Aug. 18, 1942. W. P. PLACE 2,293,307

RAILWAY TRAFFIC CONTROLLING APPARATUS

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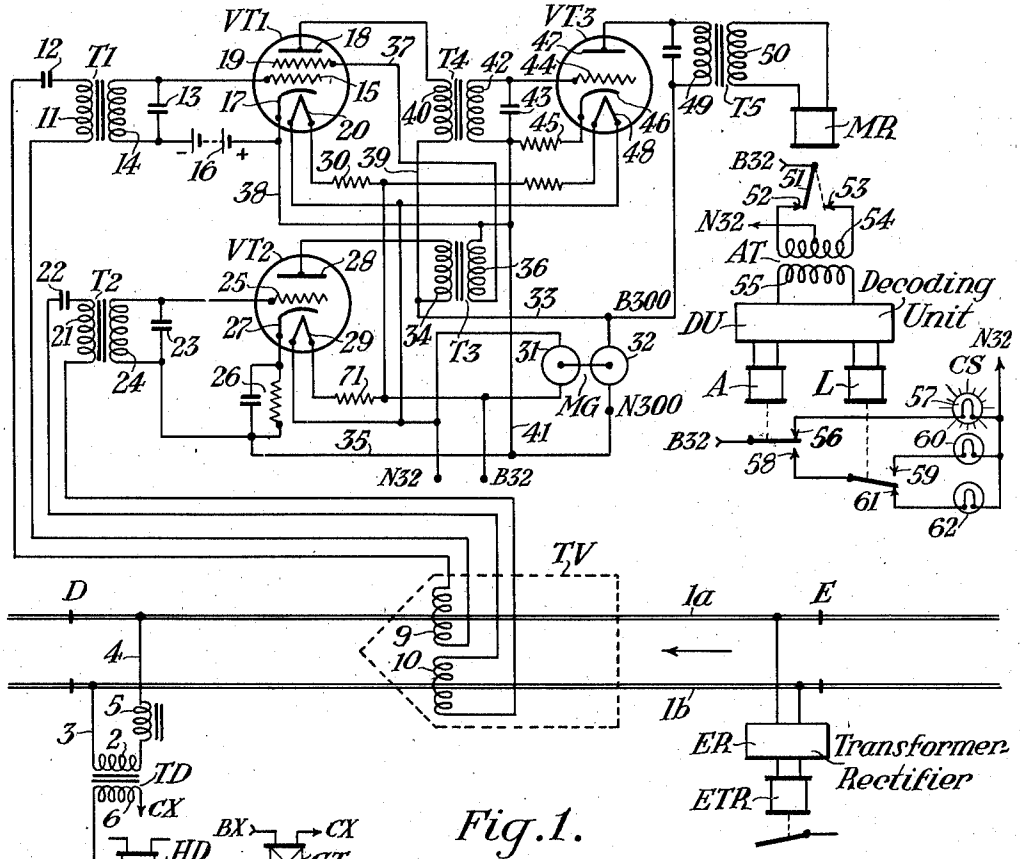



Fig. 1.

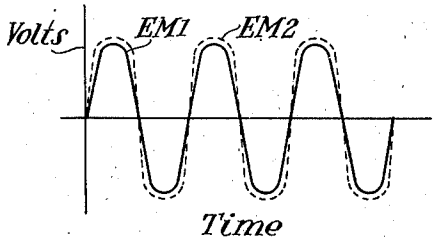



Fig. 2.

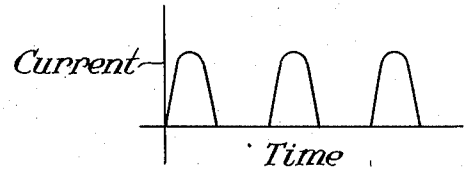



Fig. 3.

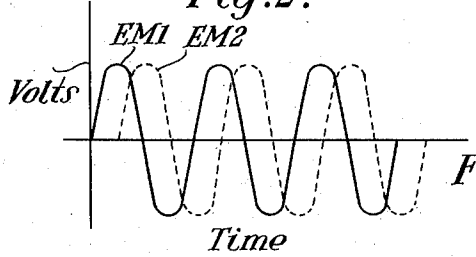



Fig. 4.

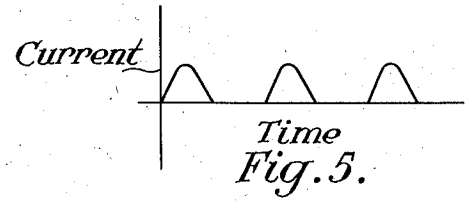



Fig. 5.

