H. A. WAGNER.

RAILWAY SIGNALING SYSTEM.

APPLICATION FILED FEB. 4, 1908.

1,264,720.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 1.

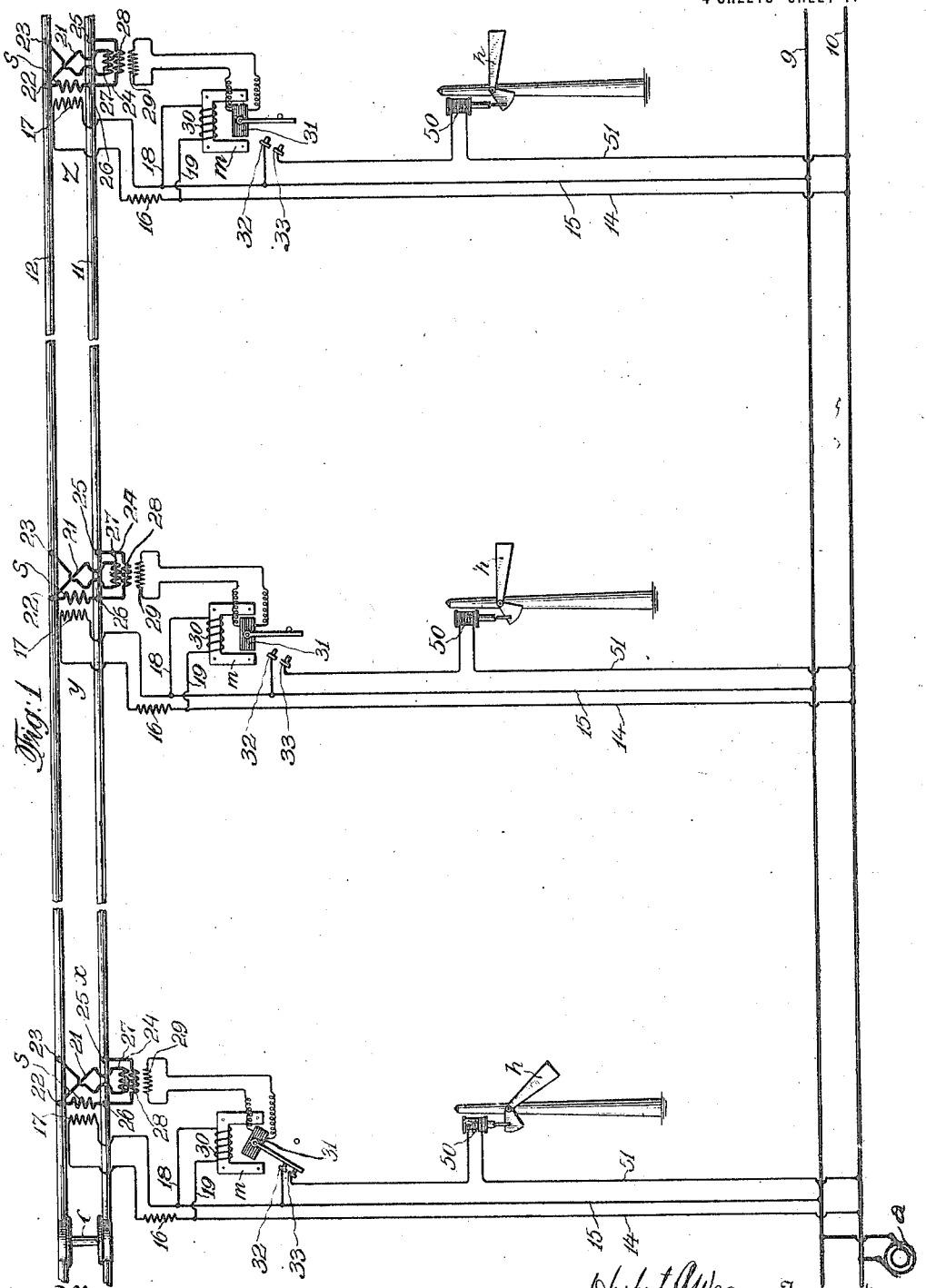


Fig. 1.

Witnesses:
John O. Gempler
Edmond Harris

Herbert A. Wagner. Inventor
By his Attorneys Kenyon & Kenyon

H. A. WAGNER.

RAILWAY SIGNALING SYSTEM.

