May 3, 1932. A. G. WILLIAMSON 1,856,822

TRAIN CONTROL SYSTEM

Original Filed Nov. 10, 1926

Fig. 1

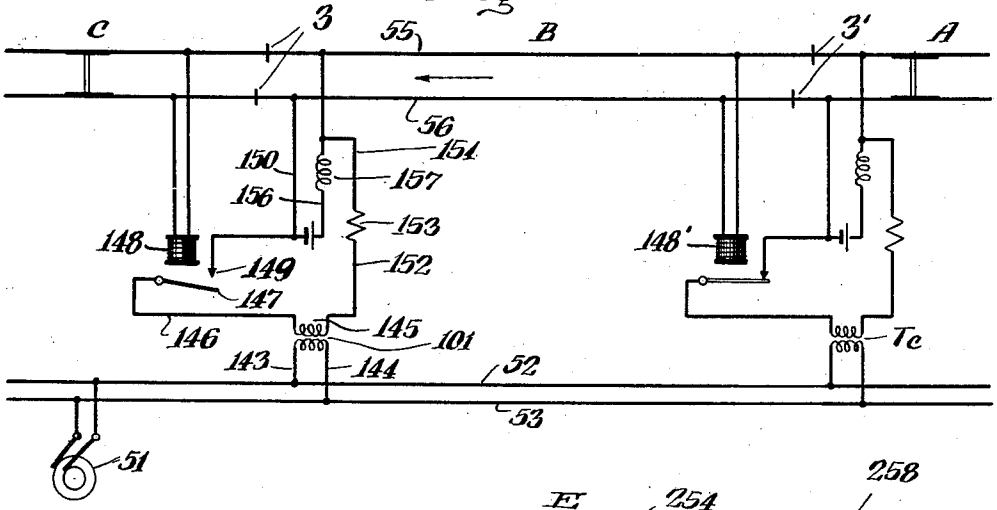


Fig. 2

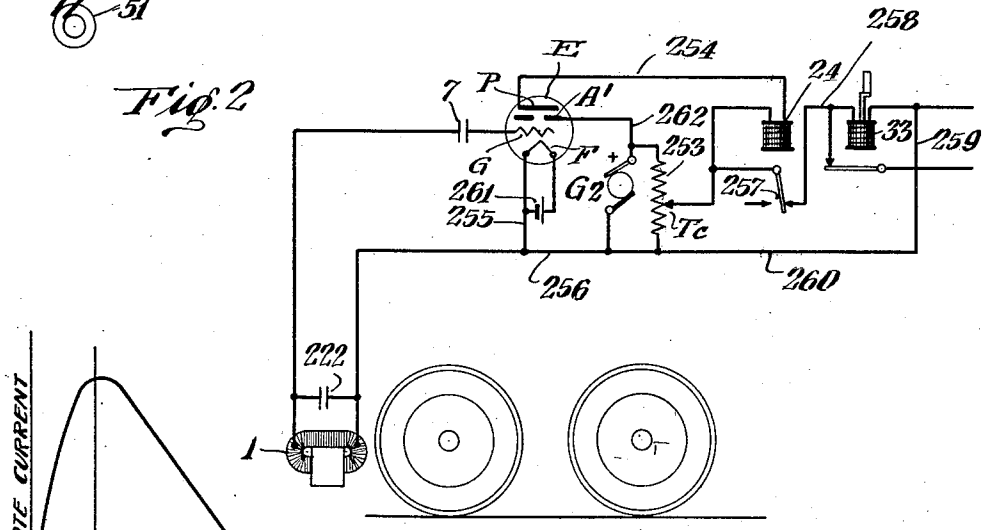
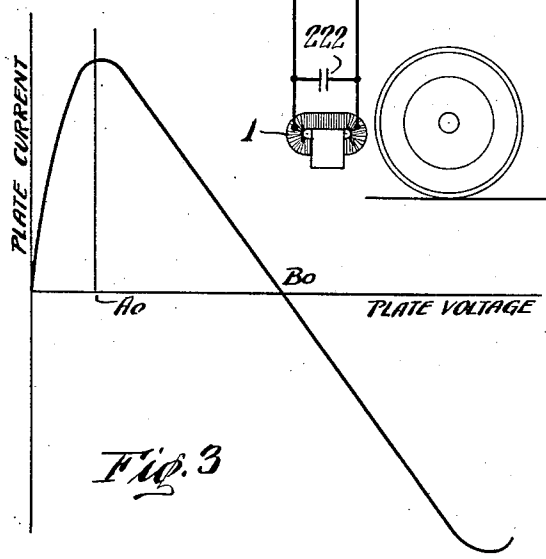


