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TRACK RELAY

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Fig. 1.

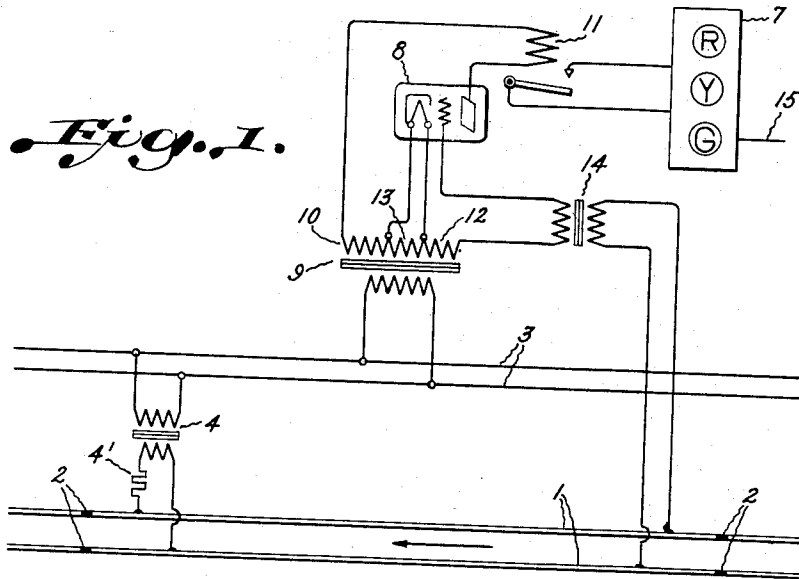
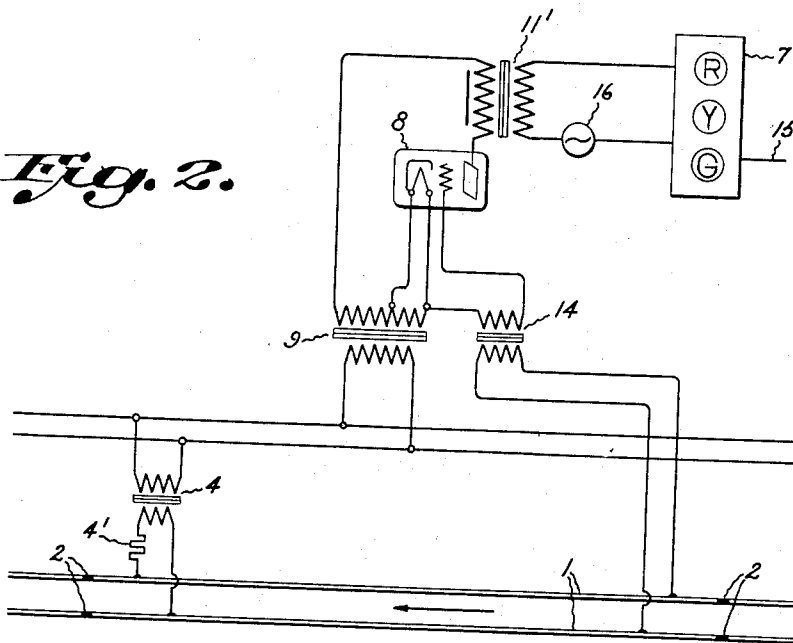


Fig. 2.



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TRACK RELAY

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My invention relates to railway signal systems and more particularly to that type of railway signal system in which a track relay is connected to respond to electromotive force impressed between the rails to control the signals, which are commonly arranged along the track.

In connection with systems of the type indicated, and in connection with block signal systems generally, a suitable electromotive force is impressed between the rails of each of the different blocks at the end of the block opposite to the end at which the railway vehicles enter. At the opposite end of the block, a track relay is provided to respond to the electromotive force there appearing between the rails. Thus this relay is energized when the corresponding block is unoccupied and is short-circuited by the vehicle when the block is occupied.

The electromotive force supplied to the track relay is subject to wide variations due to the condition of ballast of the track, i. e. for example, in dry weather when the road-bed is dry the electromotive force supplied to the track relay is of considerably greater magnitude than during wet weather conditions when there is considerable leakage between the rails through the road bed. In fact under wet weather conditions the resistance between the rails may be reduced to such an extent that a variation of only a fraction of an ohm is produced by the presence of a vehicle in the block. Accordingly it is apparent that under these conditions the voltage variation produced across the track relay by a vehicle in the block may be very minute.

To obtain the necessary degree of reliability of operation of the track signals in response to this variable voltage it is necessary to provide a type of relay which is extremely sensitive to voltage variation and further one in which the "pickup" voltage and "drop out" voltage are substantially the same. This latter characteristic is of course unattainable in relays of mechanical construction since in such relays considerably higher voltage is required to cause attraction of the armature than is subsequently necessary to maintain the armature in attracted position. A still further requirement of the track relay is that it be capable of controlling currents of relatively large magnitude in response to the small variations in track voltage which occur due to the presence and absence of a vehicle in the block.

