

Oct. 1, 1940.

A. J. SORENSEN

2,216,631

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed July 12, 1939

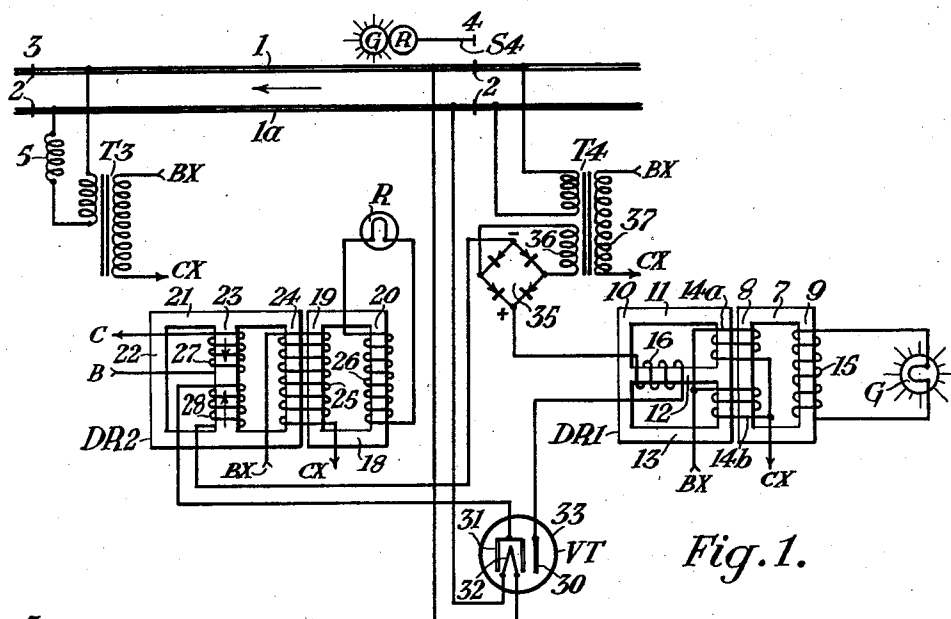


Fig. 1.

