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RAILWAY TRAFFIC CONTROLLING APPARATUS

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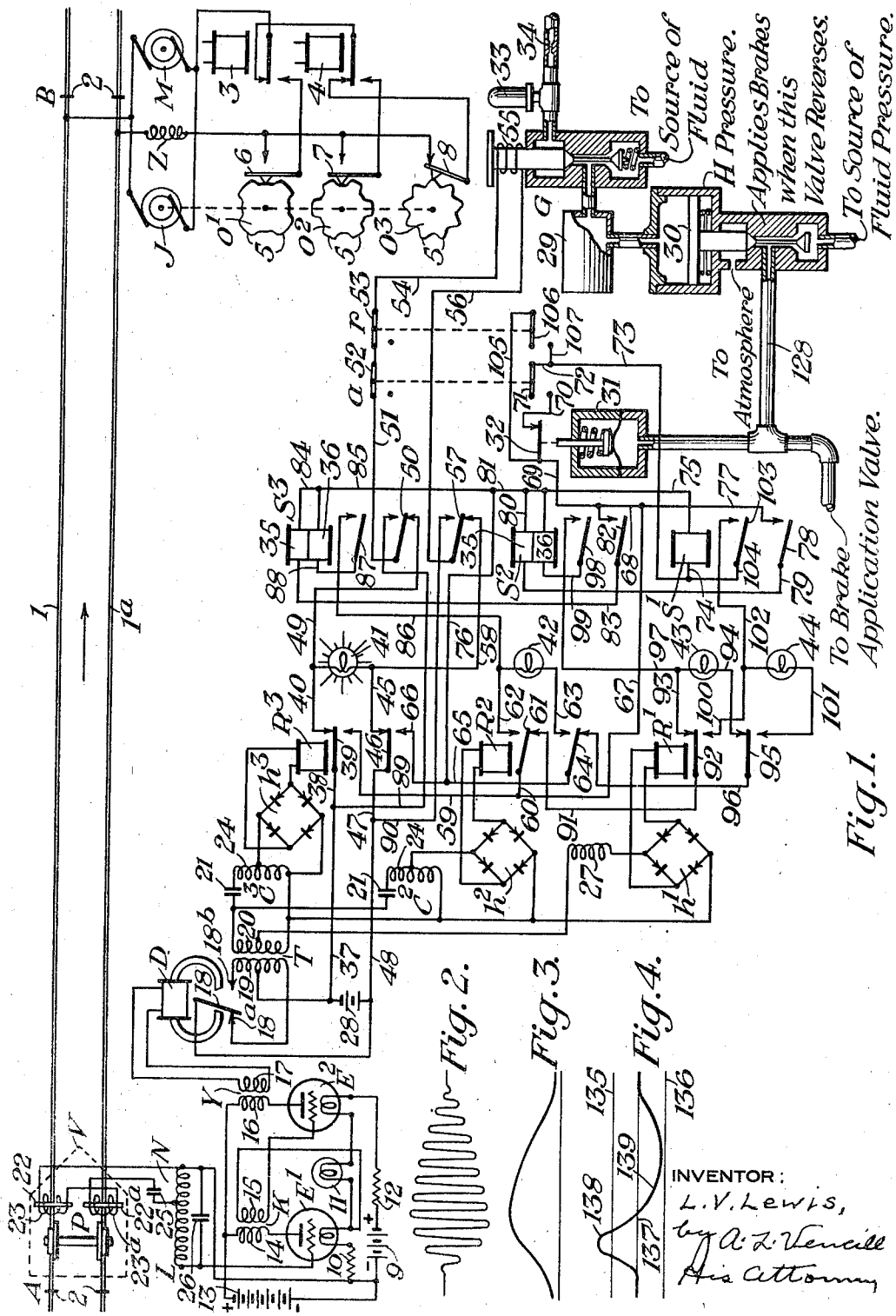


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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50 Claims. (Cl. 246—63)

My invention relates to railway traffic controlling apparatus, and particularly to apparatus of the type comprising train carried governing means controlled by energy received from the trackway.

The present case is a continuation-in-part of my co-pending application, Serial No. 116,608, filed June 17, 1926, for Railway traffic controlling apparatus, now Patent 1,824,605 of Sept. 22, 1931.

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

In the accompanying drawing, Fig. 1 is a diagrammatic view illustrating one form of trackway apparatus embodying my invention. Figs. 2, 3 and 4 are sketches illustrating the operation of certain portions of the apparatus of Fig. 1 when subjected to shock excitation.

Referring first to Fig. 1, the reference characters 1 and 1^a designate the track rails of a stretch of railway track over which traffic moves in the direction indicated by the arrow. These rails are divided by means of insulated joints 2 into a plurality of successive track sections, of which only one section, A—B, is shown complete in the drawing. Train controlling current is supplied to the rails of this section from a suitable source of energy such as an alternator M. The current supplied to the trackway by this alternator may be of a frequency of the order of the usual commercial alternating current, such for example, as 60 cycles or 100 cycles per second.

The supply of current to the track rails is controlled by a code transmitting device comprising a plurality of rotatable cams each designated by the reference character O with a suitable distinguishing exponent. The cams O are driven at a constant speed by a suitable motor J which is supplied with current from the alternator M. The cam O^1 is provided with a plurality of swells 5 spaced about its periphery, which swells successively operate a contact 6 to periodically close the contact as the cam O^1 is rotated. In similar manner the cams O^2 and O^3 are provided with different numbers of swells 5 which control contacts 7 and 8, respectively. One terminal of the alternator M is constantly connected with rail 1 of section A—B, and the other terminal of the alternator is connected with the rail 1^a through a current limiting impedance Z, and one of the contacts 6, 7 or 8, depending upon traffic conditions.

It is manifest that the alternating current supplied to the rails of the trackway by alternator M is coded or periodically varied at the frequency of operation of the contact of the code transmitting device interposed between the alternator and the track rail 1^a. The code transmitting device may be constructed to cause such variations at any reasonable frequencies, but for purposes of illustration, I will assume that the cams O are rotating at 20 revolutions per minute, that cam O^1 has 4 swells, that cam O^2 has 6 swells, and that cam O^3 has 9 swells. The selection between the several contacts of the coding device in accordance with traffic conditions may be accomplished in any suitable manner such, for example, as by means of a home relay 3 and a distant relay 4. The circuits for controlling these two relays form no part of my present invention and are omitted from the drawing for the sake of simplicity. For present purposes, it is sufficient to state that home relay 3 is normally energized but is deenergized when a train occupies the section immediately to the right of point B. The distant relay 4 is also normally energized but is de-energized when a train occupies either the first or the second section immediately to the right of point B. When relays 3 and 4 are both energized, so that the front contacts of both these relays are closed, current from alternator M, which current I will assume to be of 100 cycles per second, is supplied to the track rails over contact 8 operated by cam O^3. Under these conditions, the alternating current supplied to the trackway is periodically varied at a frequency of 180 cycles per minute. Current supplied to the trackway under these conditions, I will hereinafter term the "clear" code. When relay 3 is energized and relay 4 is deenergized, contact 7 controlled by cam O^2 is included in the trackway circuit, and under these conditions the trackway is supplied with 100 cycle current interrupted at a frequency of 120 cycles per minute; this current I shall hereinafter term the "approach restricting" code. In similar manner, when relay 3 is de-energized, a circuit is completed from alternator M to the track rails through contact 6 operated by cam O^1, and the trackway is then supplied with 100 cycle current interrupted at a frequency of 80 cycles per minute, which current I will call the "approach" code.