Fig. 3



Inventor
Arba G. Williamson
By Attorney A. D. Vencill

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UNITED STATES PATENT OFFICE

ARBA G. WILLIAMSON, OF CARNEGIE, PENNSYLVANIA, ASSIGNOR TO THE UNION SWITCH & SIGNAL COMPANY, OF SWISSVALE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

TRAIN CONTROL SYSTEM

Original application filed November 10, 1926, Serial No. 147,403. Divided and this application filed November 14, 1930. Serial No. 495,725.

The present invention relates to train control systems, the train or traffic controlling means being of any suitable character such as signals or retarding or stopping devices or both, and has for its main object and feature the employment of an electron discharge device in which the phenomenon of secondary emission is utilized for train control purposes.

This application is a division of application Ser. No. 147,403, filed November 10, 1926.

In the accompanying drawings the invention is disclosed, by way of illustration but not of limitation, in a concrete and preferred form of which

Fig. 1 is a diagrammatic view of a track circuit that may be employed in connection with the invention;

Fig. 2 is a diagrammatic view of a train-carried equipment disclosing one form of the invention; and

Fig. 3 is a graph showing certain operating characteristics of an electron tube utilizing the phenomenon of secondary emission.

Carried on the train is a pick-up coil indicated by the reference character 1. This pick-up coil 1 is suitably attached to the train in advance of the leading pair of wheels and axle of the train, and is suspended as close to the trackway induction element (here the running rails) as is practical.

A suitable traffic governing translating device, under the control of the current induced in pick-up coil 1, is employed and is here indicated by direct-current polarized relay 24 which latter is biased, in any of the ways known in the art, as fully described and disclosed in application Ser. No. 147,403, to assume one condition when direct current of an intermediate value, (say a direct current of the average value of 0.40) is flowing in the coil of the relay, and to assume a second condition when the current flow is maintained at either an increased or decreased value with respect to said intermediate value. In the case here illustrated, relay 24 is so biased that its polarized armature 257 assumes the right-hand position shown in Fig. 2, when the direct current flowing in the coil of relay 24 is of an intermediate value, and assumes the left-hand position opposite to that shown in Fig. 2, when the direct current is maintained at either an increased or decreased value with respect to said intermediate value.

On the train there is provided a translating device as the medium through which the current induced in pick-up coil 1 effects a control over traffic-governing relay 24. This translating device, or electric detector, is electron discharge device E, having four elements, a plate P, a grid G, a filament F, and an element which we shall term anode A′. The pick-up, or receiving, circuit includes pick-up coil 1, a blocking condenser 7, grid G, filament F, and connecting wires. A tuning condenser 222 spans the terminals of coil 1 to tune the circuit to resonance at the frequency of the track circuit current. The plate circuit is as follows: from direct current generator G^2, resistance 253 to adjustable contact TC, then to coil of relay 24, wire 254, plate P, filament F, and wires 255 and 256 back to generator G^2. Filament F is heated by the small battery 261 as shown. The circuit to the fourth element, anode A′, is as follows: generator G^2, wire 262, anode A′, filament F, and wires 255 and 256 back to generator G^2. The circuit through the indicating, or brake controlling magnet 33 is as follows: generator G^2, resistance 253, adjustable contact TC, armature 257, wire 258, coil of magnet 33, and wires 259, 260 and 256 back to G^2.