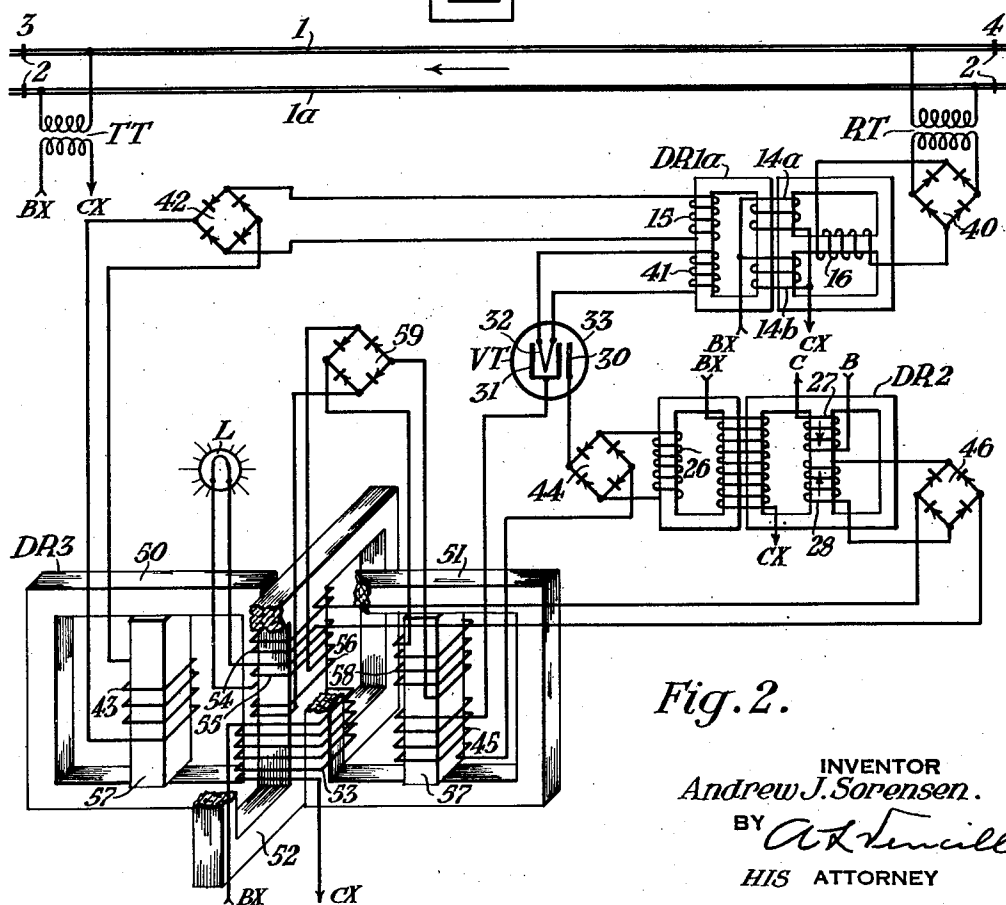


Fig. 2.

INVENTOR
Andrew J. Sorensen.

BY *A. J. Sorensen*
HIS ATTORNEY

UNITED STATES PATENT OFFICE

2,216,631

RAILWAY TRAFFIC CONTROLLING
APPARATUS

Andrew J. Sorensen, Edgewood, Pa., assignor to
The Union Switch & Signal Company, Swiss-
vale, Pa., a corporation of Pennsylvania

Application July 12, 1939, Serial No. 284,133

8 Claims. (Cl. 246—34)

My invention relates to railway traffic controlling apparatus, and has particular reference to the organization of such apparatus into railway signaling systems of the class employing static control apparatus of the saturation relay type, which is characterized by the fact that all the component parts thereof are stationary.

In certain applications of signaling systems of the above described class, it is often desirable to obtain delayed response or action of control apparatus to a control current; or in other words, it is often desirable to employ slow acting relays of the saturation type. Although I am aware that signaling systems employing saturation type relays have heretofore been proposed, none of the proposed systems to my knowledge have been able to achieve the benefits obtainable by the use of slow acting saturation type relays. Accordingly, an object of my present invention is the provision of novel and improved signaling apparatus in which saturation type relays are employed.

A further object is the organization of railway signaling apparatus to provide slow acting characteristics to saturation type relays.

An additional object is the provision of novel and improved means whereby slow acting characteristics are imparted to saturation relays by means of a static control device of the thermionic tube type.

A further object is the provision of novel and improved means wherein a thermionic tube is employed as a control device to impart slow acting characteristics to relays, in which unnecessary deterioration of the tube elements is avoided, thereby prolonging the effective life of the thermionic tube.

My invention is an improvement upon the track circuit apparatus shown in a copending application for Letters Patent, Serial No. 318,746, filed on February 13, 1940, by Bernard E. O'Hagan, and certain features of my present invention are broadly covered by claims in the said copending application.

Other objects and characteristic features of my invention will be apparent from the following description taken in connection with the accompanying drawing.

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

In the accompanying drawing, Fig. 1 is a diagrammatic view showing one form of apparatus embodying my invention. Fig. 2 is a diagrammatic view of a modified form of the apparatus

shown in Fig. 1, which also embodies my invention.

Similar reference characters refer to similar parts in each of the two views.

Referring to Fig. 1, the reference characters 1 and 1a designate the track rails of a stretch of railway track over which traffic normally moves in the single direction indicated by an arrow in the drawing, and which I shall assume to be the westbound direction. The rails 1 and 1a are divided by means of the usual insulated rail joints 2 into a track section 3—4. Section 3—4 is provided with means located adjacent its exit end 3 for supplying to the rails of the section trackway energy which may have either unidirectional or alternating characteristics. As shown, section 3—4 is supplied with alternating trackway energy through the medium of a transformer T3 which has its secondary winding constantly connected across the track rails of section 3—4 in series with a current limiting impedance 5, and has its primary winding connected to a source of alternating current such as a generator not shown in the drawing, having its terminals designated by the reference characters BX and CX.

Section 3—4 is provided adjacent its entrance end 4 with a traffic controlling signal, which may be of any suitable type but as herein shown is a two-indication signal, designated by the reference character S4, comprising a green lamp G and a red lamp R, which lamps when illuminated indicate "clear" and "stop," respectively.

Section 3—4 also is provided with means, located adjacent its entrance 4 and controlled in response to traffic conditions in section 3—4, for controlling the aspects displayed by the associated signal S4. As herein shown, the means includes two saturation type relays DR1 and DR2.

