April 23, 1929. E. J. BLAKE 1,710,495

TRAIN CONTROL SYSTEM

Original Filed Aug. 11, 1915 2 Sheets-Sheet 1

Fig. 5.

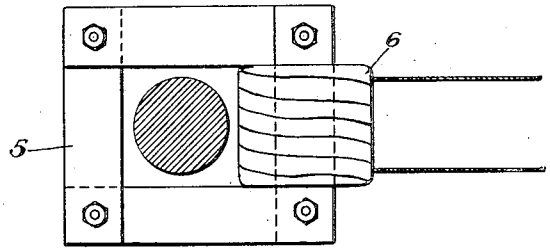
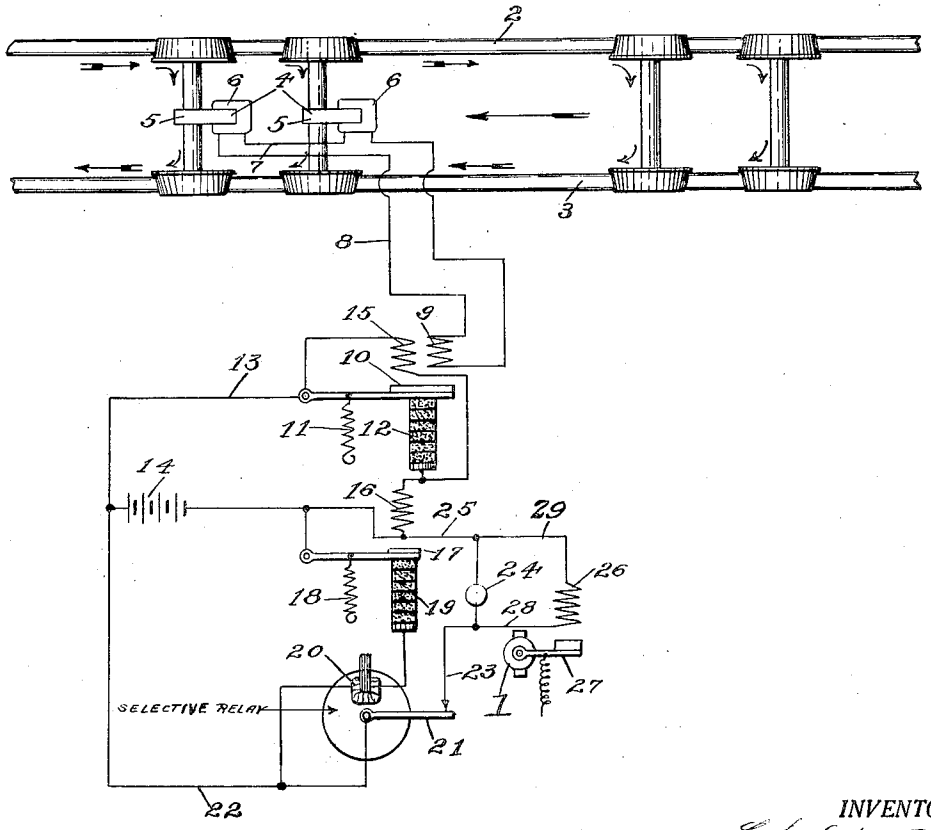


Fig. 1.



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Original Filed Aug. 11, 1915 2 Sheets-Sheet 2

Fig. 2.

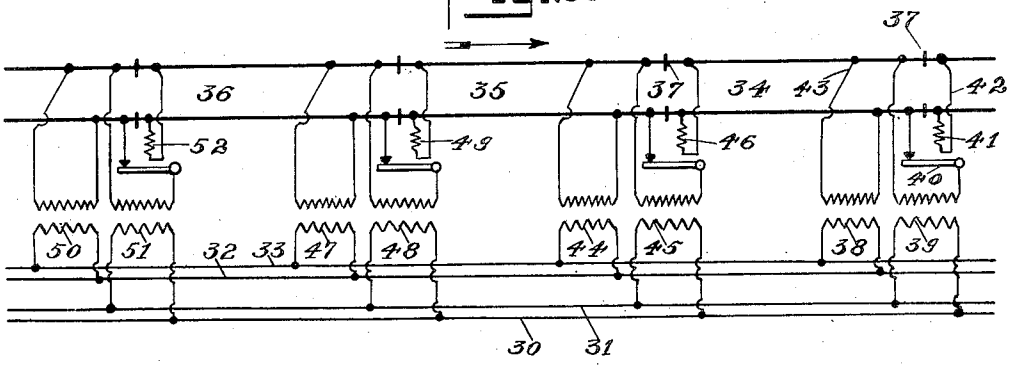


Fig. 3.