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## RAILWAY TRAFFIC CONTROLLING APPARATUS

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7 Claims. (Cl. 246—63)

My invention relates to railway traffic controlling apparatus, and more particularly to train carried train control apparatus responsive to coded energy.

Train carried train control apparatus responsive to coded energy is well known. The coded current is supplied across the track rails of a track section at the exit end of the section so that when a train occupies the section current flows along one rail through the wheels and axles of the train (train shunt) and back the other rail and consequently such current flows in opposite directions in the rails at any given instant. Two inductors are mounted on the train ahead of the leading pair of wheels with one inductor over each rail and there is an electromotive force induced in each inductor in response to each on period of the coded current. The two inductors have heretofore been connected together so that the electromotive forces induced therein due to current flowing in opposite directions in the two rails at any given instant add their effects and the resultant electromotive force is applied to the input terminals of a train carried amplifier to operate a code following relay connected to the output side of the amplifier. The practice has been to use alternating current of the order of 100 cycles per second and to code such current by periodically interrupting the current at the rates of 180, 120 and 75 times per minute according to clear, approach-medium and approach traffic conditions in advance of the track section. In some systems only two code rates of 180 and 75 interruptions per minute are used to reflect clear and approach traffic conditions, respectively.

The length of the track section is predetermined in part according to the desired spacing of trains and according to the braking distance required for the trains operating over the section. The braking distance required depends upon the maximum permissible speed and the nature of the equipment, such as passenger or freight cars. The high speeds prescribed for present day traffic in both freight and passenger train service, require relatively long braking distances and hence a relatively long track section if a train is to be brought from maximum speed to a stop in a single track section. It has been proposed to provide track sections of the order of 11,000 feet in length where high train speed prevails. Broken rail protection is also essential in such railway signaling systems. A single track circuit for a track section of 11,000 feet may not provide satisfactory broken rail protection when alternating current of 100 cycles per second is used. Consequently such 11,000 foot track section may require that it be provided with one or more cut section locations to divide the section into subsections each of which includes a track circuit. Such cut section locations add to the apparatus required and correspondingly increase the cost.

It has been proposed to use alternating current of a low frequency and current of 20 cycles per second has been considered. Furthermore, coded direct current has been proposed. When alternating current of the frequency of the order of 20 cycles per second or when coded direct current is used then satisfactory broken rail protection may be obtained for track circuits of 11,000 feet in length. Operating difficulties have been experienced when coded low frequency alternating current or coded direct current is used, because of the possible false energization of the train carried amplifier produced by the so-called "magnetized spots" in the track rails. Such magnetized spots occur at random and act to induce an electromotive force in the train carried inductors as the train moves over the rails. Such induced electromotive force when amplified may adversely affect the operation of the code following relay.

In view of the above cited conditions a feature of my invention is the provision of railway traffic controlling apparatus incorporating novel and improved train carried train control apparatus responsive to coded energy.

Another feature of my invention is the provision of a novel and improved electron tube amplifier for train carried train control apparatus.

An additional feature of my invention is the provision of train carried train control apparatus which is effectively operated only when two inductors, one over each rail, are excited by magnetic fields substantially in phase with each other, and random magnetic fields, which excite one inductor only or which excite both inductors but at different times or which excite both inductors at the same time but do not induce voltages which are in phase with each other, do not cause an effective operation of the apparatus.

Still another feature of my invention is the provision of novel train carried train control apparatus having two receiving channels through which energy is received for controlling the operation of a code following relay and wherewith the energy received by one channel must bear a predetermined relationship with the energy re-

ceived by the other channel in order to cause an operation of the relay.

Again, a feature of my invention is the provision of railway traffic controlling apparatus incorporating an electron tube amplifier wherewith operation of a code following relay coupled to the plate circuit of the electron tube is operated only when two control electromotive forces in phase with each other are simultaneously applied one to each of two different control grids of the tube.

The above features of my invention, as well as other advantages which will be apparent as the specification progresses are attained according to my invention by providing two inductors mounted on the train in advance of the leading pair of wheels with one inductor over each rail and by applying the electromotive forces induced in the inductors to two different receiving channels. An electron tube having two grids is provided and one grid is excited by the electromotive force applied to one receiving channel and the other grid is excited by the electromotive force applied to the other channel. A code following relay is coupled to the plate circuit of the tube and the tube is biased so that normally no plate current flows and the bias is high enough so that no current flows if only one grid is excited by the electromotive force applied to the respective receiving channel. Plate current flows only when the two electromotive forces are applied to the two grids of the tube simultaneously and in phase or at least plate current sufficient to operate the code following relay flows only when both grids are thus excited.