An object of my invention is to provide a track relay which fills all of the above requirements.

A further object of the invention is to provide a track relay in which the magnitude of current controlled thereby is independent of the magnitude of variation in track voltage.

Still a further object of the invention is to provide such a relay which may be economically constructed and maintained.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 represents an embodiment of my invention and Fig. 2 represents a modification thereof.

Referring to the drawing, I have shown at 1 the rails of one block of a railway track, the rails of this block being insulated from the rails of adjacent blocks at the points 2. At 3 I have shown a power distribution circuit extending along the track from which power is supplied through transformer 4 and impedance 4' to the rails of the track at the exit end of the block. The direction of traffic is indicated by the arrow 5 of the drawing. The impedance 4' serves to prevent too great voltage variations on circuit 3 due to the presence of a vehicle in the block. At the opposite end of the block and represented by the rectangle 7 are located the signals and signal equipment corresponding to the respective block. These signals may be of any suitable type but as in usual practice they provide a danger indication when the corresponding block is occupied, a caution indication when the adjacent block in advance is occupied and the corresponding block unoccupied, and a clear indication

when the two blocks are unoccupied, these signals being denoted by the letters R, Y and G appearing in the rectangle 7.

To control the signals 7 in response to voltage appearing between the rails 1, I have provided an electron discharge device 8 of the vapor electric type. This device comprises an envelope which is filled with a suitable attenuated gas such as mercury vapor and having an anode, a cathode and a grid. This discharge device is energized by means of alternating current potential supplied thereto from the distribution circuit 3 through a transformer 9. This transformer is provided with a plurality of secondary windings. The left hand winding 10 is connected between the anode and cathode in series with a suitable relay 11, the right hand winding 12 is connected between the grid and cathode, whereas the winding 13 is utilized to supply heating current to the cathode of the discharge device. The control electromotive force from the track is supplied to the grid of the discharge device by means of transformer 14 the primary of which is connected between the rails of the track at the entrance end thereof and the secondary of which is connected between the cathode and grid in series with the secondary winding 12 of the transformer 9.

The operation of the device as thus arranged is as follows: It will be noticed that the electromotive force which is supplied to the grid by the winding 12 is in opposed phase relation to that which is supplied to the anode by the winding 10. Accordingly, we may assume that if the block 1 is occupied by a vehicle such that there is no electromotive force across the secondary winding of transformer 14 then the gas within the vapor electric device 8 is not ionized and the tube is nonconducting, that is, the grid is sufficiently negative during those half-cycles when the anode is positive to prevent ionization of the gas and accordingly to prevent flow of current in the anode circuit. The relay 11 is thus deenergized and a danger indication given by signal 7. At the same time, through a connection indicated at 15, a caution indication may be given in the equipment of the adjacent block at the right.

If the vehicle now moves from block 1 to the block at the left the electromotive force is then supplied through transformer 14 to the grid. The secondary winding of this transformer is connected in opposed relation to the winding 12 of transformer 9 such that this control electromotive force causes the potential upon the grid of the device 8 to be raised in a positive direction during the half cycle when the anode is positive above the value at which the ionization of the gas occurs. The gas then becomes ionized at each positive half cycle and current flows therein causing the relay 11 to be en-

ergized and the clear signal indication to be given.

Discharge devices of the vapor electric type are particularly adapted to use for the purpose indicated for the reason that while the flow, i. e. the starting, or presence, of anode current in the circuit is delicately subject to control by the grid potential, the magnitude of the current is independent of the grid potential. Thus, after the device has become conductive the current in the anode circuit is dependent solely upon the anode voltage. For this reason alternating energizing potential is utilized upon the anode. The anode current is thus interrupted during each alternate half cycle. When once interrupted, however, the starting of the anode current is subject to delicate control by the grid potential. If the grid potential be above a definite value the full amount of anode current, as determined by the anode voltage, is permitted to flow, whereas if the grid potential is below this definite value the starting of current in the anode circuit is prevented.

Thus by means of windings 12 and 13 connected in series opposed relation the grid of the discharge may be made normally sufficiently positive to just permit anode current to flow. When the potential of transformer 14 is interrupted by the presence of a train in the block the negative potential of winding 12 is sufficient to prevent any anode current from starting during the successive alternate half cycles. Thus the anode current is definitely either "off" or "on" dependent upon the occupied condition of the track.

Of course the value of grid voltage above which the tube becomes conducting during positive half cycles is dependent upon the structure of the discharge device. The voltage and polarity of winding 12 may therefore be chosen in accordance with the characteristics of the particular discharge device.

The transformer, 14, if desired, may be one having a step-up ratio thereby to increase the voltage variation produced on the grid by the presence of a vehicle in the block. The relay 11 may be of any cheap and rugged construction. The difference between the "pick up" and "drop out" voltages of this relay does not detrimentally affect the reliability of the system because of the large anode current which the vapor electric device is capable of passing when conductive.