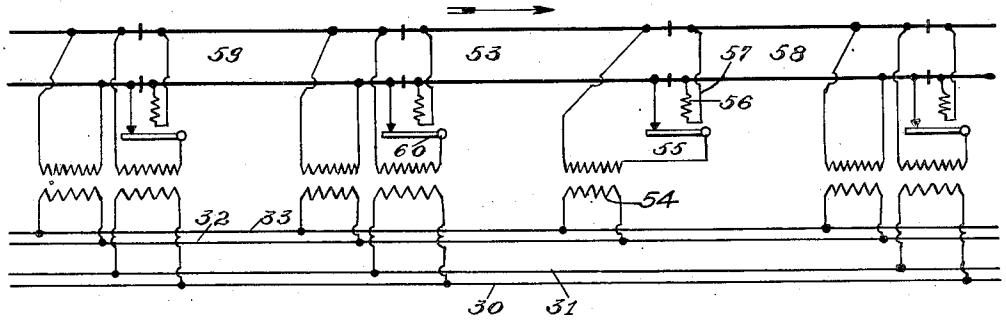
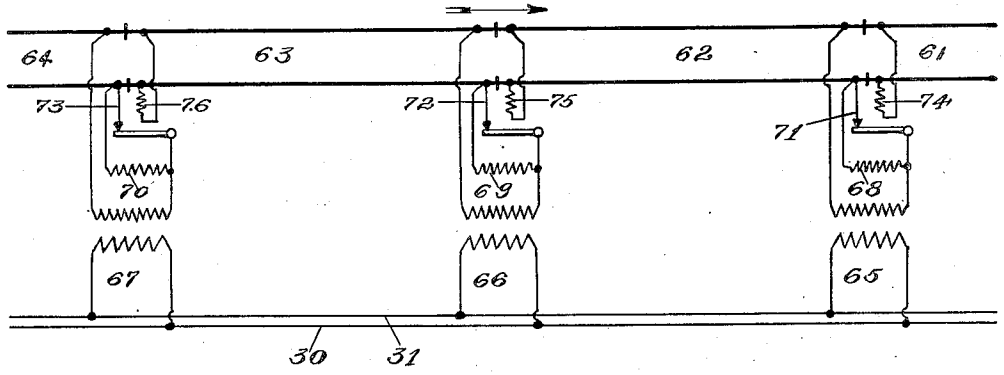


Fig. 4.



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UNITED STATES PATENT OFFICE.

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TRAIN-CONTROL SYSTEM.

Original application filed August 11, 1915, Serial No. 45,078. Divided and this application filed December 5, 1916. Serial No. 135,120.

My invention relates particularly to systems for controlling the operation of trains by a method which in its general nature is electrical.

In constructing train control systems where automatic stopping devices are used it is necessary to locate the actuating devices for the same at such a point as to bring the train to rest before reaching the entrance of an occupied block. In the case where the actuating devices are located at a certain definite point for all trains, it is necessary for them to be located to the rear of the entrance to the "braking distance" for the fastest train. Furthermore, it has been found necessary previously to locate the stop signal for the engine man in the rear of the actuating devices, as it is not desired to remove the responsibility from the engine man to operate the controlling devices of the train to bring the same to a stop when the signal indicates that the train should be stopped. The minimum headway between the trains upon a given track is thus very much increased owing to the presence of the signal and actuating devices a considerable distance in the rear of the entrance to each of the blocks and the increase in the minimum headway is the distance between the stop signal and the entrance to the block. The amount of traffic that can be carried by track in such a system is therefore correspondingly reduced.

One object of my invention is to provide a train control system which will not interfere with the control of the train by the engineer provided he is governed by the signals, and which will not therefore relieve the engineer of the responsibility of following the signals in the operation of the train; nor will it require any increase of minimum headway over that which is required with non-automatic control; but which, in the event of the engineer's disregarding a stop signal will automatically bring the train to rest near the point indicated by the stop signal, irrespective of the speed at which the train is traveling. Another object of my invention is to provide means for stopping the train automatically if predetermined speeds are exceeded over particular parts or the whole of the track. Another object is to provide signals on the train for the guidance of the engineer, which signals may be used in addition to, or in place of, fixed signals along the way as ordinarily employed heretofore.

In my prior application filed August 11, 1915, Serial #45,078, of which this application is a division, I have disclosed one means that will automatically intervene to bring the train to rest only in the event of the engineer's failing to keep the train under such control as will permit of bringing it to rest at the point where safety requires it to come to rest, or failing to reduce the speed of the train to a safe value where such reduction is required, but it is obvious that the present invention is applicable to the control of any other form of train control or cab signal system as desired.

Furthermore, my system is such that safety is indicated only when all of the devices and circuits controlling the safety indication are intact. The parts are, in other words, predisposed to the indication of danger and return automatically to such indication in case the power supply or any other part of the system fails. This is a distinct advantage over prior systems differently arranged, especially systems which depend on indications of safety received only at particular locations along the track. In my system safety is indicated continuously by current which flows over the entire block and a fraction of a block in advance of the train.

While my invention is capable of embodiment in many different forms, for the purpose of illustration I have shown only certain forms thereof in the accompanying drawings, in which

Figure 1 is a diagrammatic plan view of the track and the wheels of the car showing an arrangement of the devices on the car for controlling the car from the track;

Figures 2, 3 and 4 are diagrammatic representations of circuits energizing the tracks in different ways in accordance with my invention.

Figure 5 is a side view of one form of transformer that may be employed in conjunction with the vehicle axle.

When the blocks are clear and free from danger my system is arranged in such a manner as to indicate this fact to the engine