Relay DR1 may be of any suitable type of saturation relay characterized by the fact that a relatively large amount of energy is or is not received by an output winding of the relay from a source of energy according as a control winding of the relay is or is not supplied with current. Relay DR1, therefore, may take any one of the well-known forms of "front contact" type saturation relays, but as herein shown, relay DR1 is a front contact saturation relay of the type shown and described in United States Letters Patent No. 1,910,381 granted to Philip H. Dowling on May 23, 1933, for Electrical translating apparatus. Relay DR1 comprises a first magnetizable core 7 having two parallel legs 8 and 9; and a second magnetizable core 10 having three legs 11, 12 and 13 connected in parallel to form two magnetic paths

with the leg 12 forming a bridging member common to both paths. A primary or local input winding 14 comprising two coils 14a and 14b connected in parallel, is disposed on core 10 on opposite sides of bridging member 12 in such manner that when winding 14 is supplied with current, the fluxes created by such current in coils 14a and 14b produce substantially no flux in member 12. The coils 14a and 14b of input winding 14 also are linked by core 7 in such manner that the fluxes created in core 7 by coils 14a and 14b are additive. Core 7 also carries a secondary or output winding 15, which as shown is connected to the filament of signal lamp G of signal S4. A control or saturation winding 16 is disposed on the bridging member 12 of core 10 and is supplied at times with current to vary the permeability of that core.

The operation of relay DR1 is as follows: local input winding 14 of the relay DR1 is constantly supplied with periodically varying current from a suitable source, preferably a source of alternating current having its terminals designated by the reference characters BX and CX. The parts of the relay are so proportioned and designed that when control winding 16 of relay DR1 is deenergized, a very small amount of current is drawn by lamp G connected across output winding 15. This small amount of current is insufficient to illuminate lamp G, but is effective to force the major portion of the flux created by the current supplied to winding 14 through core 10, where this flux circulates through legs 11 and 13 but not through bridging member 12 of the core. If, now, unidirectional current is supplied to control winding 16, there is created in bridging member 12 a saturating flux which varies the permeability of core 10 to the flux created by the current supplied to winding 14, and as a result the major portion of this latter flux is forced to circulate through core 7. The electromotive force induced in output winding 15 correspondingly is increased to a value which is sufficient to illuminate lamp G. The amount of energy received by output winding 15 of relay DR1 from the source of energy provided for the relay is, therefore, controlled by the energization of control winding 16 of the relay.

Relay DR2 may be of any suitable type of saturation relay characterized by the fact that a relatively large amount of energy is received by the output winding of the relay when the control winding of the relay is deenergized, and the amount of energy received by the output winding when the control winding of the relay is energized is relatively small. Relay DR2 accordingly may take any one of the well-known forms of "back contact" types of saturation relays, but as herein shown is of the type shown and described in United States Letters Patent No. 1,835,209 granted on December 8, 1931, to Philip H. Dowling for Electrical translating apparatus.

Relay DR2 comprises a first magnetizable core 18 having two parallel legs 19 and 20; and a second magnetizable core 21 having three legs 22, 23 and 24 connected in parallel to form two magnetic circuits for core 21 with central leg 23 forming a bridging member common to both paths. A primary or local input winding 25 is disposed on leg 24 of core 21 and on leg 19 of core 18, and is constantly connected across the terminals BX and CX of a source of periodically varying current. A secondary or output winding 26 is disposed on leg 20 of core 18 and is connected across the filament of lamp R of signal S4. A biasing

winding 27 is disposed on the bridging member 23 of core 21, and is constantly supplied with unidirectional current from a suitable source, such as a battery not shown in the drawing, having its terminals designated by the reference characters B and C. The current supplied to winding 27 sets up a biasing flux in core 21 which varies the permeability of the core to the flux created by the current supplied to winding 25, and the parts of the relay are preferably so proportioned that under the above conditions, the major portion of the flux created by the current supplied to winding 25 circulates through core 18 with the result that a relatively large electromotive force is induced in output winding 26 so that lamp R is illuminated. A control or saturation winding 28 also is disposed on bridging member 23 of core 21, and is arranged so that when supplied with unidirectional current of the proper polarity and value, a saturating flux is set up in member 23 which opposes and nullifies the biasing flux created by the current supplied to biasing winding 27. Under the latter condition, therefore, the permeability of core 21 to the flux created by current supplied to winding 25 is increased to allow a greater proportion of the flux from the primary winding 25 to circulate through core 21. This results in the decrease of flux circulating in the other core 18, and hence decreases the electromotive force induced in output winding 26. The parts of relay DR2 are preferably so proportioned and designed that when current is supplied to winding 28, the magnitude of the electromotive force induced in output winding 26 is insufficient to illuminate lamp R. The amount of energy received by output winding 26 of relay DR2 from the source of energy provided for the relay is, therefore, controlled by the energization of control winding 28 of the relay.