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

In the accompanying drawings Fig. 1 is a diagrammatic view showing one form of apparatus embodying my invention when used with train carried train control apparatus. Figs. 2, 3, 4 and 5 are diagrams illustrating operating characteristics of the apparatus of Fig. 1.

Referring to Fig. 1, the reference characters 1*a* and 1*b* designate the track rails of a stretch of railway over which traffic normally moves in the direction indicated by an arrow and which rails are formed by the usual insulated rail joints into a track section D—E, which may be one section of a series of consecutive sections of a signal system. The track section D—E is provided with a track circuit comprising a source of coded current connected across the rails at the exit end of the section and a code following relay connected across the rails at the entrance end of the section. The immediate source of current for the track circuit of section D—E is a track transformer TD whose secondary winding 2 is connected across the rails at the exit end D over wires 3 and 4, a current limiting impedance 5 being interposed in wire 4. A primary winding 6 of transformer TD is connected to a suitable source of alternating current, such as a generator, not shown, but whose terminals are indicated at BX and CX, over contacts of a code transmitter CT and a contact of a control relay HD. The source of alternating current may be of any convenient frequency and may be for example of the order of 20 cycles per second.

The code transmitter CT may be of any one of several forms and is shown as of the relay type whose operating winding is permanently connected to the terminals BX and CX of the current source, and energized to cause operation of two code contact members 75 and 180, the arrangement being such that contact member 75 is operated to engage a contact 75*a* at the rate of 75 times per minute, and contact member 180 is operated to engage a contact 180*a* at the rate of 180 times per minute. The relay HD is controlled by traffic conditions in advance of the section D—E and such control apparatus is not shown since it would be in accordance with standard practice and forms no part of my present invention. It is sufficient to point out that relay HD is picked up when the section next in advance of section D—E is unoccupied and is released when such section in advance is occupied. When relay HD is picked up closing front contact 7, a circuit easily traced is completed by which current is supplied to primary winding 6 of transformer TD over code contact 180—180*a* of code transmitter CT, and when relay HD is released closing back contact 8, the primary winding 6 of transformer TD is connected to the current source over code contact 75—75*a* of the code transmitter. It follows that when the section next in advance of section D—E is unoccupied and relay HD is picked up, alternating current coded at the code rate of 180 interruptions per minute is supplied to the track rails of section D—E, and when the section next in advance is occupied and relay HD is released, alternating current coded at the code rate of 75 interruptions per minute is supplied to the track rails of section D—E.

A code following relay ETR is connected across the rails at the entrance end E of section D—E through a transformer rectifier shown conventionally at ER and hence when the section D—E is unoccupied, that is, when the train shown conventionally at TV does not occupy the section, track relay ETR is operated at the code rate of the current supplied to the rails through track transformer TD in the manner explained above. The track relay ETR would be used to govern apparatus including a control relay for the section next in the rear of section D—E and which relay would be similar to relay HD governed by traffic in the section next in advance of section D—E. This apparatus governed by relay ETR is not shown for the sake of simplicity, since as stated hereinbefore such apparatus forms no part of my present invention and would be in accordance with standard practice.

It is to be understood of course that my invention is not limited to the code rates of 180 and 75 interruptions per minute of the track circuit current, but such code rates are used for illustration since they are in general use. Also that while a low frequency alternating current of the order of 20 cycles per second may be preferred the alternating current may be of a higher frequency such as, for example, 100 cycles per second as is commonly used in railway signaling systems of the type here contemplated, or the alternating current may be of a frequency even lower than 20 cycles per second, or the current may be coded direct current.

The train shown conventionally at TV is provided with train carried train control apparatus embodying my invention and which apparatus comprises inductors 9 and 10, two receiving channels to be shortly described, a first and a second amplifier tube VT1 and VT3, a code following relay MR, a decoding unit DU and a cab signal CS together with suitable sources of current.