man, and also in such a manner as to close a valve 1 so as to prevent actuation of the brakes. This is accomplished in the following manner. The tracks are supplied with an alternating current flowing in the direction of the arrows as shown in Figure 1, that is to say, by passing along one rail 2, through the wheels and axles and then returning by the other rail 3. Transformers 4 are provided consisting of cores 5 surrounding the axles at the front of the car and coils 6, the coils 6 on a particular truck being connected together by a wire 7, and being connected together also by a wire 8 which wires are in circuit with a coil 9 of an electromagnet. While I have shown transformers surrounding the first two axles of the train, they may be applied to any number of axles in the train. The use of more than one transformer lessens the possibility of interruption of the circuit due to imperfect contact between the wheels and rails. It will be understood that the alternating current passing along the rail 2 will divide, part passing through the front axles, which are surrounded by the transformer cores, and part continuing along the rail to axles in the rear. The power delivered to the transformers including the drop in the axles on which they are located will only be a very small fraction of the power delivered to the rails as it will be merely the product of the portion of the current that passes through the transformers by a potential equal to the drop in potential in the branch circuit including rails and axles in the rear of the transformers. The electromagnet comprising the coil 9 is arranged so as to decrease the pressure exerted by an armature 10 which is pressed downwardly by a spring 11 against a pile of carbon discs 12. This pile of carbon discs 12 is located in a circuit 13 including a battery 14, so that the undulations of the alternating current in the wire 8, by causing variations in the pressure on the pile of carbon discs 12 and thereby causing variations in the resistance of the pile, produce corresponding undulations of magnified intensity in the current flowing through the circuit 13. If desired these undulations can be still further intensified by providing a coil 15 in front of the armature 10 which coil is shunted across the carbon pile 12, so that each increase in the resistance of the carbon pile will cause more current to flow through the coil 15, tending to still further decrease the pressure upon the carbon discs and increase their resistance. The same process can be repeated any number of times, producing at each step an undulating current of increased intensity, so that the feeble current received over the circuit 8 can be amplified to any desired extent. For example I have shown another magnet coil 16 in series with the carbon pile 12 which acts upon an armature 17 in opposition to a spring 18 to vary the pressure upon a second carbon pile 19 and thereby to vary its resistance. Current flowing through the carbon pile 19 from the battery 14 is thus caused to pulsate in unison with the alternations of current in the transformer coils 6 but with greatly magnified intensity.

In series with the carbon pile 19 I connect a winding 20 of a relay having a contact finger 21 in a circuit 22 including the battery 14 which is responsive only to periodic currents, and which may be made responsive only to periodic currents of a particular frequency or range of frequencies. Through the contact finger 21 of this relay, and through a wire 23, current passes from the battery 14 to a lamp 24 returning to the battery 14 through a wire 25. A branch circuit in multiple with the lamp 24 and including a magnet coil 26 controlling a lever 27 on the valve 1 passes through wires 28 and 29. Thus the lamp 24 will be lit and the valve 1 will be held closed if a suitable alternating current is passing through the axles embraced by the transformer cores 5 and not otherwise. The lamp 24 serves as a signal to the engineer, indicating when lit that the track ahead is clear to the end of the next block in advance. The valve 1 serves, when the track is clear, to cut off the connection between the air brake system and any desirable form of control mechanism such as disclosed in my prior application, which would otherwise cause the train to stop automatically.

In one form of my system, I provide not only a source for supplying to the rails the alternating current which I have described, indicated diagrammatically in Figs. 2, 3 and 4 by the supply wires 30 and 31, this current being of a frequency adapted to operate the relay 20, shown in Fig. 1, but I also supply an alternating current of a different frequency, to which the relay 20 will not respond by means of supply wires 32 and 33 for the purpose which I will now describe.

It is well known in the art that resistance or reactance should be included in the circuits by which energy is supplied to the track circuits in order that the current flowing into the track when short circuited may be limited to a proper value. In the circuits here described there is a further requirement that the flow of energy by double transformation from one transmission circuit to the other shall be limited to a value which will not permit the latter circuit to deliver it at another location in sufficient quantity to perform the function of the first circuit. It is intended that the inherent resistance or reactance of the transformers illustrated shall be sufficient to accomplish these purposes; but should transformers of lower re-

sistance or reactance be used it is obvious that the flow of energy into the track circuit and the transfer of energy between transmission lines may be limited by the usual external devices such as resistors, reactors or (between the transmission lines) resonant circuits.

As shown in Fig. 2, the track may be divided into blocks 34, 35 and 36 comprising rails which are separated by insulating joints 37. In this connection I provide means here shown in the form of transformers 38 and 39 for supplying current from the wires 32 and 33 and from the wires 30 and 31 respectively to the block 34. It is to be understood however that instead of using transformers I may use any other source for the desired current. The current from the transformer 39 is supplied to the block 34 through a relay contact finger 40. The contact in the relay 40 is controlled by a coil 41 in a wire 42 bridging the block immediately in front of the block 34 so that should the current in said block in front of the block 34 fail, the contact in the relay 40 would be broken and the current of the frequency supplied from the wires 30 and 31 would no longer be supplied to the block 34. From transformer 38 current is conveyed to the block 34 by means of a wire 43. In a similar way the block 35 is supplied with current of the two different frequencies by transformers 44 and 45, the latter conveying current through a relay 46. In the same way current is supplied to the block 36 through transformers 47 and 48 and a relay 49. For the block in the rear of the block 36 there are provided in the same way transformers 50 and 51 and a relay 52. This arrangement is such that current is at all times supplied to the different blocks over the wires 32 and 33. It therefore follows, as pointed out above, that when a block in advance of the block which a train is approaching is clear, the passage of the current through the particular relay will maintain the derivation of the current from the wires 30 and 31 to the block which the train is approaching thus showing through the various signal devices already described when the train reaches the blocks which it has been approaching that the train may enter the block in question. Should, however, another train be in the block which the first train is approaching, the wheels of the other train would short circuit the current in the block, thus breaking the contact in the relay in advance of the first train and discontinuing the supply of current derived from the wires 30 and 31 to the block in which this train is located. It will be understood, however, that when the current ceases to flow from the wires 30 and 31 in this manner in the block in which a train is located, because of the presence of a train in the block immediately in front of the first mentioned train, nevertheless the second block in the rear of the first mentioned train would still be energized by currents of both frequencies. Therefore when a train enters the block immediately in the rear of a block that is occupied by another train, current derived from the wires 30 and 31 will cease to flow through the axles of the first mentioned train, thus causing the light 24 to go out, and operating the valve 1 so as to permit the brake system to apply the brakes.