The relays DR1 and DR2 are controlled by means of a static control device VT, which in turn is controlled by energy derived from the track rails of section 3-4 to cause the relays DR1 and DR2 to be responsive to traffic conditions in the section. Device VT is characterized by the fact that all the component parts thereof are stationary, and is effective to provide slow pick-up characteristics for relays DR1 and DR2.

As shown, device VT is a thermionic tube having two electrodes, an anode or plate 30 and a cathode 31, one of which must be heated to control the tube to its conducting condition. In order to obtain a relatively long delay period for relays DR1 and DR2, the tube preferably is of the indirectly heated cathode type, and is provided with a heating element 32 receiving energy from the rails of section 3-4 for at times heating cathode 31 to its operating temperature. Tube VT may be either of the evacuated or the gas filled type, and is provided with an envelope 33 into which the two electrodes and the heating element of the tube are sealed. A rectifier 35 receiving energy from a secondary winding 36 of a transformer T4 (which has its primary winding connected across the terminals BX and CX of a source of alternating current) is connected across the two electrodes of tube VT in a plate circuit which includes in series control winding 16 of relay DR1 and control winding 28 of relay DR2. The current supplied by rectifier 35 to the control windings of relays DR1 and DR2 when tube VT is conducting is proportioned to cause relay DR1 to control lamp G to its illuminated condition, and to cause relay DR2 to control lamp R to its dark or non-illuminated condition.

The operation of the apparatus embodying my invention is as follows. When section 3—4 is unoccupied, the apparatus is in its normal condition as shown in the drawing. In this condition of the apparatus, heating element 32 of tube VT is energized by energy received from the rails of section 3—4 so that the tube cathode 31 is heated to its operating temperature and tube VT as a result is controlled to its conducting condition; control winding 16 of relay DR1 is energized so that a relatively large electromotive force is induced in output winding 15 of relay DR1 and lamp G of signal S4 is illuminated to cause signal S4 to display its "clear" indication; and control winding 28 of relay DR2 also is energized with the result that a relatively small electromotive force is induced in output winding 26 of relay DR2 and lamp R of signal S4 is dark.

When a train enters section 3—4 and establishes a train shunt across the rails of that section, the trackway energy of section 3—4 then is shunted away from the heating element of tube VT. With heating element 32 of tube VT deenergized, the element cools rapidly so that cathode 31 of the tube also cools to control tube VT to its non-conducting condition, and as a result the plate circuit current is interrupted and control winding 16 of relay DR1 and control winding 28 of relay DR2 become deenergized. Lamp G of signal S4 therefore is caused to assume its darkened condition, since the deenergization of control winding 16 of relay DR1 results in an electromotive force of relatively low magnitude being induced in output winding 15 of relay DR1, as was pointed out hereinbefore. Lamp R of signal S4, however, is controlled to its illuminated condition since the constant energization of biasing winding 27 of relay DR2 causes a relatively large electromotive force to be induced in the output winding 26 of relay DR2, which in turn causes lamp R of signal S4 to become illuminated to cause signal S4 to display its "stop" indication.

Then, when the train vacates section 3—4 and trackway energy from the section is again received by the heating element of tube VT, the tube is caused to assume its conducting condition at the end of the time interval required for the heating element to heat cathode 31 to the temperature at which the tube becomes conducting. This interval of time required to bring the cathode of the tube VT to the proper temperature provides slow acting characteristics for the saturation relays DR1 and DR2, in that current is not supplied to the control windings of the relays until the tube becomes conducting. The response of the saturation relays to a change in the traffic conditions in the section is, therefore, delayed by means of the control device VT, which causes relays DR1 and DR2 to have slow pick-up characteristics. That is to say, each of the relays is caused to be slow in responding to a change in the supply of energy from a control circuit (in this instance a track circuit) and therefore corresponds to a slow pick-up tractive armature type of relay constructed to require an appreciable time interval of energization before its armature is attracted from its deenergized position to its energized position. When the cathode of tube VT reaches its operating temperature, the plate circuit of the tube is reestablished, and the apparatus is restored to its normal condition wherein lamp G is illuminated and lamp R is dark.