The inductors 9 and 10 are preferably alike and are mounted on the train ahead of the lead-

ing pair of wheels and in inductive relation to rails *1a* and *1b*, respectively. It follows that when train TV occupies section D—E and there is no other train between it and the exit end D of the section, an electromotive force is induced in each inductor 9 and 10 during each on period of the coded track circuit current and such electromotive forces have the same frequency and code rate as the rail current. Since at any given instant the current flows along rail *1a* through the train shunt and back rail *1b* the current in each of the two rails is of substantially the same magnitude so that the electromotive forces induced in inductors 9 and 10 are of substantially the same magnitude and are in phase with each other. The inductors 9 and 10 are connected to a first and a second receiving channel, respectively. The first receiving channel comprises a transformer T1 and a first grid circuit for electron tube VT1, while the second receiving channel comprises a transformer T2, another electron tube VT2, another transformer T3 and a second grid circuit for the tube VT1. To be explicit, inductor 9 is connected to a primary winding 11 of transformer T1 of the first receiving channel through a condenser 12. A condenser 13 is connected across a secondary winding 14 of transformer T1 and secondary winding 14 and condenser 13 in multiple are interposed in a first grid circuit for electron tube VT1, which circuit can be traced from control grid 15 of the tube over secondary winding 14 and condenser 13 in multiple, a biasing battery 16 and to a cathode 17 of tube VT1. Transformer T1 together with condensers 12 and 13, are tuned to resonance at the frequency of the track circuit current and in this instance are tuned to resonance at the frequency of 20 cycles per second. It is clear that when an electromotive force is picked up by inductor 9 a corresponding electromotive force is made to appear across secondary winding 14 of transformer T1 and this latter electromotive force is applied across grid 15 and cathode 17 of the electron tube VT1.

Tube VT1 may take different forms, and in Fig. 1 is shown as an indirect heater type tube having a plate 18, a first or control grid 15, a cathode 17, a second or screen grid 19 and a filament 20.

Inductor 10 is connected to primary winding 21 of transformer T2 of the second receiving channel through a condenser 22. A condenser 23 is connected across a secondary winding 24 of transformer T2 and secondary winding 24 and condenser 23 in multiple are interposed in a grid circuit of tube VT2 which grid circuit can be traced from a control grid 25 of tube VT2, over secondary winding 24 and condenser 23 in multiple, a biasing unit 26 and to a cathode 27 of tube VT2. Transformer T2 and condensers 22 and 23 are tuned to resonance at the frequency of the coded track circuit current and hence when inductor 10 picks up an electromotive force a corresponding electromotive force is made to appear across winding 24 of transformer T2 and this latter electromotive force is applied across grid 25 and cathode 27 of tube VT2. Electron tube VT2 is an indirect heater type tube having a plate 28, grid 25, cathode 27 and a filament 29.

The train TV is provided with a suitable source of current which may be the usual 32 volt generator or battery, not shown, but whose positive and negative terminals are indicated at B32 and N32, respectively. The 32 direct volts of the train carried source is converted into a convenient higher voltage as required for the plate circuit of the tubes through a motor generator MG, the motor element 31 of which is connected across terminals B32 and N32 of the train carried source and the positive and negative terminals of the generator element 32 of which are designated B300 and N300 as will be apparent by an inspection of Fig. 1. The filaments 20 and 29 of tubes VT1 and VT2 are connected across terminals B32 and N32 over parallel circuits easily traced, current limiting resistors 30 and 71 being preferably interposed in the circuits of filaments 20 and 29, respectively.

A plate circuit for tube VT2 is formed from terminal B300 over wire 33, primary winding 34 of transformer T3, plate 28 and intervening tube space to cathode 27 of tube VT2, biasing unit 26 and wire 35 to the negative terminal N300. A secondary winding 36 of transformer T3 is connected across grid 19 and cathode 17 of tube VT1 over wires 37 and 38 to complete the second receiving channel. It is to be seen therefore that the electromotive force picked up by inductor 10 is applied to tube VT2 and is amplified in the plate circuit of that tube and a corresponding electromotive force is then applied from the secondary winding 36 of transformer T3 to the screen grid 19 and cathode 17 of tube VT1. The electron tube VT1 is provided with a plate circuit which extends from terminal B300 over wires 33 and 39, a primary winding 40 of a coupling transformer T4, plate 18 and intervening tube space to cathode 17 of tube VT1, and wires 38, 41 and 35 to negative terminal N300.

The battery 16 which is interposed in the first grid circuit of tube VT1 provides a negative grid bias voltage for that tube of such a degree that normally no current flows in the plate circuit of tube VT1. Furthermore, the bias effected by battery 16 for tube VT1 is high enough that no plate current flows even if the grid 19 is excited by the electromotive force induced in inductor 10 and applied to the tube through the second receiving channel unless the control grid 15 is also excited and driven in the positive direction to some extent. Again, if control grid 15 is excited by the electromotive force induced in inductor 9 and applied to the first receiving channel and grid 19 is not excited at the same time no effective plate current flows. When grids 15 and 19 are excited and both driven in the positive direction by the electromotive force applied through the respective receiving channel then plate current flows and energy is transferred to the secondary winding 42 of coupling transformer T4. A condenser 43 is connected across secondary winding 42 of transformer T4 and the two in multiple are interposed in the grid circuit for the second amplifying tube VT3, the circuit including a grid 44 of tube VT2, secondary winding 42 and condenser 43 in multiple, a resistor 45 and a cathode 46 of the tube.