APPLICATION FILED FEB. 4, 1908.

1,264,720.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 2.

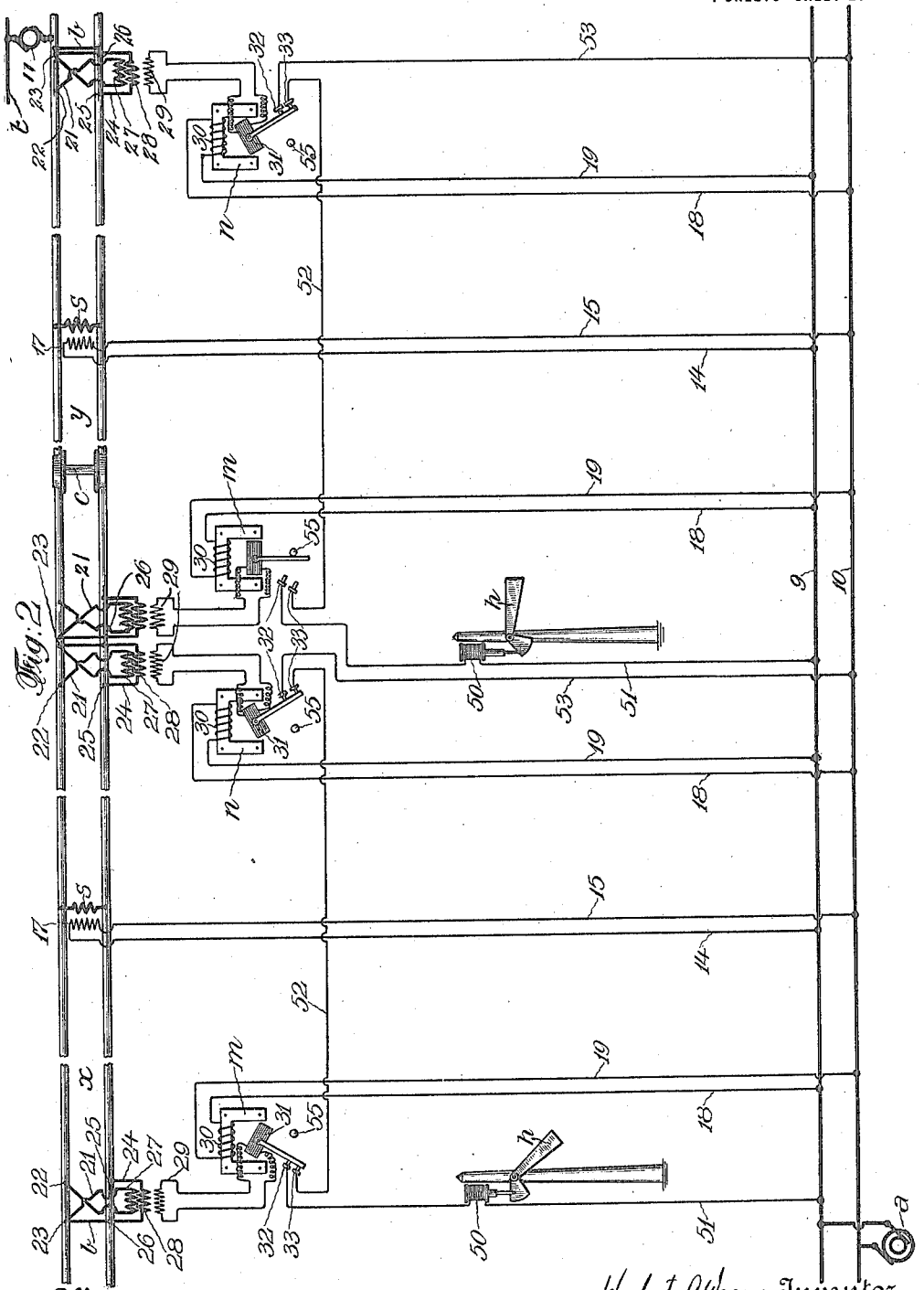


Fig. 2.

Witnesses:
John O. Gempler
Edm. Harris.

Hubert A. Wagner Inventor
By his Attorneys Kenyon & Kenyon

H. A. WAGNER.

RAILWAY SIGNALING SYSTEM.