A train, indicated diagrammatically at V, is provided with a receiver designated in general by the reference character P. This receiver comprises two magnetizable cores 22 and 22^a, carried on the train in advance of the forward axle, and located in inductive relation with the two track rails 1 and 1^a, respectively. Core 22 is provided with a winding 23, and core 22^a is provided with a similar winding 23^a; the windings 23 and 23^a

being connected in series in such manner that the voltages induced therein by alternating currents flowing in opposite directions in the track rails at any instant are additive. The windings 23 and 23^a are connected through a condenser 25 with the primary of an auto transformer L, and the circuit N comprising the above mentioned elements, which I will term the "pick-up" circuit, is tuned to resonance at the frequency of the alternating current in the trackway. The secondary circuit of the auto transformer L is tuned to resonance at the frequency of this current by a condenser 26. The periodically varying 100 cycle voltage across the terminals of condenser 26 is first amplified and then detected or converted to low frequency alternating current by two electron tube amplifiers E^1 and E^2. The filaments of these tubes are connected in a series circuit including a ballast lamp 11 and two control resistances 10 and 12, and this circuit is supplied with current from a suitable source such as a battery 9. The secondary of the auto transformer L and the condenser 26 in parallel therewith, are connected across the grid and filament of the tube E^1 and also across the resistance 10 in the filament circuit, so that the grid is normally "negative" by several volts with respect to the filament of E^1. The first stage or amplifier tube E^1 is provided with a plate circuit including a suitable source of high potential unidirectional current such as a battery 13, primary 14 of an "interstage" transformer K, the plate and filament of the tube E^1, and the resistance 10. The second stage or detector tube E^2 is provided with a plate circuit including the battery 13 and the primary 16 of a low frequency transformer Y. Secondary 15 of transformer K is connected across the grid and filament of tube E^2 in such manner that the grid normally, when no 100 cycle voltage is present, has a sufficient negative bias so that the plate current of tube E^2 is substantially zero. The secondary 17 of transformer Y is connected directly with a polarized relay D, that is, a relay which is selectively responsive to the polarity of the current supplied thereto.

When any code is being supplied to the trackway, the 100 cycle energy picked up by receiver P, after passing through the filtering apparatus comprising transformer L, is applied to the grid circuit of tube E^1. Amplified 100 cycle current of periodically varying amplitude of a value which depends upon the electromotive force across winding N, and consequently upon the value and rate of interruption of the trackway current, will be delivered by tube E^1 to the primary of transformer K, and the secondary of this transformer will supply an alternating voltage of corresponding value to the grid circuit of tube E^2. Due to the comparatively high impedance of primary 16 of transformer Y, substantially no current of 100 cycles flows through the plate circuit of tube E^2. It will be noted, however, that the normal bias of the grid of tube E^2 is negative so that the normal plate current through this tube is comparatively low. When the 100 cycle current is being supplied to the trackway, however, the alternating voltage supplied by the secondary of transformer K is superimposed upon this fixed voltage and is rectified and decreases the negative charge upon the grid of tube E^2, causing a proportionate increase in the plate current of tube E^2. When the 100 cycle voltage is cut off, that is, when the trackway current is interrupted, the plate current of tube E^2 is restored to its original value. It follows that when a code is being supplied to the trackway the plate current of tube E^2 is periodically increased and decreased at the same frequency as the periodic variations of the trackway current. Each increase in current through primary 16 of transformer Y induces in secondary 17 a current impulse which energizes a two-position polarized relay D in one direction, and each decrease of current in primary 16 induces a current impulse in secondary 17 which energizes relay D in the opposite direction. As a result, relay D is operated alternately, first in one direction, and then in the other, by low frequency impulses alternating in polarity at the frequency of the code supplied to the trackway. Between impulses, the armature 18 of relay D is held firmly in one position or the other by the attraction of its permanent magnet, and is only moved from one position to the other when the current through its winding derived from the trackway current detected by tube E^2 is of a sufficient value to overcome the pull of the permanent magnet on the armature.

Although the relay D faithfully follows the periodic variations in the trackway current when the value of this current exceeds a predetermined minimum, the relay cannot be alternately operated by energy supplied to the train carried circuits by shock excitation, that is, by free oscillations in the filtering apparatus including the auto transformer L, of the frequency to which the filtering circuits are resonant. Such excitation may be caused, for example, by sudden changes in direct or alternating currents in the trackway or from any source in the vicinity of the train carried apparatus. The wave front of the exciting current may be very steep, that is, the current change which causes the free oscillations may be very rapid, and as a result there may be induced in the filter circuits a surge of current which supplies a surge of alternating voltage to the grid circuit of tube E^1. Oscillograph analysis of these free oscillations shows that with apparatus embodying my invention, the wave form of the current supplied to the grid circuit of tube E^1 by shock excitation of the filter circuits is similar to that shown in Fig. 2. It will be observed from this diagram that a considerable greater time is required for the surge to die down than for the surge to build up to its maximum value. For example, if 4 cycles are required for the free oscillations to reach their maximum amplitude, 8 cycles or more may be required before these oscillations die out. But as has already been explained, an increase of current in the grid circuit of tube E^1 increases the plate current in tube E^2. It follows that this plate current varies as shown in Fig. 3 when free oscillations of Fig. 2 are created in the filter circuits. The rate of change of this plate current is, of course, much more rapid during the growth of the free oscillations than during the decay of such oscillations.

Referring now to Fig. 4, the increase in the plate current of tube E^2, due to the growth of the free oscillations, induces in secondary 17 an impulse of energy represented by the loop 138 which energizes the relay D in one direction. The value of energy necessary to operate the relay in such one direction is represented by line 135 above the zero axis 137, and the value of energy necessary to operate the relay in the opposite direction is represented by a line 136 below the zero axis 137. It is apparent that by properly proportioning the various parts, the relay may be so constructed that while it may operate in one direction by the impulse of energy repre-

sented by loop 138, the impulse of energy represented by loop 139 caused by the gradual return of the plate current of tube E^1 to its normal value, during the dying out of the free oscillations, will not be sufficient to operate the relay in the other direction.

Since the relay D remains in the position to which it was last positively moved, it follows that with the parts arranged in this manner, shock excitation cannot cause a complete cycle of operation of relay D, but the first shock impulse will cause relay D to move from normal to reverse while subsequent shock impulses will merely hold it in the reverse position.

The relay D controls decoding apparatus which is selectively responsive to the frequency of operation of the relay. In the present embodiment of my invention, this apparatus is constructed as follows:

Associated with relay D is a transformer T comprising a primary 19 and a secondary 20. Direct current is supplied to the primary 19 of transformer T from a suitable source of energy such as a battery 28, and the supply of such current is periodically varied in direction in accordance with the frequency at which relay D operates. As shown in the drawing, when relay D is energized in one direction to close contact 18—18^a, current flows from battery 28 through the lower half of primary 19 in one direction, but when the relay D is energized in the opposite direction so that contact 18—18^b is closed, current flows from battery 28 through the upper half of primary 19 in the opposite direction. It follows that when relay D is periodically reversed by the low frequency alternations in polarity of the current delivered by transformer Y, these alternations will be repeated by relay D and the current in primary 19 of transformer T will be periodically reversed at the frequency of the periodic variation in the trackway current. As a result of this, there is induced in the secondary 20 a low frequency alternating electromotive force which is supplied to a plurality of circuits each designated by the reference character C with a distinguishing exponent, and each comprising a reactor 24 and a condenser 21, by means of which the several circuits are tuned, respectively, to the several code frequencies. For example, circuit C^3 is tuned to resonance at the frequency of the "clear" code or 180 cycles per minute. A "clear" or "proceed" train control relay R^3 is connected across a portion of reactor 24 of circuit C^3 through a rectifier h^3, and is arranged to be energized only when the relay D is operated by a 180 cycle code picked up from the trackway. In similar manner, circuit C^2 is tuned to resonance at 120 cycles per minute and a "caution" train control relay R^2 is connected across a portion of reactor 24 of this circuit through a rectifier h^2. Relay R^2 is arranged to be energized only when relay D is operated by a 120 cycle code picked up from the trackway. A "slow speed" train control relay R^1 is connected, through rectifier h^1 and reactor 27, directly with secondary 20 of transformer T, and relay R^1 is arranged to be energized when relay D is receiving any of the train control code frequencies. The relays R are thus rendered selectively responsive to the frequency of the trackway currents, and are in this manner caused to be continuously responsive to traffic conditions in advance of the train, and these relays control visual cab signals comprising the series of lamps 41 to 44, inclusive.