Electron tube VT3 is of the indirect heater type having a plate 47, grid 44, cathode 46 and a filament 48, the latter of which is heated over a simple circuit connected to the B32—N32 current source. The plate circuit for tube VT3 includes terminal B300, a primary winding 49 of an output transformer T5, plate 47 and intervening tube space to cathode 46 of tube VT3, resistor 45, wires 41 and 35, and terminal N300. Tube VT3 is biased to have a given normal value of plate circuit current and hence energy transferred through transformer T4 to the grid cir-

cuit of tube VT3 is amplified and reproduced in the plate circuit of the tube and such variations in the plate circuit current in turn cause an electromotive force to be induced in a secondary winding 50 of the output transformer T5.

Code following relay MR is a polar relay of the type whose contact member 51 remains in the position to which it was last moved when the relay is deenergized. Relay MR is connected to secondary winding 50 of transformer T5 and the arrangement is such that the electromotive force induced in secondary winding 50 due to an increase in the average value of the plate circuit current for tube VT3 energizes relay MR at a polarity such that contact member 51 is operated to the left-hand position as viewed in Fig. 1 to engage a normal contact 52, and the electromotive force induced in secondary winding 50 due to a decrease in the average value of the plate circuit current of tube VT3 energizes relay MR as required to operate its contact member 51 to the right-hand position to engage reverse contact 53. When relay MR is operated to cause its contact member 51 to alternately engage contacts 52 and 53, direct current is alternately supplied to two portions of a primary winding 54 of a decoding transformer AT and an alternating electromotive force is induced in secondary winding 55 of transformer AT having a frequency corresponding to the rate at which relay MR is operated. Secondary winding 55 of transformer AT is connected to the input terminals of decoding unit DU to whose output side two control relays A and L are connected.

The decoding unit DU may be any one of several well-known forms, and it is sufficient for the present application to point out that relay A is energized and picked up when the electromotive force applied to decoding unit DU is of a frequency produced by operation of relay MR at the rate corresponding to the 180 code rate for the track circuit current, and relay L is effectively energized and picked up and relay A is released when the electromotive force applied to decoding unit DU is of the frequency produced by operation of relay MR at the rate corresponding to the 75 code rate for the track circuit current. Relays A and L are used to govern the operating circuit of signal CS. These operating circuits would be of standard practice and it is sufficient to point out that when relay A is picked up closing front contact 56, an operating circuit is formed for a lamp 57 and that lamp is illuminated to cause signal CS to display a clear signal indication. When relay A is released closing back contact 58 and relay L is picked up closing front contact 59, an operating circuit is formed for a lamp 60 and that lamp is illuminated causing signal CS to display an approach signal indication, and when relays A and L are released closing back contacts 58 and 61, respectively, an operating circuit is formed for a lamp 62, and that lamp is illuminated to cause signal CS to display a slow speed signal indication.