It should be pointed out that although the

control device VT is shown controlling two saturation relays each performing a single function, the device is equally suitable for use with a saturation relay having incorporated therein both "front contact" and "back contact" output windings, such for example, as is shown in the copending application for Letters Patent, Serial No. 280,731, filed on June 23, 1939, for Railway signaling apparatus, by Claude M. Hines. Device VT when used with a relay of the above type will, of course, provide such relay with slow pick-up characteristics.

Referring now to Fig. 2, the reference character TT designates a track transformer which supplies the track rails of section 3—4 of Fig. 2 with alternating trackway energy, and the reference character RT designates a receiving transformer having its primary winding connected across the rails of section 3—4 and its secondary winding connected across the input terminals of a rectifier 40.

The reference character DR1a designates a "front contact" type saturation relay, substantially similar to the relay DR1 described hereinbefore in connection with Fig. 1, except that an additional or second output winding 41 is provided for relay DR1a. The control winding 16 of relay DR1a is connected across the output terminals of rectifier 40, which functions to convert the alternating trackway energy received from section 3—4 into and supply unidirectional current to control winding 16 of relay DR1a. The first output winding 15 of relay DR1a is connected through the medium of a rectifier 42 to a first control winding 43 of a saturation relay DR3, later to be referred to. The second output winding 41 of relay DR1a is connected to the heating element 32 of control device VT.

The output winding 26 of saturation relay DR2 of Fig. 2 (which is a "back contact" type saturation relay similar to relay DR2 described in detail in connection with Fig. 1) is connected across the output terminals of a rectifier 44, which has its positive output terminal connected to plate 30 of tube VT of Fig. 2 and its negative output terminal connected to cathode 31 of tube VT in series with a second control winding 45 of saturation relay DR3. The biasing winding 27 of relay DR2 of Fig. 2 is constantly supplied with unidirectional current from a suitable source designated by the terminals B and C, and the control winding 28 of relay DR2 of Fig. 2 is supplied with unidirectional current from a rectifier 46, which in turn is supplied with energy from a first output winding 54 of saturation relay DR3.

The saturation relay DR3 hereinbefore mentioned is substantially similar to the dual control saturation relay shown and described in United States Letters Patent 1,862,204 granted to me on June 7, 1932, for Electrical translating device. As shown, relay DR3 comprises three magnetizable cores 50, 51 and 52, each of which is provided with three legs connected in parallel. The cores of relay DR3 preferably are arranged so that an outer leg of each of the cores 50 and 51 is adjacent the middle leg of core 52, a portion of the core 51 and of the core 50 being broken away in the drawing to better illustrate the arrangement of the cores. A local input or primary winding 53 is disposed to link the middle leg of core 52 and the adjacent outer leg of each of the remaining cores 50 and 51, and is constantly supplied with periodically varying current from a suitable source designated by the ter-

minals BX and CX. The middle leg of core 52 also carries three output windings 54, 55 and 56, while the middle leg of each of the remaining cores is provided with a conducting sleeve 57 for the purpose of preventing the passage of alternating flux through the associated leg of the core. The first control winding 43 for relay DR3 is disposed on the conducting sleeve mounted on the middle leg of core 50, and the second control winding 45 and a third or stick control winding 58 of the relay DR3 are each disposed on the conducting sleeve mounted on the middle leg of core 51. The operation of relay DR3 will best be understood from the following description of the apparatus of Fig. 2 as a whole.

In describing the operation of the apparatus of Fig. 2, I shall first assume that a train occupies section 3—4 so that trackway energy is shunted away from receiving transformer RT. Control winding 16 of relay DR1a is, under the above assumed condition, deenergized so that electromotive forces of relatively small magnitude are induced in output windings 15 and 41 of relay DR1a, the electromotive forces supplied from output windings 15 and 41 being insufficient to effectively energize control winding 43 of relay DR3 and heating element 32 of tube VT. Tube VT, therefore, is controlled to its non-conducting condition with the result that the plate circuit for tube VT is in effect opened and control winding 45 of relay DR3 included in such plate circuit also is deenergized. The parts of relay DR3 preferably are designed and proportioned in such manner that with both control windings 43 and 45 deenergized, the reluctances of cores 50 and 51 of relay DR3 to the flow of the flux created by the current supplied to local input winding 53 of the relay are relatively low with respect to the reluctance of the other core 52, and as a result substantially all of the flux circulates through core 50 and core 51 and relatively little flux circulates through core 52. It can be seen, therefore, that electromotive forces of relatively small magnitudes are induced at this time in output windings 54, 55 and 56 mounted on core 52 of the relay. Accordingly, a control device (herein shown as a lamp L) which is connected across the terminals of output winding 55 is controlled to its deenergized condition; control winding 28 of relay DR2 connected across the terminals of output winding 54 through the medium of rectifier 46, and control winding 58 of relay DR3 which is connected across the terminals of output winding 56 through the medium of rectifier 59, are both supplied with current of relatively low magnitude insufficient to effectively energize such control windings. The lamp L controlled by winding 55 of relay DR3 may be utilized for any suitable purpose, such for example, as a signal lamp of a traffic controlling signal.

