resonance will occur at a predetermined frequency, whereby a voltage is produced between the mid-point of said another winding and the connection between said condenser and said inductance which voltage is in predetermined phase relation with the voltage of said transformer only when the frequency of the current applied to said transformer is said predetermined frequency; and means for applying said voltage to the grid circuit of said tube, whereby the plate circuit of said tube will be rendered conductive in time phase with the voltage induced in said one winding only if the frequency of the current applied to the track rails is substantially of said predetermined value.

12. A cab signal system comprising; receiving coils supported on a car to be in inductive relation to the track rails; a transformer on said car having a plurality of secondary windings and having a primary winding energized in accordance with voltages induced in said receiving coils by current flowing in the track rails; a relay; a vacuum tube having a plate circuit, a grid circuit and a cathanode circuit; means for connecting one secondary winding of said transformer in series with said relay in the plate circuit of said tube, said relay being of a construction to be picked up when said tube has its out-put circuit rendered conductive substantially in time phase with the voltage induced in said one winding; resonating means for producing a voltage from alternating current derived from another of said secondary windings, which voltage has a phase relation with respect to the voltage induced in said one winding in accordance with the frequency of said current and said current is in predetermined phase with said voltage when the currents are of a predetermined frequency; means for applying the voltage produced by said resonating means in the grid circuit of said tube; another resonating means for producing a voltage which is a maximum when the voltage applied to said transformer is of said predetermined frequency; and means for applying said last mentioned voltage to the cathanode circuit of said tube; whereby said relay assumes its picked up condition only if the current applied to the track rails is substantially of said predetermined frequency.

13. A cab signal system comprising; receiving coils on a car in inductive relation to the track rails on which said car moves; a transformer on the car having a plurality of secondary windings and having a primary winding energized in accordance with the voltage induced in said receiving coils by current flowing in said track

rails; a relay; a vacuum tube having an anode circuit, a grid circuit and a cathanode circuit, said anode circuit including said relay and one secondary winding of said transformer in series, whereby said relay assumes its attracted condition only if said anode circuit is rendered conductive in substantially time phase with the voltage induced in said one winding; a resonated circuit including a condenser and an inductance in series having constants to produce resonance at a predetermined frequency and energized by a secondary winding of said transformer; means for producing a voltage in said cathanode circuit in proportion and in phase relation with the current flowing in said resonated circuit; a second resonated circuit including a condenser and an inductance having constants to produce current resonance at said predetermined frequency and energized by another secondary winding of said transformer; and means for applying the voltage drop across the condenser of said another resonated circuit to the grid circuit of said tube; whereby said relay assumes its attracted condition only if the alternating current applied to the track rails is substantially of said predetermined frequency.

14. A train control system of the type in which car carried receiving coils receive alternating current of a predetermined frequency from the trackway; a relay on the car; a transformer on the car having a plurality of secondary windings; means for filtering, amplifying and transmitting the alternating current received by said receiving coils to said transformer, whereby said secondary windings have voltages of said predetermined frequency induced therein; a vacuum tube having said relay and one of said transformer windings connected in its output circuit, whereby said relay is operated when said tube has its plate circuit rendered conductive; and an input circuit including an impedance bridge and a control element of said tube and other windings of said transformer, the voltages applied to said output and said input circuits if of the proper phase relation rendering said plate circuit conductive.

15. In a cab signal system of the continuous inductive type, the combination with receiving coils on the car in inductive relation to the track rails; means for filtering and amplifying the current induced in said receiving coils; a transformer on the car having a primary winding energized in accordance with the voltage delivered by said filtering and amplifying means, and having a plurality of secondary windings; a relay; a vacuum tube having a plate circuit, and a grid circuit; said plate circuit including in series one secondary winding of said transformer and said relay, whereby said relay is picked up when said plate circuit is rendered conductive in time phase with the voltage induced in said one winding; a circuit including a condenser and an inductance in series energized by another of said secondary windings, said inductance and condenser having constants that resonance will occur at a predetermined frequency, whereby a voltage is produced between the mid-point of said another winding and the connection between said condenser and said inductance which voltage is in predetermined phase relation with the voltage of said transformer only when the frequency of the current applied to said transformer is said predetermined frequency; and means for applying said voltage to the grid circuit of said tube, whereby the plate circuit of said tube will be rendered conductive in time phase with the voltage induced in

said one winding only if the frequency of the current applied to the track rails is of said predetermined value.

16. A train control system of the type in which
 5 car-carried receiving coils receive alternating current inductively from the track rails comprising; a relay on the car; a vacuum tube on the car having an anode, a cathode, a grid circuit and a cathanode circuit; said anode circuit being energized by current derived from said receiving
 10 coils and including said relay in series therein; a tuned circuit including a condenser and an inductance in series having constants to cause resonance if the frequency of the current applied thereto from said receiving coils is of a predetermined value; means for applying a potential to said cathanode circuit derived from said tuned circuit and substantially in quadrature with the current in said tuned circuit; a second tuned circuit including the secondary winding of a transformer, a second condenser and a second inductance in series, energized by current from said
 20 receiving coils and having constants to cause resonance if the frequency of the current applied thereto is of said predetermined value; means for applying the voltage existing from the midpoint of said secondary winding to the common connection between said second condenser and said second inductance into said grid circuit; the polarities of these potentials being so directed that if the frequency of the current detected by said receiving coils and applied to said vacuum tube is of said predetermined value the potentials applied to said grid circuit and to said cathanode
 30 circuit will have such phase relation with the

voltage applied to said anode circuit to cause said anode circuit to be rendered conductive and said relay to be energized.

17. A train control system of the type in which
 5 car-carried receiving coils receive alternating current inductively from the track rails comprising; a relay on the car; a vacuum tube on the car having an anode, a cathode, a grid circuit and a cathanode circuit; said anode circuit being energized by current derived from said receiving
 10 coils and including said relay in series therein; a tuned circuit including a condenser and an inductance in series having constants to cause resonance if the frequency of the current applied thereto is of a predetermined value and energized from said receiving coils; a second tuned circuit including the secondary winding of a transformer, a second condenser and a second inductance in series, energized by current from said
 15 receiving coils and having constants to cause resonance if the frequency of the current applied thereto is of said predetermined value; means for applying voltage derived from one of said tuned circuits to said cathanode circuit and voltage derived from the other of said circuits to said grid
 20 circuit by so directing these voltages with respect to the voltage applied to said anode circuit that said anode circuit will have sufficient current flowing therein to energize said relay if the frequency of the current induced in said receiving
 25 coils is of said predetermined value, but will have insufficient current flowing thereon to energize said relay if the frequency of said current deviates slightly from said predetermined value.

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