In describing the operation of the apparatus of Fig. 1, I shall assume the train TV on which the apparatus is mounted occupies section D—E. It is to be recalled that normally the electron tube VT1 is provided with a predetermined negative grid bias voltage through the battery 16, and which voltage is such that zero current flows in the plate circuit of the tube. The bias voltage applied to tubes VT2 and VT3 is such in each case that a predetermined value of current flows in the respective plate circuit. When the normal value of plate circuit current flows for tube VT3 no energy is transferred at transformer T5 and master code following relay MR is active so that relays A and L are released and lamp 62 is illuminated to display a slow speed cab signal. I shall next assume that relay HD is picked up and alternating current coded at the 180 code rate is applied to the track rails of section D—E. During each on period of the coded rail current electromotive forces are induced in inductors 9 and 10 which electromotive forces are of substantially the same magnitude since the value of current flowing in each rail is the same and furthermore, these electromotive forces are in phase with each other. This condition is illustrated in Fig. 2 where the solid line EM1 represents the electromotive force picked up by inductor 9 and applied to the first receiving channel of the train carried apparatus and the dash line EM2 represents the electromotive force picked up by inductor 10 and applied to the second receiving channel. During the positive half cycle of the electromotive force applied to the first receiving channel, the grid 15 of tube VT1 is driven in the positive direction with the result that the potential of the grid 15 with respect to cathode 17 is less negative. The electromotive force applied to the second channel is amplified at tube VT2 and the resultant electromotive force induced in secondary winding 36 of transformer T3 is applied to grid 19 of tube VT1 and during a positive half cycle of the electromotive force grid 19 is driven positive in potential with respect to cathode 17. Since these two electromotive forces are in phase with each other grids 15 and 19 are simultaneously driven positive and current flows in the plate circuit of tube VT1. During the negative half cycle of each of the electromotive forces, grids 15 and 19 are both more negative and no plate current flows. The current flowing in the plate circuit of tube VT1 under these conditions is illustrated in Fig. 3 which shows that during the positive half cycle of the electromotive forces plate current flows and during the negative half cycle of the electromotive forces no current flows. This results in a series of half cycle pulses of current which induce an electromotive force in secondary winding 42 of coupling transformer T4. The circuit made up of condenser 43 and secondary winding 42 smooths out the electromotive force induced in secondary winding 42 to form a reasonably smooth sine wave voltage. The electromotive force transferred by transformer T4 is amplified by tube VT3 in the usual manner to cause corresponding variations of the plate circuit current of that tube with the result that there is an increase in the average value of the plate circuit current at the start of each on period of the coded current and a corresponding decrease in the average value of the plate circuit current at the start of each off period of the coded current. Such variations in the plate current for tube VT3 induce electromotive forces in secondary winding 50 of transformer T5 to cause operation of relay MR in the well-known manner. Since the track circuit current is of the 180 code rate, relay MR is operated at a corresponding code rate so that relay A is picked up and lamp 57 is illuminated to display a clear signal indication.

In the case relay HD is released and the rail current is coded at the 75 code rate, the operation of the apparatus is the same except for the rate at which code following relay MR is operated

and with relay MR operated at the rate corresponding with the 75 code rate of the track circuit current, relay L is picked up and relay A is released causing lamp 60 to be illuminated to display an approach signal indication.

As pointed out hereinbefore when relay MR is inactive as in the case when no coded current is supplied to the track circuit then relays A and L are both released and signal lamp 62 is illuminated to display a slow speed signal indication.

Figs. 4 and 5 illustrate the action when the electromotive forces induced in inductors 9 and 10 are shifted by as much as 90 degrees out of phase. Since plate current can flow for tube VT1 only when both grids 15 and 19 are driven positive by a predetermined amount, then when the electromotive forces are shifted 90 degrees out of phase, both grids 15 and 19 are driven positive for only a quarter cycle and even then their products are quite small. The resultant plate circuit is illustrated in Fig. 5. These pulses of plate circuit current are effective to induce electromotive forces in secondary winding 42 of coupling transformer T4 but such electromotive forces even when amplified by tube VT3 are not sufficient to cause operation of code following relay MR. It is to be observed that if the electromotive forces induced in inductors 9 and 10 are out of phase more than 90 degrees practically no plate current would flow for tube VT1 and no energy would be applied to the code following relay MR.

In the event so-called magnetized spots exist in either rail 1*a* and 1*b*, that is, there are spots which in effect appear to be permanently magnetized, an electromotive force may be induced in inductor 9 when such a magnetized spot exists in rail 1*a* and may be induced in inductor 10 when such a spot occurs in rail 1*b* when the corresponding inductors pass over the magnetized spots in the respective rail. In the event such an electromotive force is induced in inductor 9 and applied to grid 15 of tube VT1 and this stray electromotive force is such as to drive grid 15 in the positive direction no plate current flows in the tube due to the high negative bias voltage effected by battery 16 because grid 19 is not at the same time excited. If the stray electromotive force is induced in inductor 10 and applied to grid 19 to drive that grid in the positive direction no plate current flows for tube VT1 due to the bias of battery 16 because grid 15 is not at the same time excited. For such magnetized spots in the track rails to cause a flow of plate current, such spots must occur opposite each other and of a polarity that the stray electromotive forces induced in inductors 9 and 10 drive both grids 15 and 19 in the positive direction simultaneously. These magnetized rail spots are random and the possibility of the last cited condition occurring is very remote.

Again stray electromotive forces induced in inductors 9 and 10 from an adjacent power line would be 180 degrees out of phase and for the reasons pointed out hereinbefore would produce no flow of plate current in tube VT1 and hence no operation of relay MR.