When, however, the train vacates section 3—4 so that trackway energy energizes control winding 16 of relay DR1a, then electromotive forces of relatively large magnitude are induced in output windings 15 and 41 of relay DR1a. The electromotive force induced in output winding 15 of relay DR1a is supplied to control winding 43 of relay DR3, and the flux created by such electromotive force in winding 43 increases the reluctance of core 50 of relay DR3, preferably to a point where core 50 is magnetically saturated. The major portion of the flux created by the current supplied to input winding 53 of relay DR3 accordingly is caused to circulate through core 51 of the relay because of the different rela-

tive reluctances of the three cores and as a result relatively small electromotive forces are still induced in output windings 54, 55 and 56 of relay DR3.

The electromotive force induced in output winding 41 of relay DR1a is supplied to heating element 32 of tube VT, whereupon the element becomes heated and at the end of a short time interval raises the cathode 31 of tube VT to its proper operating temperature. When the cathode of tube VT reaches its operating temperature, the potential due to rectifier 44 causes current to flow in the plate circuit of the tube, with the result that control winding 45 of relay DR3 also is energized. This energization of control winding 45 creates a magnetic flux which increases the reluctance of core 51 and preferably magnetically saturates that portion of relay DR3, with the result that substantially all the flux created by the current supplied to input winding 53 of the relay circulates through core 52 since the reluctances of both cores 50 and 51 are at this time relatively large with respect to the reluctance of core 52, and relatively large electromotive forces are induced as a result in the relay output windings 54, 55 and 56. Lamp L connected across winding 55 accordingly becomes effectively energized and is illuminated. Control winding 58 disposed on core 51 of relay DR3 and connected with output winding 56 through the medium of rectifier 59 also becomes energized to supply saturating flux to core 51 in agreement with the saturating flux supplied by control winding 45 disposed on that core. In addition, control winding 28 of relay DR2 of Fig. 2 becomes energized by current supplied from output winding 55 of relay DR3 to supply to relay DR2 a saturating flux which opposes the flux supplied by biasing winding 27, and as a result the electromotive force induced in output winding 26 of relay DR2 becomes relatively small and is insufficient to maintain the ionization of tube VT. Since no current flows in the plate circuit of tube VT, control winding 45 of relay DR3 connected in such circuit becomes deenergized, but since control winding 58 of relay DR3 now is energized from output winding 56 of relay DR3, the relay is retained in its condition wherein the flux supplied by winding 53 is circulated through core 52 of the relay to induce relatively large electromotive forces in the output winding of the relay. This is the normal condition of the apparatus of Fig. 2 illustrated in the drawing.

It is readily apparent from the foregoing that control winding 58 of relay DR3 provides "stick circuit" control of the relay in that once the relay is controlled to its "energized" condition wherein relatively large electromotive forces are induced in its output windings, the relay is maintained in this condition by virtue of energy supplied from one of its output windings. It follows, therefore, that control winding 45 of relay DR3 functions as a "pick-up" winding and is effective when energized to aid in the control of the relay to its energized condition, and that control winding 58 of relay DR3 functions as a "stick" winding, which becomes energized only when the relay has once become energized, and which is effective to maintain the relay energized in the event that the pick-up winding of the relay subsequently becomes deenergized.