Associated with the relays R are a plurality of normally deenergized retaining relays or stick relays each designated by the reference character S with a distinguishing exponent. The relays R and S may control governing means of any suitable type, which as here shown is winding 55 of a magnet valve G arranged when energized to connect a reservoir 29 with a suitable source of fluid pressure not shown in the drawing. The reservoir 29 is connected with a relay valve H so that when this reservoir is charged valve H occupies the position shown in the drawing and a pneumatic relay 31 is connected by pipe 128 with a source of fluid pressure so that contact 32 of this relay is closed. Pipe 128 controls also a "brake application valve" (not shown) for causing an application of the brakes when this pipe is connected to atmosphere. When winding 55 of valve G becomes de-energized, the reservoir 29 is connected with atmosphere through a restricted orifice 34 and also through a whistle 33 which serves as a warning signal and sounds to give to the engineman an audible indication within the cab of a change in traffic conditions to a more restrictive condition. After a brief interval of time, such, for example, as 6 seconds, the pressure in reservoir 29 is so reduced that piston 30 of valve H reverses, thereby venting pipe 128 to atmosphere and applying the brakes. At the same time the reversal of valve H connects the pneumatic relay 31 with atmosphere, opening the normally closed contact 32. If magnet valve G is again energized, reservoir 29 is again charged with fluid pressure so that valve H is restored to its original position and pneumatic relay 31 closes its contact 32.

The train is also provided with a manually operable circuit controller or acknowledging switch *a* located at some convenient place in the cab within the reach of the engineman, and comprising a normally closed contact 52 and a normally open contact 71. When the acknowledging switch is reversed, contact 52 is opened, and contact 71 is closed. Furthermore, a reset switch, designated by the reference character *r*, and comprising a normally closed contact 53 and a normally open contact 106, is provided, and located outside the cab where it will be inaccessible to the engineman when the train is in motion.

In explaining the operation of the apparatus as a whole, I will first assume that the "clear" code is being supplied to the trackway so that the trackway current is being interrupted at the frequency of 180 cycles per minute. Relay D therefore operates at the rate of 180 cycles per minute and alternating current of a corresponding frequency is supplied by secondary 20 of transformer T. Relays R^1 and R^3 are therefore energized, but relay R^2 is de-energized because the circuit C^2 is not resonant at the frequency of the current now supplied to such circuit. With relay R^3 energized, current flows from battery 28, through wires 37 and 38, front contact 39 of relay R^3, wire 40, lamp 41, wire 45, front contact 46 of relay R^3, and wires 47 and 48, back to battery 28. The lamp 41 is therefore lighted to indicate "clear" or "proceed". At the same time, current flows over the circuit just traced as far as wire 40, and thence through wire 49, back contact 50 of relay S^3, wire 51, contact 52 of acknowledging switch *a*, contact 53 of the reset switch *r*, wire 54, winding 55 of magnet valve G, wire 56, back contact 57 of relay S^3, wire 58 to wire 45. It will therefore be plain that winding 55 of magnet valve G is

connected in parallel with lamp 41 and that the magnet valve G is energized so that the brakes are not applied.

I will next assume that a change occurs in traffic conditions so that the "approach restricting" code is supplied to the trackway. Relay R^3 therefore opens and relay R^2 picks up, relay R^1 remaining in its energized condition. The circuits for lamp 41 and magnet valve G are therefore opened at front contacts 39 and 46 of relay R^3, so that lamp 41 is extinguished and the magnet valve G is de-energized to start the reduction of pressure in reservoir 29, and to cause the whistle 33 to sound. Current now flows from battery 28, through wires 37 and 38, back contact 39 of relay R^3, wires 59 and 60, front contact 61 of relay R^2, wire 62, lamp 42, wire 63, front contact 64 of relay R^2, wires 65 and 66, back contact 46 of relay R^3 and wires 47 and 48 back to battery 28. The lamp 42 therefore becomes energized to indicate "approach restricting" or "caution" and, by the change of visual indication, to inform the engineman that upon the expiration of the time interval required for the blow-down of reservoir 29, an automatic application of the brakes will result. If, however, prior to the reversal of valve H the engineman operates the acknowledging switch *a*, he may forestall an automatic application of the brakes in the following manner:

When contact 71 of switch *a* is closed, current flows from battery 28, over wires 37 and 38, back contact 39 of relay R^3, wires 59, 67, 68 and 69, contact 32 of pneumatic relay 31, wire 70, contact 71 of acknowledging switch *a*, wires 72, 73 and 74, winding of relay S^1, wires 75, 81, 76 and 66, back contact 46 of relay R^3, and wires 47 and 48, back to battery 28. Relay S^1 therefore becomes energized and closes a pick-up circuit for relay S^2 from battery 28, over wires 37 and 38, back contact 39 of relay R^3, wires 59, 67 and 77, front contact 78 of relay S^1, wire 79, winding 35 of relay S^2, wires 80, 81, 76 and 66, back contact 46 of relay R^3, and wires 47 and 48 back to battery 28. Relay S^2 therefore picks up. The closing of front contact 82 of relay S^2 completes a pick-up circuit for relay S^3, from battery 28 over wires 37 and 38, back contact 39 of relay R^3, wires 59, 67 and 68, front contact 82 of relay S^2, wire 83, winding 35 of relay S^3, wires 84, 85, 76 and 66, back contact 46 of relay R^3, and wires 47 and 48, back to battery 28. The relay S^3 therefore closes its front contacts. When front contact 87 of relay S^3 becomes closed, a stick circuit is closed for this relay from battery 28, over wires 37 and 38, back contact 39 of relay R^3, wires 59 and 60, front contact 61 of relay R^2, wires 62 and 86, front contact 87 of relay S^3, wire 88, winding 36 of relay S^3, wires 85, 76 and 66, back contact 46 of relay R^3, and wires 47 and 48, back to battery 28. The acknowledging switch *a* may now be restored to its original position, thereby closing contact 52 and opening contact 71. The circuit for relay S^1 is therefore opened and this relay becomes de-energized, and the opening of contact 78 thereon de-energizes relay S^2. When contact 82 of relay S^2 opens, the pick-up circuit including winding 35 of relay S^3 becomes deenergized, but relay S^3 maintains its front contacts closed by virtue of the stick circuit including winding 36 of this relay. With relay S^3 energized and contact 52 of switch *a* closed, current from battery 28 flows over wires 37 and 89, front contact 50 of relay S^3, wire 51, contact 52 of switch *a*, contact 53 of switch *r*, wire 54, winding 55 of magnet valve G, wire 56, front contact 57 of relay S^3, and wires 90 and 48 back to battery 28. It follows therefore that when the train is receiving the "approach restricting" code, and if the engineman has acknowledged the change in traffic conditions from "clear" to "approach restricting" the relay S^3 will be held energized and the magnet valve G will be energized to prevent an automatic application of the brakes.