If one track rail is broken current might flow in the other rail at about the usual magnitude due to the ballast leakage, but the current in the broken rail would be considerably less, and hence while one grid 15 or 19 might be excited in the usual manner, the excitation of the other grid would be absent or very small and sufficient plate current to cause operation of relay MR would not be effected.

While indirect heater type tubes are shown in Fig. 1, it is clear that other types of tubes may be used. Also tubes VT1 and VT2 may be combined in one tube structure such as a petrode-triode tube. If further amplification is needed a stage of amplification could be included in the receiving channels in advance of tubes VT1 and VT2. Furthermore the final state of amplification including tube VT3 may not be required.

It is clear that I have provided railway traffic controlling apparatus incorporating a novel and improved electron tube amplifier wherewith the electromotive force picked up from one rail of a track circuit is applied through one receiving channel to a first control grid of the amplifier tube, and the electromotive force picked up from the other rail of the track circuit is applied through another receiving channel to a second control grid and plate current flows for the tube only when these two electromotive forces are simultaneously applied to the respective grids and the electromotive forces are substantially in phase with each other.

Although I have herein shown and described only one form of railway traffic controlling 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, a track section, means to supply coded alternating current from a preselected source across the rails of the section to cause such current to flow in the rails in series, a train to travel said section; a train carried electron tube having a plate, a cathode and a first and a second grid; a first circuit means on the train coupled to one of the track rails only and connected across the first grid and cathode of said tube to create an alternating electromotive force between the first grid and cathode each on period of such coded current, a second circuit means on the train coupled to the other track rail only and including a transformer whose secondary winding is connected across the second grid and cathode of said tube to create an alternating electromotive force between the second grid and cathode each on period of such coded current, a plate circuit including a current source connected across the plate and cathode of said tube, means including a source of direct voltage connected to said first grid and cathode to create a predetermined negative grid bias voltage which is ineffective to prevent a flow of current in said plate circuit only when said electromotive forces are created between the respective grids and cathodes simultaneously and in phase with each other, said first and second circuit means disposed to create said alternating electromotive forces in phase to cause plate current to flow in response to rail current supplied by said preselected source only, and a train carried train control means coupled to said plate circuit effectively governed by the current thus caused to flow in the plate circuit.

2. In combination, a track section, means to supply coded alternating current from a preselected source across the rails of the section to cause such current to flow in the rails in series, a train to travel the section; a train carried electron tube having a plate, a cathode, a control grid and another grid; a first circuit means on the train including a winding coupled to one

of the track rails only and connected across the control grid and cathode of the tube to impress on the control grid an alternating electromotive force in response to said coded current flowing in said one rail, a second circuit means on the train including a winding coupled to the other one of the track rails only and another electron tube amplifier and a transformer having a winding connected across the other grid and cathode of the first mentioned tube to impress on said other grid an amplified alternating electromotive force in response to said coded current flowing in said other rail, a plate circuit including a winding and a current source connected across said plate and cathode of said first mentioned tube, means including a source of direct voltage connected across said control grid and cathode of the first mentioned tube to provide a predetermined negtaive grid bias voltage for that tube to permit current to flow in said plate circuit only when said electromotive forces are impressed on the respective grids of said first mentioned tube simultaneously and in phase with each other, said first and second circuit means disposed to impress said alternating electromotive forces in phase on the respective grids to create a plate current only in response to said coded current supplied by said preselected source, and a code following relay coupled to said plate circuit winding to operate the relay by the current thus caused to flow in said plate circuit.

3. In railway traffic controlling apparatus for use with a track section whose track rails are supplied with coded alternating current which flows in the rails in series, the combination comprising; an electron tube having a plate, a cathode and a first and a second grid; a first receiving channel electrically coupled to one rail only of the section and connected across said first grid and cathode of said tube to impress upon said first grid an alternating electromotive force in response to each on period of said coded current flowing in said one rail, a second receiving channel electrically coupled to the other rail only of the section and connected across said second grid and cathode of said tube to impress upon said second grid an alternating electromotive force in response to each on period of said coded current flowing in said other rail, a plate circuit including a winding and a current source connected to said plate and cathode of the tube, means including a source of direct voltage connected across said first grid and cathode of the tube to provide a preselected negative grid bias voltage for the tube to cause no current to normally flow in said plate circuit and to permit plate current to flow only when said electromotive forces are applied to the respectlve grids simultaneously and in phase with each other, said first and second receiving channels poled to impress said alternating electromotive forces on the respective grids in phase to provide a plate current only during an on code period of the current supplied by said preselected source, and a code following relay coupled to said plate circuit winding effectively operated by the plate current thus caused to flow in said plate circuit.