It should be noted that the time interval required to bring cathode 31 of tube VT to its operating temperature delays the response of re-

lay DR3 to a change in traffic conditions in section 3—4, and provides slow pick-up characteristics for the relay. It should further be noted that the plate circuit for tube VT draws current for but a relatively short time, whereby deterioration of the tube is minimized and prolonged life of the tube is effected. In this connection, it should be pointed out that tube VT is non-conducting during the interval that section 3—4 is occupied (due to the fact that its heating element 32 and cathode 31 are cold), and that although tube VT is controlled to its conducting condition during the interval that section 3—4 is unoccupied (due to the heating of element 32 and cathode 31), current flows in the plate circuit of the tube for only the relatively short time interval required for the current induced in output winding 54 of relay DR3 to build up to its maximum value. That is to say, when cathode 31 of tube VT is heated to its operating temperature, the potential which is normally applied across the electrodes of tube VT by rectifier 44 causes current to flow in the plate circuit of the tube. However, when the current induced in winding 54 of relay DR3 builds up to a relatively large value, relay DR2 then is controlled to limit the potential applied across the electrodes of tube VT to a value insufficient to maintain the flow of current in tube VT. Tube VT, therefore, operates for but a relatively short interval of time whenever section 3—4 becomes unoccupied.

In the event that section 3—4 becomes occupied so that trackway energy is shunted away from the control winding 16 of relay DR1a, the electromotive forces induced in output windings 15 and 41 of relay DR1a become relatively small. As a result, heating element 32 of tube VT is deenergized so that the heating element and cathode 31 of tube VT cool off and tube VT becomes non-conducting. Control winding 43 of relay DR3 also becomes deenergized, whereupon the flux created by input winding 53 of relay DR3 circulates through core 50 and as a result, the electromotive forces induced in output windings 54, 55 and 56 of relay DR3 drop to a relatively small magnitude. Stick control winding 58 of relay DR3 accordingly becomes deenergized with the result that the primary flux circulates through both cores 50 and 51 of relay DR3. Lamp L also becomes deenergized and as a result is dark, while control winding 28 of relay DR2 of Fig. 2 becomes deenergized so that relay DR2 is controlled by its constantly energized biasing winding 27 to cause a relatively large electromotive force to be induced in output winding 26 of relay DR2. Since tube VT is in its cooled or non-conducting condition, the plate circuit for tube VT cannot at this time be established and control winding 45 of relay DR3 accordingly is deenergized.

An advantage of the apparatus of Fig. 2 embodying my invention is that slow pick-up characteristics are provided for a saturation relay by means of a thermionic tube which is controlled to its operating condition for but a short interval of time, thereby preventing unnecessary deterioration of the tube so that a prolonged life of the tube is effected.

Although I have herein shown and described only two forms 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 with a section of railway track supplied with trackway energy, a relay of the saturation type having an output winding receiving energy from a source of energy, said saturation relay also having a saturation winding which controls the amount of energy received by said output winding from said source, a static control device, and means controlled by said static control device controlled by energy from the track rails of said section for energizing the saturation winding of said saturation relay to render that relay responsive to traffic conditions in said section, said static control device being effective to delay the response of said saturation relay to a change in traffic conditions in said section.

2. In combination with a section of railway track supplied with trackway energy, a relay of the saturation type having an output winding which receives energy from a source of energy, said relay also having a control winding which controls the magnitude of energy received by said output winding from said source, and means controlled by energy received from the track rails of said section to render the control winding of said saturation relay responsive to traffic conditions in said section, said means including a static control device which is acted upon by the energy received from the track rails and which is slow to react to such energy whereby said saturation relay is caused to be slow in responding to a change in traffic conditions in the section.

3. The combination with a section of railway track supplied with trackway energy and a saturation type relay having an output winding receiving energy from a source of energy under the control of a control winding, of a thermionic tube having two electrodes one of which must be heated to render the tube conducting, means receiving energy from the rails of said section for heating said one electrode of said tube, a plate circuit for said tube including a source of current and the control winding of said relay connected across said two electrodes of said tube, and railway traffic controlling means controlled by said saturation relay.

4. In combination, a magnetizable core provided with an output winding receiving energy from a source of energy under the influence of a saturation winding which at times supplies a saturating flux to said core, a thermionic tube having two electrodes and controlled to its operating condition when and only when one of said electrodes is heated to an operating temperature and a potential of a given magnitude is applied across the two tube electrodes, a plate circuit including a source of current and the saturation winding of said relay connected in series across the two tube electrodes to apply a potential of said given magnitude across the two electrodes of said tube, a control circuit from which energy is at times derived, and means controlled by energy derived from said control circuit for heating said one tube element to its operating temperature, whereby the response of said saturation relay to said control circuit is caused to be delayed for the time interval required to heat said one tube element to its operating temperature.