The passage of current derived from wires 32 and 33 will not affect the apparatus on the train because it is of a frequency to which the latter will not respond. However, it can be seen that any number of selective relays 20 might be employed in this circuit, each responsive to a certain given frequency to thereby control various functions upon the vehicle.

In the arrangement of the system indicated in Figure 3 the parts are constructed in exactly the same manner as shown in Figure 2 except that in this instance I have shown a system in one block 53 in which it is desired to limit the speed of the train irrespective of the presence of a train in the block in advance thereof. In the case of this block no provision is made for supplying any current thereto from wires 30 and 31, but instead there is supplied thereto merely current from wires 32 and 33 through a transformer 54 connected by a relay contact finger 55 to the rails in that block and adapted to be controlled in the usual way by a coil 56 connected by wire 57 to the block 58 in advance of the block 53. When arranged in this manner the system will operate in such a way that when a train reaches the block 53 the light 24 will be extinguished and the automatic stopping devices operated.

By this arrangement, furthermore, in order for a train located in the block 59 in the rear of the block 53 to proceed, it is necessary for both of the blocks 53 and 58 in advance thereof to be clear as the current over wires 30 and 31 will not be supplied to the block 59 except in the case where the relay containing contact finger 55 supplying current to the block 53 and the relay 60 supplying current to the block 59 have their respective coils energized from the blocks 58 and 53.

Another arrangement for energizing the system may be provided instead, if desired, as shown in Figure 4. In the arrangement as shown in this figure only current from wires 30 and 31 is supplied to blocks 61, 62, 63 and 64 by transformers 65, 66 and 67 which are arranged to supply current continuously through resistances 68, 69 and 70 to the said blocks. Shunted around the resistances 68, 69, and 70, however, I have pro-

vided relays 71, 72 and 73, which when maintained with their contacts closed by coils 74, 75 and 76 supply current of sufficient strength to actuate the indicating and controlling devices on the train. When, however, the circuits through the relay contacts are broken, the current which is continuously supplied to the blocks through the resistances 68, 69 and 70 is not sufficiently strong to actuate the controlling devices on the train but is sufficiently strong to energize the magnets 74, 75 and 76, so as to operate the relays 71, 72 and 73. In this way one source of current serves to perform all of the required operations.

While I have described my invention above in detail, I wish it to be understood that many changes may be made therein without departing from the spirit of my invention.

I claim:

1. A railway signaling system comprising track rails; means for supplying to said track rails, at intervals, an alternating signaling current; a vehicle for travel along said track rails; a circuit carried by said vehicle and arranged to collect energy from the signaling current on the track rails; means also carried by the vehicle for amplifying the variations in energy collected in said circuit; and vehicle governing means also on the vehicle and operated by reason of said amplified energy variations.

2. A railway signaling system comprising track rails, means for impressing alternating current thereon, a vehicle, a circuit on the vehicle receiving energy from the track rails, means for amplifying the variations in energy in said circuit, and vehicle governing apparatus controlled through the amplified current.

3. A railway signaling system comprising a trackway; means for dividing the trackway into signaling sections; a source of current connected with each signaling section and a relay device also connected with each signaling section so as to form a closed track circuit; a source of signaling current for each signaling section and connected therewith through the relay device of a section in advance; a vehicle for travel along the trackway; a circuit on the vehicle arranged to receive energy from the signaling current in the track rails of a signaling section; an amplifier on the vehicle and included in said circuit for amplifying the variations of energy in said circuit; vehicle governing means on said vehicle; an electrically operated device for controlling said means, said device acting when energized to cause one operation of said governing means and when de-energized to cause another operation of said means; a circuit for said electrically operated device including a source of current and said circuit being controlled as to the flow of current therein by the operation of the amplifier by said alternating signaling current.

4. A railway signaling system comprising track rails; means for supplying thereto an alternating signaling current; a railway vehicle, a circuit thereon arranged to receive energy from the alternating signaling current in the track rails; an amplifier on the vehicle and included in said circuit for amplifying the variations of energy in said circuit; vehicle governing means on said vehicle; an electrically operated device for controlling said means, said device acting when energized to cause one operation of said governing means and when deenergized to cause another operation of said means; a circuit for said electrically operated device including a source of current and said circuit being controlled as to the flow of current therein by the operation of the amplifier by said alternating signaling current.

5. Railway traffic controlling apparatus comprising track rails divided into sections; a track circuit for each section comprising a source of track circuit current and a track relay; means for each section for supplying alternating signaling current thereto differing in frequency from the track circuit current, said means being controlled by the track relay for the section next in advance; a vehicle; a circuit thereon in which current is caused to flow by virtue of current in the track rails; an amplifier on the vehicle receiving current from said vehicle circuit; vehicle governing means; electrical means controlling said vehicle governing means and responsive to current of the frequency of said alternating signaling current but not to the track circuit current; a source of current on the vehicle; and a circuit including said electrical means and said source and controlled by said amplifier as to the flow of current.