4. In railway tracffic controlling apparatus for use with a track section whose rails are supplied with coded alternating current, the combination comprising, two inductors mounted one for inductive relation to one rail of the track section and the other for inductive relation to the other rail; an electron tube having a plate, a cathode and a first and a second grid; means to couple a first one of said inductors to the first grid and cathode of said tube to apply across said first grid and cathode the alternating electromotive force induced in said one inductor each on period of such coded current, means including a transformer having a winding connected directly across said second grid and cathode to couple the second one of said inductors to the second grid and cathode of said tube to apply across said second grid and cathode the alternating electromotive force induced in said second inductor each on period of the coded current, a plate circuit for said tube and including a winding and a current source, means connected to at least one of said grids and the cathode to provide a predetermined negtaive bias voltage for the tube that causes no current to normally flow in said plate circuit and permits plate current to flow only when said electromotive forces are applied to the respective grids in phase to drive the grids in the positive direction simultaneously, said inductors poled to apply said electromotive forces to the respective grids in phase, and a code following relay coupled to said plate circuit winding to operate the relay in response to the plate current thus caused to flow.

5. In railway traffic controlling apparatus for use with a track section whose rails are supplied with coded current from a preselected source of alternating current, the combination comprising, two inductors mounted one for inductive relation to one rail of the track section and the other for inductive relation to the other rail; an electron tube having a plate, a cathode and a first and a second grid; means to couple a first one of said inductors to the first grid and cathode of said tube to apply across said first grid and cathode the alternating electromotive force induced in said one inductor each on period of such coded current, means including a transformer having a winding connected directly across said second grid and cathode to couple the second one of said inductors to the second grid and cathode of said tube to apply across said second grid and cathode the alternating electromotive force induced in said second inductor each on period of the coded current, a plate circuit for said tube and including a winding and a current source, means connected to a selected one of said grids and the cathode to provide a predetermined negative bias voltage for the tube to normally cause zero plate current and to permit plate current to flow only when said electromotive forces are applied to the respective grids simultaneously and in phase with each other, said inductors poled to apply the respective electromotive forces to the respective grids in phase with each other to cause plate current to flow due to current supplied by said preselected source, and a code following relay coupled to said plate circuit winding to operate the relay in response to the plate current thus caused to flow.

6. In railway traffic controlling apparatus for use with a track section whose track rails are supplied with coded current from a preselected source of alternating current, the combination comprising, two inductors mounted one for inductive relation to one of the track rails of the section and the other for inductive relation to the other track rail; a first electron tube having a plate, a cathode, a control grid and a screen grid; a first receiving channel to couple a selected one of said inductors to the control grid

and cathode of said tube to apply across the control grid and cathode the alternating electromotive force induced in said first inductor each on period of such coded current, a second electron tube, a transformer provided with a primary winding included in the plate circuit of said second tube and a secondary winding connected directly across said screen grid and cathode of said first tube, a second receiving channel including said second electron tube and said transformer to couple the other inductor to the screen grid and cathode of said first tube to apply across the screen grid and cathode of the first tube the alternating electromotive force induced in said other inductor by each on period of the coded current when amplified by said second tube, a plate circuit for said first tube including a winding and a current source, and a code following relay coupled to said plate circuit winding to operate said relay in response to the variations in the plate current of said first tube effected only when the electromotive forces applied to the control grid and screen grid of the first tube are in phase with each other.

7. In combination, a track section, means to supply alternating current from a preselected source across the rails at the exit end of the section to cause such current to flow in the rails in series, a train to travel the section; a train carried electron tube having a plate, a cathode and a first and a second grid; a first receiving channel on the train including a winding coupled to one of the rails only of the section and connected across the first grid and cathode of said tube to impress between the first grid and cathode an alternating electromotive force in response to said alternating current flowing in said one rail, a second receiving channel on the train including a winding coupled to the other rail only of the section and a transformer provided with a secondary winding connected directly across the second grid and cathode of said tube and said second channel effective to impress between the second grid and cathode an alternating electromotive force in response to said alternating current flowing in said other rail, a plate circuit including a current source connected across the plate and cathode of said tube, means including a source of direct voltage connected across the first grid and cathode of the tube to create a predetermined negative grid bias voltage for the tube, said receiving channels poled to impress said electromotive forces in phase on the respective grids to overcome said negative bias voltage each positive half cycle of said electromotive forces to cause plate current to flow only in response to current supplied by said preselected source, and a train carried train control means governed by said plate circuit and effectively energized in response to the current thus caused to flow in the plate circuit.

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