The electron discharge device E makes use of the phenomenon of secondary emission. If an electron (from filament F) traveling at high speed collides with a metallic surface such as plate P, the giving up of the energy at said surface is likely to "jar" other electrons out of the surface at the point where the collision occurs. This emission of the electron from the surface, caused by the colliding electrons, is called secondary emission, and the number of electrons so emitted depends upon the speed of the colliding electrons—it may be none at all or it may be as many as a dozen or more. Ordinarily the electrons constituting the secondary emission will at once reenter the surface from which

they were emitted, but, if there is, in the vicinity of said surface, an electrode such as anode A′ of high potential, the secondary electrons will not reenter the surface (plate P) from which they came but will go to the high potential electrode (anode A′), thereby causing a secondary electron flow from the surface toward which the first electron flow occurred. Thus when filament F is heated primary electrons will be emitted therefrom, and these electrons will pass, some to positive anode A′ and some to positive plate P, and if A′ has a higher potential than P, secondary emission from plate P to anode A′ will be the result.

In Fig. 3 is shown a characteristic curve of a tube of this type, for a given potential of anode A′. In said Fig. 3 the horizontal axis represents the voltage of the plate with respect to the filament, and the vertical axis represents the current flowing in the plate circuit. From this curve it will be seen that the plate current, for a given potential of anode A′, at first increases with the plate voltage, but that, after the value of the plate voltage reaches the point designated by point A*o*, the plate circuit current decreases as the plate voltage increases—in fact becomes zero at the plate voltage designated by point B*o*.

Let us assume that, in the construction of Fig. 2, the voltages of the anode and plate are so adjusted by contact TC that tube E is operating at point B*o* on the curve of Fig. 3. In other words: the primary and secondary emission is substantially equally powerful and the value of the plate circuit current is substantially zero. When current is induced in coil 1, by current flow in the trackway equipment, grid G will be rendered negative with respect to filament F, and this will affect the primary emission of electrons from F, but it will also affect, and to a greater extent, secondary emission of electrons from P to A′. Thus the two electron streams will be unbalanced to such an extent that a current flow of intermediate value will take place in the plate circuit. Relay 24, being biased in the manner previously indicated, will therefore move polarized armature 257 to its right-hand position and the circuit through magnet 33 will be established, but, if there is no current flow in the plate circuit, armature 257 will move to the left-hand position and the circuit through magnet 33 will be ruptured. Likewise, if the anode circuit should be ruptured or so affected that the potential of said anode is no longer greater than that of the plate, no secondary emission will take place and the full value of the current supplied by generator G^2 will flow in the plate circuit, which current value, being greater than the intermediate value, will move armature 257 to its left-hand position and thus open the circuit through 33.

In Fig. 1 is shown a suitable trackway equipment to cooperate with the train-carried equipment above described. As shown in Fig. 1, 55 and 56 represent the two traffic rails arranged into blocks A, B and C by means of insulation 3′. The normal direction of traffic through said blocks is indicated by the arrow between the rails. At the ingoing end of each block is a relay, marked 148 in block C and 148′ in block B, connected across the rails by suitable leads, and at the outgoing end of each block is a track battery 158 which is connected across the rails by leads 150 and 156. The function of this battery is merely to energize a track relay like 148′—it is not sufficiently powerful to control the train. The train control current is here supplied from generator 51, in this instance of the alternating current type, by way of line wires 52 and 53 to a track transformer associated with each block. Taking block B as an example, it will be seen that the primary of track transformer 101 is connected by wires 143 and 144 to line wires 52 and 53. Secondary 145 of the track transformer is connected to rail 56 by wire 146, armature 147 (of the track relay of the block in advance) contact 149 and wire 150, and is connected to rail 55 by wire 152, resistance 153 and wires 154 and 156. The function of resistance 153 is to prevent secondary 145 from short circuiting the battery. An impedance coil 157 is interposed in wire 156 to choke back the flow of alternating current so that it will not pass to the battery. The power supplied from secondary 145 to the rails is of such amplitude as to energize the pick-up circuit on the train. It will now be understood that the presence, in the rails, of current from 145 will choke down the current in the train-carried charged circuit so that it will have the intermediate value of 0.40, and therefore the circuit under control of relay 24 will remain closed.