6. Railway traffic controlling apparatus comprising track rails; means for supplying alternating signaling current thereto; a railway vehicle; a circuit thereon arranged to receive energy from the signaling current in the track rails; an amplifier controlled by current in said circuit for amplifying the variations of the energy in said circuit; an electroresponsive device on the vehicle, a circuit for said electroresponsive device including a source of current and the flow of current in which circuit is governed by said amplifier; and vehicle governing means controlled by said electroresponsive device.

7. Railway traffic controlling apparatus comprising track rails; means for supplying alternating signaling current thereto; a railway vehicle; vehicle governing apparatus thereon; a circuit on the vehicle receiving energy from said track rails; an amplifier controlled by the current received in said circuit; and a second circuit on the vehicle for

controlling the operation of said vehicle governing means, said second circuit including a source of current and the flow of current in said circuit being controlled by the action of said amplifier.

8. A railway signaling system comprising track rails; means for supplying to said track rails at intervals an alternating signaling current; a vehicle for travel along said track rails; a circuit carried by said vehicle and arranged to collect energy from the signaling current on the track rails; an amplifier also carried by the vehicle including a source of current for amplifying the variations in energy collected in said circuit; and vehicle governing means also on the vehicle and operated by reason of said amplified energy variations.

9. Railway traffic controlling apparatus comprising a track divided into blocks, a source of current connected across the rails of each block at the exit end thereof, means connected with the rails of each block at the entrance end thereof for modifying the character of the current supplied to the adjacent block when the block to which said means is connected is unoccupied, a vehicle, and traffic governing means thereon controlled by current in the track rails in advance of the vehicle and responsive to said modified current but not to the track current supplied to the block in the rear of an occupied block.

10. Railway traffic controlling apparatus comprising a plurality of successive blocks, a track circuit for each block comprising a source of track circuit current and a track relay, means for each block controlled by the track relay for the block next in advance for supplying vehicle governing current differing in character from the track circuit current to the rails of the block when said relay is energized but not when said relay is de-energized, a vehicle, and vehicle governing means thereon receiving energy from the track rails and responsive to said vehicle governing current but not to said track circuit current.

11. In combination, a railway vehicle, a circuit thereon, means for supplying alternating current to the rails of the trackway from which an alternating signaling current is produced in said circuit, a second circuit on said vehicle including a local source of current, an amplifier on the vehicle for varying the current in said second circuit in accordance with the alternations of the current collected in said first circuit, and vehicle governing means controlled by the current variations in said second circuit.

12. In combination, a railway vehicle, a circuit thereon, means for supplying alternating current to the rails of the trackway from which an alternating signaling current is produced in said circuit, a second circuit on said vehicle including a local source of current, an amplifier in said second circuit and controlled by the first circuit for causing variations of the current in the second circuit corresponding to the alternations of the current in the first circuit but of greater amplitude, and vehicle governing means controlled by the current variations in said second circuit.

13. In combination, a railway vehicle, a circuit thereon, means for supplying alternating current to the rails of the trackway from which an alternating signaling current is produced in said circuit, a second circuit on said vehicle including a local source of current, an amplifier on the vehicle for causing variations of the energy in the second circuit corresponding in character to the energy variations in the first circuit, and vehicle governing means controlled by the energy variations in said second circuit.

14. In combination, a railway vehicle, a circuit thereon, means for supplying alternating current to the rails of the trackway from which an alternating signaling current is produced in said circuit, a second circuit on said vehicle including a local source of current, an amplifier on the vehicle for modifying the effect of said local source in accordance with variations of the energy in the first circuit, and vehicle governing means controlled by the modified current in the second circuit.

15. A railway traffic governing system comprising track rails, means for supplying alternating signaling current thereto, a vehicle, a circuit on said vehicle receiving energy from said rails, a second circuit on the vehicle including a local source of current, an amplifier on the vehicle for varying the current in said second circuit in accordance with the alternations of the current collected in said first circuit, and vehicle governing means controlled by the current variations in said second circuit.

16. Railway traffic apparatus comprising a trackway divided into sections; a source of alternating current for supplying current across the track rails of the section at one end thereof; a vehicle; a signaling circuit formed by the opposite track rails of each section and the wheels and axles of the vehicle as it travels along the section; a circuit on the vehicle which receives energy from the current flowing in the said signaling circuit; a second circuit on the vehicle including a source of current; an amplifier on the vehicle for varying the current in said second circuit in accordance with the energy variations of the current collected in the first circuit; a relay device having a movable element with a gravity bias and operated by continuously maintained current variations in said second circuit; and ve-

hicle governing means controlled by said relay to give safety indications to the vehicle.

17. Railway traffic controlling apparatus comprising a trackway divided into sections; means for each section for continuously supplying alternating current to the rails of the section; means for controlling the supply of alternating current to the rails of the section; a vehicle; a circuit on said vehicle receiving energy from the alternating current in said track rails; a second circuit on the vehicle including a source of current; an amplifier on the vehicle responsive to energy variations in the first circuit for varying the strength of the current in said second circuit in accordance with the energy variations in the first circuit; and vehicle governing means operated by the continuously maintained current variations in said second circuit to give safety indications to the vehicle.

18. Railway traffic controlling apparatus comprising a trackway divided into sections; means for each section for continuously supplying alternating current to the rails of the section; means for controlling the supply of alternating current to the rails of the section; a vehicle; a circuit on said vehicle receiving energy from the alternating current in said track rails; a second circuit on the vehicle including a source of current; an amplifier on the vehicle responsive to energy variations in the first circuit for varying the strength of the current in said second circuit in accordance with the energy variations in the first circuit; a relay device having a movable element with a gravity bias and operated by the current in said second circuit; and vehicle governing means controlled by said relay for giving safety indications to the vehicle.