APPLICATION FILED FEB. 4, 1908.

1,264,720.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 3.

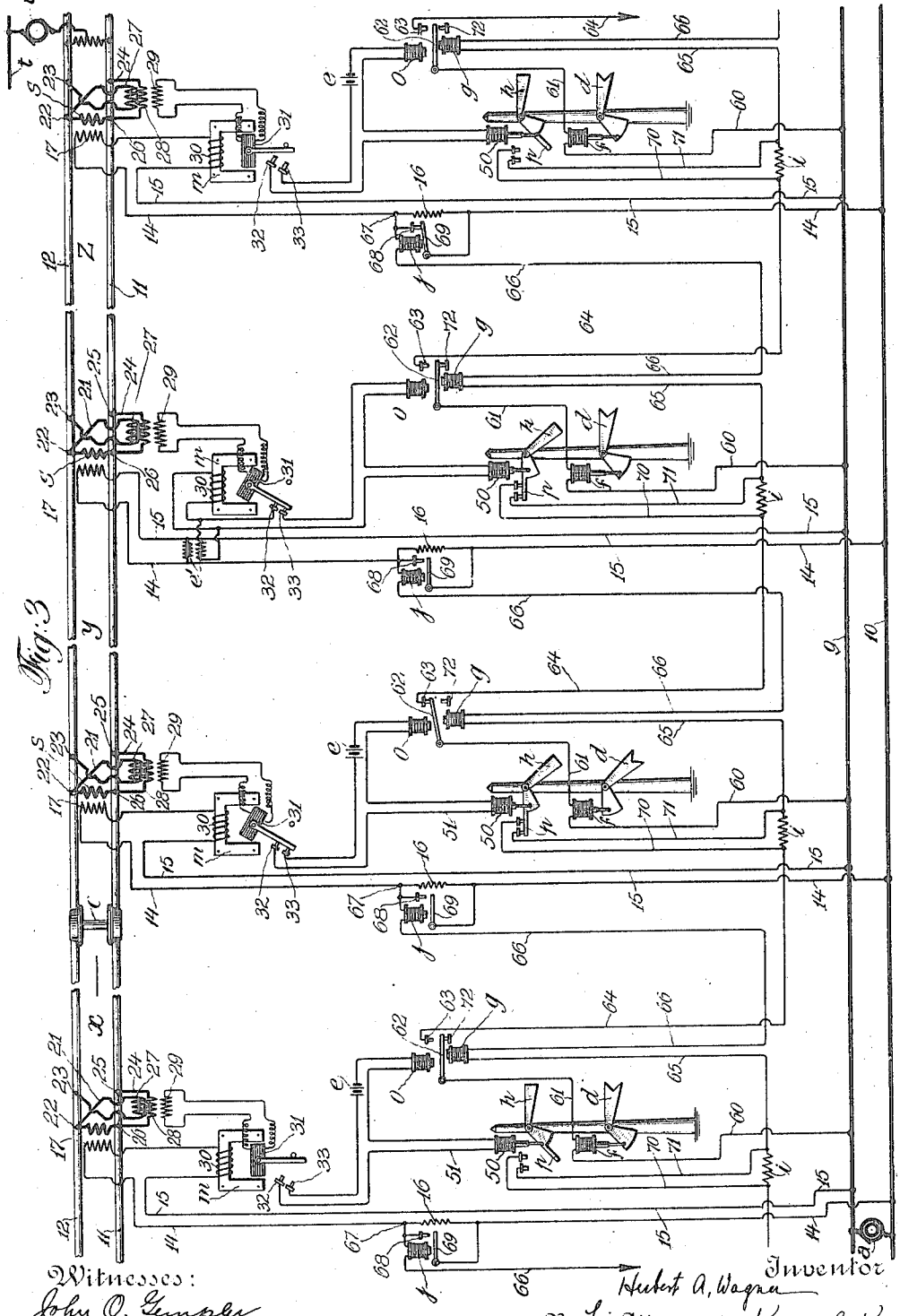


Fig. 3.

Witnesses:
John O. Gempler
Geo. H. Harris.