In Fig. 2, I have shown a modification of my invention in which the anode circuit of the discharge device includes a reactor 11', instead of the mechanical relay of Fig. 1. This reactor may be of any suitable construction but comprises a direct current winding which is connected in the anode circuit of the discharge device and designated by a bar adjacent thereto and an alternating current

winding connected in series to the source of alternating electromotive force 16 and suitable control mechanism included in the equipment 7. These windings are arranged upon a core of iron, or ferromagnetic material, such that when the direct current winding is energized the iron core becomes saturated and the alternating current winding becomes of low impedance whereas when the direct current winding is energized the alternating current winding is of high impedance.

Thus the impedance of the alternating current winding of the reactor is controlled by controlling the conductivity of the discharge device.

In this figure the grid potential is supplied entirely by the secondary winding of transformer 14 this winding being connected directly between the grid and cathode of the discharge device. The discharge device may be maintained in its conducting condition by the positive electromotive force supplied by this transformer and be caused to become nonconducting when this electromotive force is removed. If the device be one however in which ionization occurs when the grid is at cathode potential, or at negative potential with respect to the cathode, transformer 14 may be so polarized as to impress a negative potential on the grid when the block is unoccupied and thereby render the discharge device nonconducting.

While I have shown a particular circuit arrangement utilizing a vapor electric device for the purpose contemplated by my invention it will of course be understood that different circuit arrangements may be employed and that I contemplate by the appended claims to cover any such circuit arrangements as fall within the true scope of my invention.

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

1. The combination in a railway signal system, of a track, a signal along said track, means for impressing an electromotive force between the rails of said track, an electron discharge device comprising an envelope filled with attenuated gas and having an anode, a cathode and a control electrode, a source of electromotive force connected between said anode and cathode having a value sufficient to cause ionization of said gas, and means for supplying said electromotive force between said rails to said control electrode thereby to control the state of ionization of said gas, and means responsive to current through said device to control said signal.

2. The combination in a railway signal system of a track, a signal, means for impressing an electromotive force between the rails of said tracks, an electron discharge device having an anode, a cathode, and a control electrode, a source of electromotive force con-

nected between said anode and cathode, said discharge device having the characteristics that no current flows between the anode and cathode when the electromotive force between the control electrode and cathode is below a certain value and that when the electromotive force between the control electrode and cathode is raised to said certain value said discharge device permits current to flow between said cathode and anode, having a value independent of said electromotive force between the control electrode and cathode, means dependent upon said electromotive force between the rails for impressing an electromotive force upon said control electrode sufficient to cause said device to permit current to flow in said anode, and means responsive to current through said device to control said signal.

3. The combination, in a railway signal system of a track, a signal along said track, means for impressing an electromotive force between the rails of said track, an electron discharge device comprising an envelope filled with attenuated gas and having an anode, a cathode and a control electrode, whereby said device is in a substantially nonconducting condition when the potential on the control electrode with respect to said cathode is below a certain value and in a highly conducting condition when said potential is above said certain value, a source of electromotive force connected between said cathode and control electrode having a value sufficient and so polarized that said device is just maintained in one of said conditions, and means dependent upon the presence of electromotive force between the rails of said track to impress an additional electromotive between said cathode and control electrode in opposed relation to said last mentioned electromotive force and having a value sufficient to cause said device to assume the other of said conditions, and means responsive to current through said device to control said signal.

4. The combination, in a railway signal system of a track, a signal, means for impressing an alternating electromotive force between the rails of said track, an electron discharge device comprising a vessel filled with attenuated gas, and having an anode, a cathode, and a grid, a source of alternating electromotive force connected between said anode and cathode, whereby when the electromotive force between the grid and cathode is greater than a certain value said devices in a conducting condition and current flows in the anode having a value dependent upon the anode electromotive force and independent of the grid electromotive force, whereas when the electromotive force between the grid and cathode is less than said certain value said device is nonconducting, a transformer having a primary winding connected between

- said rails and a secondary winding connected between said grid and cathode whereby electromotive force from said rails is normally impressed between said grid and cathode having a value greater than said certain value, thereby to maintain said device in said conducting condition, whereas when a vehicle occupies said track and said electromotive force is removed from said grid and cathode, said device becomes nonconducting at the end of the half cycle when said electromotive force is removed, and means responsive to current through said device to control said signal.
5. The combination, in a railway signal system of a track, a signal along said track, means for impressing an electromotive force between the rails of said track, an electron discharge device having an anode, a cathode, and a grid, means for supplying said electromotive from the rails to said grid and cathode, means for supplying a second electromotive force to said grid and cathode in opposed relation to said first electromotive force, said electromotive forces having such magnitude and polarities that when no vehicle is on said track said discharge is highly conductive to current between said anode and cathode and when the vehicle is on the track said discharge device is nonconductive, a signal, and current responsive means connected between the anode and cathodes to control said signal.

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