19. Railway traffic controlling apparatus comprising a trackway divided into a plurality of sections; means for each section controlled by traffic conditions in advance for supplying alternating traffic controlling current to the rails of the section, a vehicle, a circuit on said vehicle receiving energy from said track rails; an amplifier on the vehicle for amplifying the variations in energy collected in said circuit, a relay controlled by the amplified energy variations; and vehicle governing means controlled by said relay.

20. In combination, a vehicle; a track therefor divided into sections; means normally supplying alternating signaling current to the track rails of each section, said means being responsive to the shunting action of a train in advance of the section to cut off said signaling current, said signaling current also being cut off in the rear of the vehicle due to the shunting action of its wheels and axles; a receiving circuit on the vehicle influenced by said signaling current; a local circuit and a source of current on the vehicle; an amplifier on the vehicle for causing variations in the strength of the current in the local circuit in accordance with the variations in the current in the receiving circuit produced by said signaling current; and automatic train controlling means on the vehicle acting under the influence of the variations in the strength of the current in the local circuit to give a safety indication.

21. A railway traffic-controlling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electro-motive-force from said flow of current in the controlling rail circuit, micro-responsive electrical amplifying means carried on said train or vehicle and controlled by the said derived electro-motive-force, and electrically controllable retarding apparatus carried on the train or vehicle and arranged to retard its progress and to be maintained in non-retarding condition by the amplified energy from said amplifying means under control of the said electro-motive-force derived from the controlling rail circuit.

22. A railway traffic-controlling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electro-motive-force from said flow of current in the controlling rail circuit, micro-responsive electrical amplifying means carried on said train or vehicle and controlled by the said derived electro-motive-force, and retarding apparatus carried on the train or vehicle and arranged to retard its progress and including a governing member arranged to move in response to the amplified energy of said amplifying means from a position effecting the retarding condition of said apparatus to a position effecting its non-retarding condition.

23. A railway signaling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of signal-controlling current through said rail circuit, means on said train or vehicle for deriving electro-motive-force from said flow of signal-controlling current in the rail circuit, micro-variant electrical amplifying means carried on said train or vehicle and controlled by the said derived electro-motive-force, and electrically controllable signaling means carried on the

train or vehicle and arranged to be controlled by energy from the said amplifying means under control of the said electro-motive-force derived from the controlling rail circuit.

24. A railway signaling system comprising a signal-controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of signal-controlling current in said rail circuit, means on said train or vehicle for deriving electro-motive-force from said flow of current in the signal-controlling rail circuit, micro-responsive electrical amplifying means carried on said train or vehicle and controlled by the said derived electro-motive-force, and signaling apparatus carried on the train or vehicle and including a local governing circuit and a movable member in control thereof arranged to move in response to the amplified energy of said amplifying means from a position effecting the warning indication of said apparatus to a position effecting its clear indication.

25. A train control system comprising a railway track and a vehicle for travel thereon, a generator furnishing alternating current of a predetermined frequency to the rails of said track, means for supplying an alternating electromotive force to the vehicle from the flow of current in the track and of the same frequency as the latter, traffic governing means on the vehicle, and means controlled by said electromotive force and responsive to said predetermined frequency but not to another frequency for controlling said traffic governing means.

26. Railway traffic controlling apparatus comprising track rails; a vehicle for travel thereon; a circuit on the vehicle; means located in the trackway from which an alternating electromotive force of a predetermined frequency is produced in said circuit; a second circuit on said vehicle including a local source of current; an amplifier controlled by the variations of electromotive force in the first circuit for causing variations, having said predetermined frequency, in the flow of current from said local source in said second circuit; vehicle governing means on the vehicle; and means on said vehicle controlled by the variations of current flow in said second circuit and responsive to variations of said predetermined frequency but not to variations of another frequency for controlling said vehicle governing means.

27. Railway traffic controlling apparatus comprising a vehicle, a track on which it travels, means for supplying alternating current to said track, and vehicle governing means on said vehicle controlled by said current in the track and comprising a plurality of concatenated amplifying devices.

28. Railway traffic controlling apparatus comprising a trackway and a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of current, an amplifying device controlled by the alternating electromotive force in said first circuit for varying the strength of the current in said second circuit, a third circuit on said vehicle, including a source of current, a second amplifying device controlled by the variations in current strength in said second circuit for varying the strength of the current in the third circuit, the variations of current strength in the third circuit being of greater amplitude than those in the second circuit, and vehicle governing means controlled by the variations in current strength in said third circuit.

29. Railway traffic controlling apparatus comprising a trackway divided into block sections, a vehicle for travel on said trackway, a circuit on said vehicle, means in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a local source of current, an amplifier in said second circuit controlled by said first circuit and causing variations in the flow of current in the second circuit of a frequency corresponding to the alternations of electromotive force in the first circuit, but of greater energy than could be derived directly therefrom, and vehicle governing means controlled by said second circuit.

30. Railway traffic controlling apparatus comprising a trackway and a vehicle for travel thereon, a circuit on said vehicle, means in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of current, amplifying means controlled by the alternating electromotive force in said first circuit for causing variations in the flow of current in the second circuit, and vehicle governing means controlled by the variations in the current in said second circuit.

31. Railway traffic controlling apparatus comprising a trackway divided into block sections and a vehicle for travel thereon, a circuit on said vehicle, means associated with each section and controlled by traffic conditions in advance from which an alternating electromotive force is produced in said vehicle-carried circuit, a second circuit on said vehicle including a local source of current, amplifying means controlled by the alternating electromotive force in said first circuit for causing variations in the current in said second circuit, and vehicle governing means controlled by the current variations in the second circuit.