If block C be unoccupied, then track relay 148 will be energized and train-control current from secondary 145 will pass to the rails of block B, with the result that if a train enters block B from block A, such train will have its cab equipment controlled thereby giving a clear indication. On the other hand, if block C is occupied when a train enters block B from A, then such train, entering block B from A, will receive no train-control current because track relay 148 of block C will have been deenergized by the train in block C thereby dropping armature 147 and opening the circuit from secondary 145 to rails. The effect of this condition on the train is that no current will flow in the charged circuit passing through relay 24, and that therefore the circuit through 33 is ruptured.

It will further be observed that, although the presence of a train in block C deenergizes track relay 148 and thus cuts off train-control current from the rails of block B, track relay 148′ of block B will nevertheless remain energized (provided B is unoccupied) by reason of current flow from battery 158 so that a train in block A will not be controlled by a train in block C.

If a train enters a block already occupied by another train, then the train so entering will be subject to no train-control current.

I claim:

1. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device containing four elements, charged train-carried circuit means for maintaining two of said elements at a positive potential with respect to a third element, a train-carried receiving circuit, in an inductive relation with the trackway circuit and responsive to current flowing therein, to control the potential of the fourth element of said device with respect to the third element, whereby the flow of current in the circuit means of the first two-mentioned elements of said device is varied.

2. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device containing plate, anode, filament and grid elements, charged train-carried circuit means for maintaining the plate and anode at a positive potential with respect to the filament, a train-carried receiving circuit, in an inductive relation with said trackway circuit and responsive to current flowing therein, to control the potential of the grid with respect to the filament, whereby the flow of current in the plate circuit is varied.

3. A train control system including: a track-way circuit having a source of current, a train-carried electron discharge device containing plate, anode, filament and grid elements, charged train-carried circuit means, to maintain the plate and anode at a positive potential with respect to the filament, a train-carried receiving circuit in an inductive relation with the trackway circuit and responsive to current flowing therein, to control the potential of the grid with respect to the filament, whereby a predetermined flow of direct current in the plate circuit is established in response to a flow of current in the track way circuit.

4. A train control system including: a trackway circuit having a source of current, a train-carried electron discharge device containing plate, anode, filament and grid elements, charged train-carried circuit means, to maintain the plate and anode at a positive potential with respect to the filament, a train-carried receiving circuit in an inductive relation with the trackway circuit and responsive to current flowing therein to maintain the grid at a negative potential with respect to the filament, whereby a predetermined flow of direct current in the plate circuit is established in response to a flow of current in the trackway circuit.

5. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device containing plate, anode, filament and grid elements, charged train-carried circuit means, for maintaining the plate and anode at different positive potentials with respect to the filament, the anode having greater potential than the plate, and a train-carried receiving circuit in an inductive relation with the trackway circuit and responsive to current flowing therein, to control the potential of the grid with respect to the filament.

6. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary electron emission of the electron discharge device, and a train-carried circut, controlled by the trackway circuit to unequally vary the primary and secondary electron emission of the electron discharge device.

7. A train control system including: a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary emission of the electron discharge device, and a trackway circuit to unequally vary the primary and secondary electron emission of the electron discharge device.

8. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, means on the train to control said primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary electron emission of the electron discharge device, and a train-carried circuit controlled by the trackway circuit to unequally vary the primary and secondary electron emission of the electron discharge device.

9. A train control system including: a trackway circuit having a source of current, a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, means on the train to substantially balance said primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary electron emission of the electron discharge device, and a train-carried circuit controlled by the trackway

circuit to unbalance the primary and secondary electron emission of the electron discharge device.

10. A train control system including: a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, means on the train to control said primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary electron emission of the electron discharge device, and a trackway circuit to unequally vary the primary and secondary electron emission of the electron discharge device.

11. A train control system including: a train, a train-carried electron discharge device having elements capable of primary and secondary electron emission, means on the train to substantially balance said primary and secondary electron emission, a train-carried circuit controlled by the relative amount of primary and secondary electron emission of the electron discharge device, and a trackway circuit to unbalance the primary and secondary electron emission of the electron discharge device.

Signed at Swissvale, in the county of Allegheny, and State of Pennsylvania, this 13th day of November, 1930.

ARBA G. WILLIAMSON.