It should be pointed out that after operation of the acknowledging switch *a* to close contact 71, the acknowledging switch must be again restored to its original position to close contact 52 after relay S^3 has been picked up, in order to permit the magnet valve G to become energized.

Furthermore, if the acknowledging switch *a* is not operated before valve H reverses, the operation of the acknowledging switch will be ineffective to prevent an automatic application of the brakes. The reason for this is that as soon as valve H reverses, the pneumatic relay 31 operates to open contact 32, but the contact 32 is included in the pickup circuit for relay S^1 so that after this contact is open, manipulation of the acknowledging switch *a* cannot pick up relay S^1. If valve H does reverse, the train must be brought to a full stop in order to enable the engineman to operate the reset switch *r* before valve H can be restored. When switch *r* is operated, a branch is closed from wire 69, through wire 105, contact 106 of releasing switch *r* and wire 107 back to wire 73. It will be plain that the closing of contact 106 shunts current around the contact 32 of pneumatic relay 31 and around contact 71 of the acknowledging switch *a*. When the reset switch *r* is operated, therefore, the relays S^1, S^2 and S^3 are picked up in order in exactly the same manner as has already been explained for the operation of these relays upon manipulation of acknowledging switch *a*. When relay S^3 has become energized, the reset switch *r* may be restored to its original position, thereby allowing relays S^1 and S^2 to drop. Relay S^3 remains energized and magnet valve G becomes energized in the manner already described.

I will next assume that a change to a more restricting traffic condition occurs, so that the "approach" or "slow" code is supplied to the trackway. Relay R^2 opens, but relay R^1 is still energized by the current of 80 cycles per minute which is now supplied to it by transformer T. The de-energization of relay R^2 interrupts the circuit for lamp 42 and also breaks the stick circuit for relay S^3. The relay S^3 therefore becomes deenergized, and opens the circuit for magnet valve G. The whistle 33 is therefore operated and the blow down of reservoir 29 is initiated so that an automatic application of the brakes will result at the expiration of a time interval unless the engineman acknowledges. The necessity for this acknowledgment is indicated by the extinguishment of lamp 42 and also by the lighting of lamp 43, which latter is now energized by current which flows from battery 28 over wires 37 and 38, back contact 39 of relay R^3, wires 59 and 60, back contact 61 of relay R^2, wire 91, front contact 92 of relay R^1, wire 93, lamp 43, wire 94, front contact 95 of relay R^1, wire 96, back contact 64 of relay R^2, wires 65 and 66, back contact 46 of relay R^3 and wires 47 and 48 back to battery 28.

If the engineman wishes to forestall an automatic application of the brakes, he operates the acknowledging switch *a* before valve H reverses.

Since relay R^3 is de-energized, the closing of the contact 71 completes the circuit for relay S^1 and this relay picks up, and in turn closes the circuit for winding 35 of relay S^2. Furthermore, the closing of contact 82 of relay S^2 picks up relay S^3. Acknowledging switch *a* can now be restored to its original position. When this happens, the opening of contact 71 opens the circuit for relay S^1 and this relay becomes de-energized. Relay S^2, however, is held in its energized position by current which flows from battery 28 over the circuit already traced for lamp 43 as far as wire 93, and thence over wire 97, front contact 98 of relay S^2, wire 99, winding 36 of relay S^2, wires 81, 76 and 66, back contact 46 of relay R^3 and wires 47 and 48 back to battery 28. Relay S^2 is therefore held closed as long as the "approach" code is received on board the train. With contact 82 of relay S^2 closed, relay S^3 is also energized and since contact 52 is closed, the magnet valve G is also energized over front contacts 50 and 57 of relay S^3, to prevent an automatic application of the brakes. It should be pointed out that should the relay 31 open its contact before the engineman actuates the acknowledging switch *a*, the acknowledgment will be ineffective and he must bring his train to a full stop and operate the reset switch *r* to pick up the stick relays S.

I will now assume that the track circuit current is cut off to give the most restrictive or "stop" indication of the system, which indication is given under "danger" conditions and is usually designated as "caution slow speed". Relay D does not periodically reverse and relays R^3, R^2 and R^1 are therefore all de-energized, lamp 43 becomes extinguished, and the stick circuit for relay S^2 is opened. Relay S^2 therefore becomes de-energized, and the opening of front contact 42 thereon de-energizes relay S^3. The magnet valve G is therefore de-energized to commence the blow down of reservoir 29 and to sound the whistle 33. The de-energization of relay R^1 also lights lamp 44, current flowing from battery 28, over wires 37 and 38, back contact 39 of relay R^3, wires 59 and 60, back contact 61 of relay R^2, wire 91, back contact 92 of relay R^1, wire 100, lamp 44, wire 101, back contact 95 of relay R^1, wire 96, back contact 64 of relay R^2, wires 65 and 66, back contact 46 of relay R^3 and wires 47 and 48 back to battery 28. If the engineman wishes to acknowledge the change in traffic conditions to prevent an automatic application of the brakes, he operates the acknowledging switch *a*. The relays S^1, S^2 and S^3 are therefore picked up in sequence. The engineman then restores the acknowledging switch to its original position. Relays S^1 is now maintained in its energized condition by current which flows over the circuit for lamp 44 as far as wire 100, and thence through wire 102, front contact 103 of relay S^1, wires 104 and 74, winding of relay S^1, wires 75, 81, 76 and 66, back contact 46 of relay R^3 and wires 47 and 48 back to battery 28. Relay S^1 therefore remains in its energized condition and since contact 78 of this relay is closed, relay S^2 is also picked up, and relay S^3 is energized over front contact 82 of relay S^2. The magnet valve G is therefore energized by current from battery 28 over the circuit including front contacts 57 and 58 of relay S^3.

Should traffic conditions now become less restrictive and change in such manner that the "approach" code is supplied to the trackway, relay R^1 becomes energized and relays R^2 and R^3 remain de-energized. The energization of relay R^1 completes the circuit for lamp 43 and extinguishes lamp 44 and opens the stick circuit for relay S^1. Relay S^1 therefore becomes de-energized but the stick circuit for relay S^2 is now closed at front contact 92 of relay R^1 and front contact 98 of relay S^2. The de-energization of relay S^1 therefore does not affect relays S^2 or S^3 and does not de-energize magnet valve G. Upon a change in traffic conditions from the "caution slow speed" to the "approach" therefore, no acknowledgment is necessary upon the part of the engineman to prevent an automatic application of the brakes.

If now traffic conditions become still less restrictive and change from "approach" to the "approach restricting" condition, relay R^2 becomes energized. The energization of relay R^2 extinguishes lamp 43 and completes the circuit for lamp 42 and breaks the stick circuit for relay S^2 at back contact 61 of relay R^2. The stick relay S^2 therefore opens, but the stick circuit for relay S^3 is now closed at front contact 61 of relay R^2 and front contact 87 of relay S^3. The relay S^3 therefore holds its front contacts closed and magnet valve G continues to receive current from battery 28 so that no application of the brakes results from a change in traffic conditions from "approach" to "approach restricting".