Inventor
Hubert A. Wagner
By his Attorneys
Kenyon & Kenyon

H. A. WAGNER.

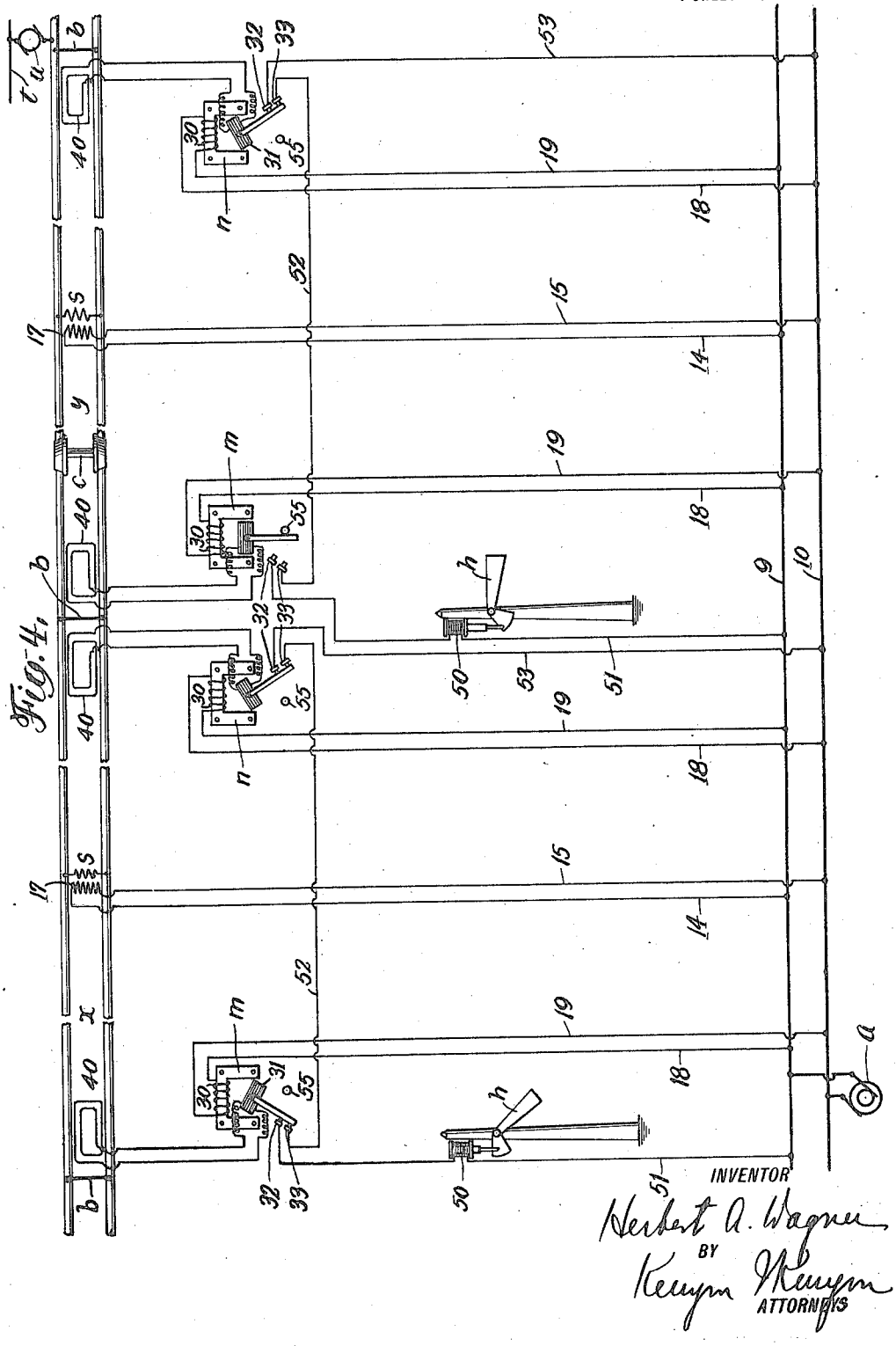
RAILWAY SIGNALING SYSTEM.

APPLICATION FILED FEB. 4, 1908.

1,264,720.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 4.



INVENTOR

Herbert A. Wagner

BY

Kenyon & Kenyon

ATTORNEYS

UNITED STATES PATENT OFFICE.

HERBERT A. WAGNER, OF SHORT HILLS, NEW JERSEY.