5. In combination with a section of railway track supplied with trackway energy, a saturation type relay having an input winding normally supplied with periodically varying current and an output winding inductively coupled with

said input winding, said relay also having a control winding effective when energized to vary the inductive coupling of the relay input and output windings, a thermionic tube having two spaced electrodes and caused to be conducting when and only when one of the two electrodes is heated to an operating temperature and a potential of a given magnitude is impressed across the two tube electrodes, means receiving energy from the track rails of said section for heating said one electrode of said tube, a source of current, and a circuit including said source of current in series with the control winding of said relay for impressing a potential of said given magnitude across the two electrodes of said tube, whereby said saturation relay is caused to be responsive to traffic conditions in said section but is slow in responding to a change in such traffic conditions due to the time interval required for said one tube element to heat up to its operating temperature.

6. In combination with a section of railway track supplied with trackway energy, a signal for controlling traffic in said section and having two signal lamps, a front contact saturation relay for controlling one of said two signal lamps, said front contact saturation relay having a control winding effective when energized to cause the associated signal lamp to be illuminated, a back contact saturation relay for controlling the other of said two signal lamps, said back contact saturation relay having a control winding effective when energized to cause the associated signal lamp to be dark, a thermionic tube having two electrodes, and controlled to an operating condition when and only when one of said electrodes is heated to an operating temperature and a potential of a given magnitude is applied across the two electrodes of the tube, a plate circuit including a source of current connected in series with the control winding of said front contact saturation relay and the control winding of said back contact relay for applying a potential of said given magnitude across the two electrodes of said tube, and means receiving energy from the track rails of said section for heating said one electrode of said tube to its operating temperature.

7. In combination, a section of railway track, a saturation relay having two pick-up control windings and a stick control winding, said relay also having a primary winding constantly supplied with periodically varying current and having output windings inductively coupled with said primary winding in such manner that relatively high electromotive forces are induced in said output windings when and only when a particular one of said two pick-up control windings is energized and at least one of the remaining two control windings also is energized, means responsive to traffic conditions in said section for supplying energy to said particular one pick-up control winding, slow acting circuit controlling means also controlled by traffic conditions in said section and caused to assume a circuit completing condition at the end of a predetermined time interval after a change in traffic conditions in said stretch, a source of energy,

means controlled by one of said relay output windings for controlling the magnitude of energy supplied from said source to a relatively large or a relatively small value according as relatively small or relatively large electromotive forces are induced in said one relay output winding, circuit means controlled by said slow acting means and effective only when such means is in its circuit completing condition for connecting said source of energy to said other pick-up control winding of the relay and means for supplying energy from another of said output windings to said stick control winding whereby when the supply of energy to said other pick-up control winding is cut off in response to the relatively large electromotive forces induced in said one relay output winding there will be maintained induced in said relay output windings the relatively large electromotive forces until such time as the supply of energy to said particular one pick-up control winding is cut off.

8. In combination, a section of railway track, a saturation relay having two pick-up control windings and a stick control winding, said relay having a primary winding constantly supplied with periodically varying current and also having output windings inductively coupled with said primary winding in such manner that relatively high electromotive forces are induced in said output windings when and only when a particular one of said two pick-up control windings is energized and at least one of the remaining two control windings also is energized, means responsive to traffic conditions in said section for supplying energy to said particular one pick-up control winding, a two element thermionic tube of the type controlled to its operating condition when and only when one of said elements is heated to an operating temperature and a potential of a given magnitude is applied across its two elements, means controlled by traffic conditions in said section for heating said one tube element to its operating temperature, plate circuit means controlled by one of said output windings of said tube to be effective only when an electromotive force of relatively low magnitude is induced in such output winding and including said other pick-up control winding of said relay for applying a potential of said given magnitude across the two elements of said tube, whereby said saturation relay is controlled in response to traffic conditions in said section at the end of the time interval required to heat said one tube element to its operating temperature, and means for supplying energy from another of said output windings of said relay to said stick control winding whereby when said one output winding controls said plate circuit means to reduce the potential applied across said two tube elements to a magnitude below said given magnitude to thereby cut off the supply of energy to said other pick-up control winding, there will be maintained induced in said relay output windings the relatively large electromotive forces until such time as the supply of energy is cut off to said particular one pick-up control winding.

ANDREW J. SORENSSEN.