32. Railway traffic controlling apparatus comprising a trackway divided into block sections, and a vehicle for travel thereon, a circuit on said vehicle, means for each block section controlled by traffic conditions in advance from which an alternating electromotive force is produced in said vehicle-carried circuit, a second circuit on said vehicle includng a local source of current, amplifying means controlled by the alternating electromotive force induced in said first circuit for causing variations in the current in said second circuit, and vehicle governing means controlled by the current variations in said second circuit.

33. Railway traffic controlling apparatus comprising a trackway divided into block sections, a vehicle for travel on said trackway, means located in the trackway from which an alternating magnetic field is produced on the vehicle, a circuit on the vehicle subject to said alternating magnetic field, a second circuit on said vehicle including a local source of current, an amplifier in said second circuit controlled by the first circuit in response to the variations of said magnetic field, and producing in said second circuit alternating current corresponding in frequency to said magnetic field but of greater amplitude than could be derived directly therefrom, and vehicle governing means controlled by the current in said second circuit.

34. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; a relay having a winding included in said second circuit and responsive to variations of current strength in said circuit but not to direct current, and vehicle governing means controlled by said relay.

35. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electrmotive force in the first circuit for causing variations in the strength of current in the second circuit; a relay having a winding included in said circuit and responsive to variations of current strength but not to direct current and said relay being so designed that its responsiveness to current variations is not impaired by the direct current in said second circuit, and vehicle governing means controlled by said relay.

36. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; an induction motor relay having a winding included in said second circuit, and vehicle governing means controlled by said relay.

37. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; an induction motor relay having a winding supplied with energy by said second circuit, and vehicle governing means controlled by said relay.

38. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; a relay having a winding included in said second circuit, a rotor of non-magnetizable material and a contact actuated by said rotor; and vehicle governing means controlled by said relay contact.

39. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; a relay comprising an iron core having an air gap, a winding on said core and included in said second circuit, a rotor of non-magnetizable material moving in said air gap and a contact actuated by said rotor; and vehicle governing means controlled by said relay contact.

40. Railway traffic controlling apparatus

comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; a relay having a winding included in said second circuit and responsive to current variations of the frequency of the alternating electromotive force created in said first circuit but not to variations of a different frequency, and vehicle governing means controlled by said relay.

41. Railway traffic controlling apparatus comprising a trackway, a vehicle for travel thereon, a circuit on the vehicle, means located in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current, amplifying means on the vehicle controlled by the alternating electromotive force in the first circuit for causing variations in the strength of current in the second circuit; a regenerative circuit for said amplifying means receiving electromotive force from said second circuit, and vehicle governing means controlled by the current variations in said second circuit.

42. Railway traffic controlling apparatus comprising a trackway and a vehicle for travel thereon, a receiving circuit on the vehicle, means in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current; a microphone amplifier comprising a magnet receiving energy from said receiving circuit, an armature controlled by said magnet, and a carbon mass included in said second circuit and the resistance of which mass is varied by the motion of said armature; and vehicle governing means controlled by the current variations in said second circuit.

43. Railway traffic controlling apparatus comprising a trackway and a vehicle for travel thereon, a receiving circuit on the vehicle, means in the trackway from which an alternating electromotive force is produced in said circuit, a second circuit on said vehicle including a source of direct current; a microphone amplifier comprising a magnet receiving energy from said receiving circuit, an armature controlled by said magnet, and a carbon mass included in said second circuit and the resistance of which mass is varied by the motion of said armature; regenerative means for said amplifier comprising a second magnet acting on said armature and connected in the second circuit in multiple with the carbon mass, and vehicle governing means controlled by the current variations in said second circuit.

44. The method of controlling traffic, which consists in producing an alternating disturbance along a trackway carrying traffic to be controlled, governing said disturbance by traffic conditions in advance, producing by said disturbance an alternating E. M. F. in a vehicle to be controlled, influencing thereby a local source of energy to produce energy changes greater than could be directly derived from the disturbance, and causing said local energy changes to actuate traffic controlling means.

45. The method of controlling traffic, which consists in producing, along a trackway carrying traffic to be controlled, an alternating disturbance having a predetermined frequency, governing said disturbance by traffic conditions in advance, producing by said disturbance an alternating E. M. F. in a vehicle to be controlled, causing said E. M. F. to control a source of direct current on said vehicle to produce alternating currents of the same frequency but greater energy than that directly derived from said disturbance, and actuating traffic controlling means thereby.

46. The method of controlling traffic, which consists in producing along a trackway carrying traffic to be controlled, an alternating disturbance having a predetermined frequency, governing said disturbance by traffic conditions in advance, producing by said disturbance an alternating E. M. F. in a vehicle to be controlled, controlling thereby a local source of direct current to produce alternating current of the same frequency, regeneratively amplifying said current, actuating a signal on said vehicle in accordance with changes in said E. M. F. and actuating traffic controlling means on said vehicle by said amplified current to permit manual control of said train only when said manual control is in accord with said signals.

47. In a railway block signal system, in combination, a section of traffic rails constituting a block, a source of current for energizing said section, a coil across said rails, a switch under the influence of said coil, and an alternating current circuit passing through said switch to a preceding block.

48. In a railway block signal system, a track divided electrically into signal sections, a plurality of current sources of different frequencies, means associated with and controlled by each of said sections for connecting said current sources to preceding sections.