Finally, if the "clear" condition is re-established, relay R^3 becomes energized. Lamp 42 is therefore extinguished and lamp 41 is lighted. The stick circuit for relay S^3 is also broken so that relay S^3 becomes de-energized. But with relay R^3 energized and with relay S^3 de-energized, current is supplied from battery 28 to winding 55 of magnet valve G, over front contacts on relay R^3 and back contacts of relay S^3 so that no automatic application of the brakes results from a change in traffic conditions from "approach restricting" to "clear". Furthermore, if the whistle is sounding, it is evident that its operation will be automatically interrupted upon a change to "clear" traffic conditions.

In conclusion, it should be pointed out that not only does the visual signal continuously indicate within the cab the condition of the track in advance, but the apparatus is arranged in such manner that upon any change in traffic condition from a less restrictive to a more restrictive indication, an audible warning signal is sounded, and an automatic application of the brakes will result unless the engineman operates the acknowledging switch *a* during the time interval required for the blow down of reservoir 29. Upon any change from a more restrictive to a less restrictive indication however, the magnet valve G does not become de-energized and no acknowledgment by the engineman is necessary.

Relays S^1, S^2 and S^3 are slightly slow acting, in order that momentary opening of the circuits for these relays, as during the reversal of a relay R, will not compel acknowledgment of a change from a more restrictive to a less restrictive indication.

It will be apparent from the foregoing explanation that in order to give any indication on board the train except the "caution slow speed" indication represented by the lighting of lamp 44, it is necessary that relay D be energized alternately. But this alternate operation of relay D cannot be accomplished as a result of shock excitation. It follows that under no condition can a false indication be received upon the train as a result of shock excitation.

Another advantage possessed by the apparatus shown in the drawing, is that since relay D requires for its operation a reversal of the polarity

of the current supplied thereto, there will be much less variation in the relative lengths of time that a contact of the relay is opened and closed due to variations in the magnitude of the impulses delivered to the relay than would be the case if a neutral relay were employed in place of relay D. This is due to the fact that in normal operation the current supplied to relay D is alternating, and the reversals of the relay are uniformly spaced, since they occur at corresponding current values of opposite polarity, irrespective of the magnitude of the impulses, whereas a neutral relay which picks up and releases as its current exceeds or drops below fixed values of the same polarity will have its timing materially changed by a variation in the magnitude of the impulses.

I do not claim as my invention the combination of a stretch of track supplied with alternating current periodically varied at different frequencies, a master relay on the train operated at the rate of such periodic variations, and train carried relays controlled by the master relay and selectively responsive to the rate of operation of the master relay, such combination being disclosed and claimed in the following applications for Letters Patent of the United States: L. L. Lockrow, Serial No. 166,395, filed February 7, 1927, now Patent No. 1,745,629, granted Feb. 4, 1930, for Railway traffic controlling apparatus; P. N. Bossart, Serial No. 166,407, filed February 7, 1927, now Patent No. 1,773,472, granted Aug. 19, 1930, for Railway traffic controlling apparatus; and C. C. Buchanan, Serial No. 166,408, filed February 7, 1927, now Patent No. 1,773,515, granted Aug. 19, 1930, for Railway traffic controlling apparatus.

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 stretch of railway track, means for supplying the stretch with alternating current periodically varied at different frequencies, a train carried polarized relay, means controlled by the current in the trackway for supplying the relay with impulses of energy of alternately reversed polarity to operate the relay at the frequency of such variation, and governing means selectively responsive to the frequency of operation of the relay.

2. In combination, a stretch of railway track, means for supplying the stretch with alternating current periodically varied at different frequencies, a train carried electron tube, means for varying the potential of the grid of such tube in accordance with such variations, a transformer, a plate circuit for the tube including the primary of the transformer, and a relay connected with the secondary of such transformer and responsive to the polarity of the current supplied thereto.

3. In combination, a stretch of railway track, means for supplying the stretch with alternating current periodically varied at different frequencies, a train carried transformer having a primary supplied with unidirectional current, means for varying the magnitude of such unidirectional current at the frequency of the variations in the trackway current, a polarized relay receiving energy from the secondary of the transformer, and governing means selectively responsive to the frequency of operation of said relay.

4. In combination, a stretch of railway track, means for supplying the stretch with periodically varied alternating current, a train carried electron tube having a plate circuit, means for varying the current in such plate circuit in accordance with the variations in the trackway current, a polarized relay, means for energizing the relay alternately in opposite directions at a frequency depending upon the frequency of the variations in the plate circuit and governing means controlled by the relay and responsive to the frequency at which such relay operates.

5. In combination, a stretch of railway track, means for supplying periodically varying alternating current thereto, a train carried auto-transformer having a secondary tuned to resonance at the frequency of such current, a pick-up circuit receiving energy from the trackway and including a portion of the transformer and tuned to resonance at the frequency of such current, a first electron tube having a plate circuit, means for applying to the filament and grid of the first tube an alternating potential which varies as the electromotive force of the secondary of the auto-transformer, a second electron tube having its grid circuit coupled with the plate circuit of the first tube, a transformer, a plate circuit for the second tube including the primary of the transformer, a polarized relay connected with the secondary of the transformer, and governing means responsive to the frequency of operation of the relay.

6. In combination, a stretch of railway track, means for supplying the stretch with periodically varying alternating current, a train carried transformer having a primary supplied with current, means including a tuned circuit for varying the current in the primary in response to variations in the trackway current, and a relay connected with the secondary of the transformer and arranged to be operated in one direction by the energy supplied thereto when the current in said primary is increasing and to be operated in the other direction by the energy supplied thereto when the current in said primary is decreasing but requiring for operation in such other direction a greater electromotive force than is supplied thereto as a result of free oscillations in said tuned circuit caused by shock excitation.

7. Railway traffic controlling apparatus comprising a train carried relay, means located partly in the trackway and controlled by traffic conditions for at times energizing such relay, a magnet valve on the train, a governing device controlled by the valve, a stick relay, a manually operable circuit controller having a normal and a reverse contact, a circuit for picking up said stick relay including a reverse contact of said circuit controller and a back contact of the train carried relay, a second circuit for said stick relay including its own front contact and a back contact of the train carried relay; a circuit for said valve including a normal contact of said circuit controller, a back contact of the stick relay, and a front contact of the train carried relay; and a second circuit for said valve including a normal contact of the circuit controller, a front contact of the stick relay, and a back contact of the train carried relay.

8. Railway traffic controlling apparatus comprising a series of train carried stick relays, manually operable means effective under certain traffic conditions to energize the first relay of said series, a pick-up circuit for each of the remaining relays including a front contact of the

preceding relay in said series, a stick circuit for each relay controlled in accordance with traffic conditions, and governing means controlled by said stick relays.

9. Railway traffic controlling apparatus comprising a series of train carried stick relays, manually operable means effective under certain traffic conditions to energize the first relay of said series, a pick-up circuit for each of the remaining relays including a front contact of the preceding relay in said series, a stick circuit for each relay controlled in accordance with traffic conditions, and governing means controlled by the last relay in said series and by said manually operable means.