49. The method of controlling railway traffic which consists in producing in the track rails a periodic current of commercial frequency, deriving from said rail current a periodic E. M. F. available on a railway

vehicle, employing said derived E. M. F. to control an amplifying means on the vehicle, and employing the output energy of said amplifying means to govern traffic-controlling means on the vehicle.

50. Railway traffic-controlling apparatus comprising means for producing a periodic current in the track rails, means for deriving E. M. F. therefrom on a moving vehicle, a polarized electro-magnetic telephonic microphone amplifier on said vehicle arranged to be controlled by said derived E. M. F., and traffic-controlling apparatus on the vehicle governed by the output energy of said microphone.

51. A railway traffic-controlling system comprising means for producing a flow of periodic current in the track rails, means on a railway vehicle for deriving from said rail current a periodic E. M. F., a cascade series of amplifiers on the vehicle arranged to be excited by said derived E. M. F., and traffic controlling means on the vehicle governed by the output circuit of said cascade amplifier series.

52, A railway traffic-controlling system comprising means for producing a flow of periodic current in the track rails, means on a railway vehicle for deriving from said rail current a periodic E. M. F., a regenerative amplifier on the vehicle having its input circuit excited by said derived E. M. F., and traffic-controlling means on the vehicle governed by the output circuit of said amplifier.

53. A railway traffic-controlling system comprising means for producing a flow of periodic current in the track rails, means on a railway vehicle for deriving from said rail current a periodic E. M. F., a telephonic wave-form-repeating amplifier on the vehicle receiving said derived E. M. F. in its input circuit and reproducing the waves thereof, in its output circuit, and traffic-controlling means on the vehicle responsive to and governed by said repeated waves delivered by the amplifier.

54. A track circuit; a vehicle circuit deriving energy from the track circuit; a second vehicle circuit deriving energy from a local source; a controlling element whereby the current in the second vehicle circuit is varied in accordance with the current in the first vehicle circuit; and a train control device governed by the current in the second vehicle circuit.

55. A railway traffic controlling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electromotive force from said flow of current in the controlling rail circuit, micro-responsive electrical amplifying means carried on said train or vehicle and controlled by the said derived electromotive force, and electrically controllable retarding apparatus carried on the train or vehicle and arranged to retard its progress and to be governed by the amplified energy from said amplifying means under control of the said electromotive force derived from the controlling rail circuit.

56. A railway traffic controlling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electromotive force from said flow of current in the controlling rail circuit, micro-responsive electrical amplifying means carried on said train or vehicle and controlled by the said derived electromotive force, and retarding apparatus carried on the train or vehicle and arranged to retard its progress and including a local governing circuit and a movable member in control thereof arranged to move in response to the amplified energy of said amplifying means from a position effecting the retarding condition of said apparatus to a position effecting its non-retarding condition.

57. A railway signaling system comprising a controlling rail circuit including the opposite track rails and wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electromotive force from said flow of current in the controlling rail circuit, micro-responsive electric amplifying means carried on said train or vehicle and controlled by the said derived electromotive force, and visual signaling means carried by the train or vehicle and arranged to be energized by the amplified energy from said amplifying means to effect its clear indication.

58. A railway signaling system comprising a controlling rail circuit including the opposite track rails and the wheels and axles of a railway train or vehicle, means for producing a flow of controlling current through said rail circuit, means on said train or vehicle for deriving electromotive force from said current flow in the controlling rail circuit, micro-variant electric amplifying means on said train or vehicle controlled by said derived electromotive force, and signalling apparatus carried by the train or vehicle and including a governing member arranged to move in response to the amplified energy of said amplifying means from a position effecting the warning indication of the apparatus to a position effecting its clear indication.

59. In a railway signal system, in combination, a circuit for carrying alternating current of a definite frequency, means in

said circuit for normally maintaining it in one condition, and another circuit under the influence of a train for affecting said means.

60. In a railway signal system, in combination, a circuit for carrying alternating current of a definite frequency, an indicating device responsive to said current, an electromagnetic switch in said circuit, and another circuit connected to said switch and having a connection across the traffic tracks in advance of said indicating device, whereby the axle of a train preceding said indicating device will effect it.

61. A traffic regulating system comprising a track rail, means for impressing a varying current thereon, a vehicle, a circuit on the vehicle receiving energy from the track rail, an amplifier controlling a greater flow of energy in accordance with the variations of the received energy, and traffic regulating apparatus controlled by the increased energy.

62. A traffic regulating system comprising a vehicle, a circuit thereon deriving a relatively small power from a rail circuit, a second circuit for regulating the progress of the vehicle and a static amplifier interposed between the first and second train circuit.

63. A traffic regulating system comprising a vehicle, a circuit thereon deriving power from a rail circuit, a second circuit including a source of power, and a traffic regulating device and a variable resistance influenced by the first train circuit.

64. A traffic regulating system comprising a rail circuit, a train carried circuit coupled therewith, a variable resistance amplifying device controlled by the second circuit, and a third circuit including the variable resistance and an independent source of electromotive force.

65. In a traffic regulating system a track circuit, a roadside relay responsive to current in the track circuit, and a train borne amplifier and relay selectively responsive to track current of one character and unresponsive to track current of another character.

66. In a traffic regulating system, a train borne circuit picking up indications of relatively little power, and a second circuit having its own source of power coupled to the first circuit by an element which controls the intensity of power in the second circuit but does not originate the flow of power.

In testimony whereof, I have signed my name to this specification.

ELI J. BLAKE.