10. Railway traffic controlling apparatus comprising three train-carried relays R^1, R^2 and R^3, means for energizing relays R^1 and R^3 under proceed conditions, means for energizing relays R^1 and R^2 under caution conditions, means for energizing relay R^1 under slow conditions, all such relays R^1, R^2 and R^3 being de-energized under stop conditions, three stick relays S^1, S^2 and S^3, an electromagnetic valve for controlling the brakes, a first circuit for said valve including a front contact of relay R^3 and a back contact of relay S^3, a second circuit for said valve including a back contact of relay R^3 and a front contact of relay S^3, a manually operable contact, a pick-up circuit for relay S^1 including said manually operable contact and a back contact of relay R^3; a stick circuit for relay S^1 including a front contact of relay S^1 and back contacts on relays R^1, R^2 and R^3; a pick-up circuit for relay S^2 including a front contact of relay S^1 and a back contact of relay R^3; a stick circuit for relay S^2 including a front contact of relay S^2, a front contact of relay R^1, and back contacts of relays R^2 and R^3; a pick-up circuit for relay S^3 including a front contact of relay S^2, and a back contact of relay R^3; and a stick circuit for relay S^3 including a front contact of relay S^3, a front contact of relay R^2, and a back contact of relay R^3.

11. Railway traffic controlling apparatus comprising a train carried warning signal, a normally deenergized relay, means located partly in the trackway and effective to prevent operation of the signal under certain traffic conditions if said relay is deenergized, manually operable means effective under certain other traffic conditions to energize the relay, and means effective under such other traffic conditions to prevent operation of said signal when said relay is energized.

12. Railway traffic controlling appartus comprising a plurality of signals carried on the train, means located partly in the trackway and continuously responsive to traffic conditions in advance of the train for energizing a selected one or another of said signals in accordance with traffic conditions, a whistle, means for operating said whistle upon a change in traffic conditions to a more restrictive condition, a manually operable circuit controller, and means operating if said circuit controller is reversed and then restored to its normal condition to prevent operation of said whistle.

13. Railway traffic controlling apparatus comprising a visual cab signal controlled by traffic conditions in advance, an audible signal, means for operating said audible signal upon a change from a less to a more restrictive traffic condition, manually operable means for preventing operation of said audible signal, and means for automatically interrupting the operation of said audible signal upon a change from a more restrictive to a less restrictive traffic condition.

14. Railway traffic controlling apparatus comprising three train-carried relays R^1, R^2 and R^3, means for energizing relay R^3 under proceed conditions, means for energizing relay R^2 under caution conditions, means for energizing relay R^1 under slow conditions, all such relays R^1, R^2 and R^3 being deenergized under stop conditions, three stick relays S^1, S^2 and S^3, an electropneumatic valve for controlling the brakes, a first circuit for said valve including a front contact of relay R^3, a second circuit for said valve including a front contact of relay S^3, a manually operable contact, a pickup circuit for relay S^1 including said manually operable contact, a stick circuit for relay S^1 including a front contact of relay S^1 and a contact closed only when relays R^1, R^2 and R^3 are deenergized, a pickup circuit for relay S^2 including a front contact of relay S^1, a stick circuit for relay S^2 including a front contact of relay S^2 and a front contact of relay R^1, a pickup circuit for relay S^3 including a front contact of relay S^2, and a stick circuit for relay S^3 including a front contact of relay S^3 and a front contact of relay R^2.

15. Railway traffic controlling apparatus comprising a vehicle carried relay continuously responsive to trackway conditions and energized only under clear conditions, a normally energized magnet, a circuit for said magnet including a front contact of the relay, mechanism for causing an automatic application of the brakes upon the expiration of a time interval after deenergization of said magnet, a normally closed contact arranged to open at the expiration of said time interval, an audible signal arranged to sound at the beginning of said time interval to attract attention to the deenergization of said magnet, and manually operable means effective only prior to the opening of said normally closed contact to reenergize said magnet.

16. Railway traffic controlling apparatus comprising a vehicle carried relay continuously responsive to trackway conditions and energized only under clear conditions, a normally energized magnet, a circuit for said magnet including a front contact of the relay, mechanism for causing an automatic application of the brakes upon the expiration of a time interval after deenergization of said magnet, a normally closed contact arranged to open at the expiration of said time interval, an audible signal arranged to sound at the beginning of said time interval to attract attention to the deenergization of said magnet, cab-carried manually operable means effective only prior to the opening of said normally closed contact for reenergizing said magnet, and other manually operable means inaccessible from the cab of the vehicle and independent of said contact for reenergizing said magnet.

17. Railway traffic controlling apparatus comprising a vehicle carried relay continuously responsive to trackway conditions and energized only under clear conditions, a normally energized magnet, a circuit for said magnet including a front contact of the relay, mechanism for causing an automatic application of the brakes upon the expiration of a time interval after deenergization of said magnet, a normally closed contact arranged to open at the expiration of said time interval, a stick relay, a switch inaccessible from the cab of the vehicle and manual-

ly operable to pick up said stick relay even though said normally closed contact is open, a cab-carried manual switch operable to pick up said stick relay only if said normally closed contact has not been opened, means for holding said stick relay energized when the front contact of the vehicle carried relay is open, and means effective when the stick relay is energized provided both said switches have been restored to their normal positions for preventing said mechanism from causing an application of the brakes.

18. Railway traffic controlling apparatus comprising a vehicle carried magnet, mechanism for causing an automatic application of the brakes upon the expiration of an interval of time after deenergization of the magnet, a normally closed contact arranged to open at the expiration of such time interval, a vehicle carried relay continuously responsive to trackway conditions and arranged to be energized only under clear traffic conditions, a circuit for said magnet including a front contact of said relay, cab-carried manually controlled means including said normally closed contact for at times shunting the front contact of the relay, and other manually controlled means inaccessible from the cab of the vehicle and independent of said normally closed contact for at times shunting the front contact of the relay.

19. Railway traffic controlling apparatus comprising a first vehicle carried contact closed only under clear conditions of the trackway, and a second vehicle carried contact closed only under caution conditions of the trackway, a magnet, a first circuit for said magnet including said first contact, mechanism for causing an automatic application of the brakes upon the expiration of a time interval after deenergization of said magnet, a normally closed contact arranged to open at the expiration of said time interval, a first and a second stick relay, a holding circuit for the second stick relay including said second contact, a holding circuit for said first stick relay adapted to be closed only when said first and second contacts are open, a pickup circuit for the first stick relay including said normally closed contact and a manually operable switch, a pickup circuit for the second stick relay closed when the first stick relay is energized, and a circuit for said magnet including a front contact of said second stick relay.

20. A railway cab signaling system comprising a vehicle, a train control relay controlled by current in the track rails and continuously responsive to trackway conditions in advance of the vehicle, a visual cab signal controlled by said relay comprising means for indicating clear when said relay is energized and for indicating danger when said relay is deenergized, a fluid pressure operated warning signal, a source of fluid pressure, means for connecting said source with said signal when the train control relay becomes deenergized, and manually operable means effective when the train control relay is deenergized for discontinuing the supply of fluid pressure to said signal from said source although the train control relay remains deenergized.

21. Railway traffic controlling apparatus comprising a train carried audible signal, a normally deenergized stick relay, a train carried relay continuously controlled by current in the track rails and responsive to trackway conditions in advance of the vehicle, means for preventing operation of said audible signal when said train carried relay is energized, manually operable means effective under other conditions to energize said stick relay, and means effective when said stick relay is energized for preventing operation of said audible signal.

22. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate a clear condition and a plurality of restrictive conditions of the track, an audible signal, means for causing said signal to operate upon a change from a clear condition to a restrictive condition of the track, means manually operable under a restrictive condition for stopping the operation of said audible signal while said restrictive condition exists, and means for causing said signal to again operate upon a change from said restrictive condition to a different restrictive condition of the track.

23. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate clear, caution, or danger condition of the track, an audible signal, means for preventing the operation of said signal under clear conditions, a first and a second stick relay, manually controlled means operable upon a change from clear to caution or danger conditions for picking up the second stick relay, means effective when said second stick relay is picked up for picking up the first stick relay, holding means for the first stick relay effective only under caution conditions, holding means for the second stick relay effective only under danger conditions, and means for preventing the operation of said audible signal when the first stick relay is energized.

24. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate a clear condition and a plurality of restrictive conditions of the track, an audible signal, a series of stick relays including one for each restrictive condition, manually operable means for energizing the first relay of said series, a pickup circuit for each of the remaining relays including a front contact of the preceding relay of the series, a stick circuit for each relay closed only under the track condition to which such relay corresponds, and means for preventing the operation of said audible signal effective only under clear conditions or when the last relay of said series is energized.

25. Railway traffic controlling apparatus continuously responsive to a plurality of different trackway conditions and including a series of train carried stick relays, an audible signal, a manually operable acknowledging switch, a pickup circuit for the first relay of said series including a contact of said switch, a pickup circuit for each of the remaining relays including a front contact of the preceding relay of the series, a stick circuit for each relay, each controlled in accordance with a different traffic condition, and a circuit controlled by the last relay of the series for controlling the audible signal, whereby said signal is caused to sound when a change in traffic condition occurs unless said acknowledging switch is operated.

26. Railway traffic controlling apparatus comprising a series of train carried relays continuously responsive to trackway conditions in advance of the train and including a clear relay energized to indicate a clear condition and a caution relay energized to indicate a restrictive condition of the track, an audible signal, a pair of

stick relays, manually operable means for energizing the first relay of said pair, a pickup circuit for the second relay of the pair closed when the first relay is energized, a stick circuit for the second relay of the pair closed only when the caution relay is energized and the clear relay is deenergized, a stick circuit for the first relay of the pair closed only when both the caution and clear relays are deenergized, a first circuit for controlling said audible signal including a contact of the clear relay, and a second circuit for controlling said audible signal including a contact of the second stick relay.

27. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate clear, caution, or danger conditions of the track, an audible signal, means for preventing the operation of said signal under clear conditions, a first and a second stick relay, manually operable means effective under caution or danger conditions for picking up both of said stick relays, means effective under caution conditions for holding the second stick relay energized but not the first, means effective under danger conditions for holding the first stick relay energized and for holding the second stick relay energized only if the first relay is energized, and means for preventing the operation of said audible signal under clear conditions or when said second stick relay is energized.

28. Railway traffic controlling apparatus comprising a series of train carried stick relays, a normally energized magnet, an acknowledging switch having a normal and a reverse position, a pickup circuit for the first relay of said series including a contact closed by the acknowledging switch in the reverse position, a pickup circuit for each of the remaining relays including a front contact of the preceding relay of the series, a stick circuit for each relay controlled in accordance with a particular trackway condition, means for deenergizing said magnet, and means for reenergizing said magnet effective when the last relay of said series is energized provided said acknowledging switch is in its normal position.

29. Railway traffic controlling apparatus comprising a series of train carried stick relays, manually operable means effective only under certain traffic conditions to energize the first relay of said series, a pickup circuit for each of the remaining relays including a front contact of the preceding relay in said series, a stick circuit for each relay controlled in accordance with traffic conditions, and governing means controlled by said stick relays.

30. Railway traffic controlling apparatus comprising a series of train carried stick relays, manually operable means effective only under certain traffic conditions to energize the first relay of said series, a pickup circuit for each of the remaining relays including a front contact of the preceding relay in said series, a stick circuit for each relay controlled in accordance with traffic conditions, and governing means controlled by the last relay in said series and by said manually operable means.

31. Railway traffic controlling apparatus comprising a train carried warning signal, a normally deenergized relay, a manually operable circuit controller, means effective under certain traffic conditions to prevent operation of said signal when said relay is deenergized and when said circuit controller occupies its normal position, a pickup circuit for said relay closed under certain other traffic conditions when said circuit controller is reversed, a stick circuit for said relay including its own front contact for subsequently holding the relay closed under such other traffic conditions, and means for preventing operation of the signal under such other traffic conditions when the circuit controller occupies its normal position and when said relay is energized.

32. A railway cab signaling system comprising a vehicle, a normally energized train control relay thereon continuously responsive to trackway conditions, a visual cab signal comprising means effective when the train control relay is energized to indicate a clear track condition, and effective when the train control relay is deenergized to indicate a danger track condition, a magnet, an audible cab signal controlled by said magnet for indicating a change in track condition from clear to danger, and arranged to sound when the magnet becomes deenergized, a stick relay, a manually operable acknowledging switch having a normal and a reverse position, a pickup circuit for the stick relay adapted to be closed when said switch is reversed, a stick circuit for the stick relay including its own front contact and a contact closed only when the train control relay is deenergized, a first circuit for said magnet closed only when the train control relay is energized and said switch is normal, and a second circuit for said magnet closed only when said stick relay is energized and said switch is normal.

33. A railway cab signaling system comprising a vehicle, a normally energized train control relay thereon continuously responsive to trackway conditions, a visual cab signal comprising means effective when the train control relay is energized to indicate a clear track condition and effective when the train control relay is deenergized to indicate a danger track condition, a magnet, a normally closed circuit for said magnet controlled by a front contact of said train control relay, an audible cab signal controlled by said magnet for indicating a change in track condition from clear to danger and arranged to sound when the magnet becomes deenergized, a stick relay, a normally open circuit for said magnet controlled by a front contact of said stick relay, a manually operable acknowledging switch having a normally closed contact in the circuits of said magnet and a normally open contact; and circuits for picking up and for holding said stick relay, each including a back contact of said train control relay, the circuit for picking up said stick relay also including the normally open contact of said acknowledging switch.

34. A railway cab signaling system comprising a vehicle, a normally energized train control relay theeron continuously responsive to trackway conditions, a visual cab signal comprising a normally energized lamp controlled by a front contact of said relay for indicating a clear condition and a normally deenergized lamp controlled by a back contact of said relay for increasing a danger condition of the trackway, an audible cab-signal comprising a magnet and arranged to audibly indicate when the relay becomes deenergized to thereby direct attention to the change in indication of said visual signal, said magnet being normally energized by a front contact of said relay, a manually operable acknowledging switch having a normal and a reverse position, means for energizing said magnet to stop the sounding of said audible signal rendered effective if said acknowledging switch is reversed and is then restored to normal when the train control

relay is deenergized, said means being effective to cause the sounding of said audible signal if said acknowledging switch is reversed when the train control relay is energized.

35. Railway traffic controlling apparatus comprising a train carried magnet valve, an audible signal controlled by said valve and arranged to sound when the magnet of said valve becomes deenergized, a train carried relay continuously responsive to trackway conditions and arranged to be energized only when traffic conditions are safe, a manually operable circuit controller having a normal and a reverse contact, an acknowledging relay, a circuit for picking up said acknowledging relay including the reverse contact of said circuit controller, a stick circuit for said acknowledging relay including its own front contact and a back contact of said train control relay, a circuit for said magnet valve including a front contact of said train carried relay and the normal contact of said circuit controller, and a second circuit for said magnet valve including a front contact of said acknowledging relay and the normal contact of said circuit controller.

36. Railway traffic controlling apparatus comprising a train carried audible signal, a normally deenergized relay, a manually operable circuit controller train carried means continuously controlled by current in the track rails and responsive to trackway conditions in advance of the vehicle, said means being effective to prevent operation of said audible signal under clear track conditions provided said circuit controller occupies its normal position, a pickup circuit for said relay closed under other traffic conditions when said circuit controller is reversed, a stick circuit for said relay including its own front contact for subsequently holding the relay closed under certain other traffic conditions, and means for preventing operation of the signal under said certain other traffic conditions when the circuit controller occupies its normal position and when said relay is energized.

37. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate a clear condition and a plurality of restrictive conditions of the track, a magnet, means for causing said magnet to invariably become deenergized upon a change from a clear condition to a restrictive condition, manually operable means effective under a restrictive condition to reenergize said magnet, and means invariably effective upon deenergization of said magnet to indicate a change in track conditions.

38. Railway traffic controlling apparatus comprising train carried means continuously responsive to trackway conditions in advance of the train and arranged to visually indicate a clear condition and a plurality of restrictive conditions of the track, a normally energized magnet, means for causing said magnet to invariably become deenergized upon a change from a clear condition to a restrictive condition, manually operable means effective under a restrictive condition to reenergize said magnet, means for causing said magnet when energized under a restrictive condition to again become become deenergized upon a change from said restrictive indication to a different restrictive indication, and means effective upon deenergization of said magnet to indicate a change in track conditions.

39. Railway traffic controlling apparatus comprising a stretch of railway track, means for supplying the track rails of the stretch with alternating current, means for periodically varying said current at a predetermined rate, detecting means controlled by said current and arranged to deliver alternating current having a value which depends upon the value of the current in the track rails and a frequency which corresponds to its rate of variation, a relay repeating each alternation in polarity of the current delivered by said detecting means when such current has a predetermined value, and traffic governing means controlled by the alternations delivered by said relay and responsive to the frequency at which such relay operates.

40. Railway traffic controlling apparatus comprising a stretch of railway track, means for supplying the track rails of the stretch with alternating current, means for periodically interrupting said current at a predetermined rate, detecting means controlled by said current and arranged to deliver alternating current having a value which depends upon the value of the current in the track rails and a frequency which corresponds to its rate of interruption, a relay repeating each alternation in polarity of the current delivered by said detecting means when such current has a predetermined value, and traffic governing means controlled by the alternations delivered by said relay and responsive to the frequency at which such relay operates.

41. Railway traffic controlling apparatus comprising a stretch of railway track, means for supplying the track rails of the stretch with alternating current, means for periodically interrupting said current at a predetermined rate, detecting means controlled by said current and arranged to deliver alterating current having a value which depends upon the value of the current in the track rails and a frequency which corresponds to its rate of interruption, means for repeating each alternation in polarity of the current delivered by said detecting means when such current has a predetermined value, means for rectifying the repeated alternations of current, and traffic governing means controlled by said rectified current.

42. In combination, a stretch of railway track, means for supplying the track rails of said stretch with alternating current which varies periodically at different rates, a two-position relay responsive to each change in polarity of the current supplied thereto when such current exceeds a predetermined value, means for supplying the relay with current impulses of alternately opposite polarity of which the value and frequency correspond to the amount and rate of variation of the current in the track rails, to operate the relay at a frequency corresponding to said rate of variation, and traffic governing means selectively responsive to the frequency of operation of the relay.

43. Railway traffic controlling apparatus comprising a stretch of railway track, means for supplying the track rails of the stretch with alternating current, means for periodically interrupting said current at any one of a plurality of predetermined rates, detecting means controlled by said current and arranged to deliver alternating current of a value which depends upon the value of the current in the track rails and of a frequency which depends upon its rate of interruption, a relay for repeating each alternation in polarity of the current delivered by said detecting means when such current has a predetermined value, and traffic governing means controlled by

the alternations delivered by said relay and selectively responsive to the frequency of operation of the relay.

44. In combination, a stretch of railway track, means for supplying the track rails of the stretch with alternating current periodically varied at different frequencies, an electron tube having a plate circuit including a source of direct current and a grid circuit including a fixed negative voltage for reducing the current normally flowing in said plate circuit substantially to zero value, means for superimposing an alternating voltage varying at the frequencies of the track rail current upon said negative voltage, a transformer having its primary winding included in said plate circuit, and a relay connected with the secondary of such transformer and responsive to the polarity of the current supplied thereto.

45. In combination, a stretch of railway track, means for supplying the track rails of the stretch with alternating current periodically varied at different frequencies, a train carried transformer, means for supplying the primary of said transformer with unidirectional current of which the magnitude depends upon the value of the current in the track rails, said unidirectional current varying in magnitude at the frequency of variation of said track current, a two-position relay responsive to each change in polarity of the current delivered by the secondary of said transformer when such current exceeds a predetermined value, and train governing means selectively responsive to the frequency of operation of said relay.

46. In combination, a stretch of railway track, means for supplying the track rails of the stretch with periodically varying alternating current, a train carried transformer having a winding tuned to resonance at the frequency of such current, means for energizing said transformer comprising an inductive circuit receiving energy from the track rails and tuned to resonance at said frequency, a first electron tube having a plate circuit and a grid circuit, means for applying to the grid circuit of said tube an alternating potential which varies as the electromotive force of said winding, a second electron tube having a grid circuit coupled with the plate circuit of said first tube, a second transformer, a plate circuit for the second tube including the primary of said second transformer, a polarized relay connected with the secondary of the transformer, and train governing means responsive to the frequency of operation of the relay.

47. In combination, a stretch of railway track, means for supplying the track rails of said stretch with alternating current, means for periodically varying said current at any one of a plurality of different frequencies, receiving means comprising a plurality of resonant circuits which respond selectively to current in the track rails having the frequency of said alternating current, detecting means adapted to deliver impulses of alternately opposite polarity of which the value and frequency corresponds to the amount and frequency of variation of the current delivered by said receiving means, a plurality of traffic governing means each selectively responsive to a different one of said plurality of frequencies, and means controlled by each of said impulses for delivering a current impulse of corresponding polarity to each of said traffic governing means.

48. In combination, a stretch of railway track, means for supplying the track rails of said stretch with alternating current, means for periodically interrupting said current at any one of a plurality of different frequencies, receiving means comprising a plurality of resonant circuits which respond selectively to current in the track rails having the frequency of said alternating current, detecting means adapted to deliver impulses of alternately opposite polarity of which the value and frequency correspond to the amount and frequency of variation of the current delivered by said receiving means when energized by said interrupted alternating current, a plurality of traffic governing means each selectively responsive to a different one of said plurality of frequencies, and means controlled by each of said impulses for delivering a current impulse of corresponding polarity to each of said traffic governing means.

49. In combination, a stretch of railway track, means for supplying the track rails of said stretch with alternating current, train carried receiving means comprising a plurality of resonant circuits which respond selectively to current in the track rails having the frequency of said alternating current, detecting means controlled by said receiving means and adapted to convert periodically varying alternating current delivered by said receiving means into low frequency alternating current of which the value and frequency corresponds to the amount and frequency of such variation, a plurality of traffic governing means controlled by said detecting means, each being selectively responsive to a different low frequency, and means controlled in accordance with traffic conditions for periodically interrupting the current in the track rails at one or another of said low frequencies to selectively control said traffic governing means.

50. In combination, a stretch of railway track, means for supplying the track rails of said stretch with periodically interrupted alternating current, receiving means selectively responsive to current in the track rails having the frequency of said alternating current, detecting means adapted to deliver impulses of alternately opposite polarity of which the value and frequency correspond to the amount and frequency of variation of the current delivered by said receiving means when energized by said periodically interrupted alternating current, a traffic governing relay responsive to unidirectional current and means controlled by each of said impulses for delivering a current impulse to said relay to maintain it energized.

LLOYD V. LEWIS.