RAILWAY SIGNALING SYSTEM.

1,264,720. Specification of Letters Patent. Patented Apr. 30, 1918.

Application filed February 4, 1908. Serial No. 414,171.

To all whom it may concern:

Be it known that I, HERBERT A. WAGNER, a citizen of the United States, residing in Short Hills, in the county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Railway Signaling Systems, of which the following is a specification.

My invention relates to electric signaling systems for railroads and is especially adaptable for use with railroads employing electric traction, although the system is not necessarily limited to such use.

The object of my invention is, generally speaking, to provide an efficient, economical and reliable system which may be utilized in connection with the movable arms or semaphores of a railway block signal system, such arms and semaphores being automatically operated to advise the engineer as to the condition of the track in the block or blocks which he is approaching. In making use of the terms signal and signaling system I do not intend to suggest that my invention is limited to this particular type of system but wish it to be understood that by such terms, which I have for purposes of simplicity used throughout this specification and throughout the claims, I include systems in which the automatic devices may operate alarms or set switches or act upon a train circuit or act upon any other apparatus in such a way as to automatically give warning to an operator or train device to control the operation of the cars.

One feature of my invention relates to an arrangement and construction of track circuits, sources of signal current supplying the track circuits and relays or electro-responsive devices governing the signals whereby the relay will be operated responsively to current conditions in a track circuit completed independently of the relay, and whereby a current flow in such track circuit in one direction (or from a source at one side of the relay) will operate the relay in one direction to cause the relay to close a signal circuit, whereas a current in said track circuit in the opposite direction (or from a source at the other side of the relay) will act oppositely upon the relay to open the signal circuit, tending to move the relay contact fingers to the same position that they are moved by gravity or spring when there is no relay operating current. With this arrangement I am enabled to produce either a normally open circuit system for normal danger signals without the special devices usual to a normal danger system, or I can provide a system having normally closed rail and signal circuits with signals normally clear and this system may be changed, if desired, to normal danger in the usual way. In the latter case the track circuit, which is independent of the relay coils, is completed by a bond connecting the opposite rails of the track at the end of a block or section, while the relay is operated by being so related to some portion of the rail circuit that it receives a current responsive to and determined by the current flowing in the rail circuit. This current, so long as the bonds are effective, will always flow in the same direction (being dependent upon one source of supply and governed solely by conditions obtaining in that block or section). But in case of a broken bond, the direction of current flow would be dependent also upon conditions existing in the adjoining block and the system would be put into an unsafe condition. Currents that would be established at times in the rail circuit from a source in the adjoining block or section would be in a direction opposite to that which would normally flow through the rails from the first and proper source. The feature of my invention above referred to causes such a reverse current to cooperate with gravity (or the retractile force) to so move the relay arm as to place the signal at danger.

Another feature of my invention involves a normally open rail circuit, an arrangement of signaling current sources supplying the rails of the track and relays operated responsively to a current flow in the rails by which signals standing normally at danger are cleared by an approaching train. This train by completing a circuit from the source of signal current next in advance of the train, lowers the electro-motive-force applied by that source to the rails and permits a current to flow from the next source of signal current forward of the first mentioned source through the rails and through the wheels and axles of the approaching

train or car, the relays being such that this particular direction of current flow in the rails from the second source, but not from the first, will cause the signal ahead of the train to clear.

My invention also involves novel features relating to the operation of home and distant signals in a system of the general character of that set forth in the last paragraph. This feature of my invention involves means whereby the approaching train in clearing the home signal immediately in advance of the train, also clears the home signal of the next block in advance, provided the track protected by that signal is clear, this being accomplished by raising the electro-motive-force of the signal current source located next forward of the last mentioned home signal so that current caused by this abnormally increased electro-motive-force will flow toward the train (completing the circuit through the wheels and axles of the train) and actuate the relay of this said last home signal to clear the same. The clearing of this home signal also clears its distant signal immediately in advance of the train, as will hereinafter appear.

My invention also involves more specific features relating to the construction, combination and arrangement of the system as will hereinafter appear, including means for preventing the approaching train from clearing more than two home signals ahead of it.

I have referred, and will refer, throughout the specification and claims for purposes of simplicity, to the signal controlling circuit as being a track or rail circuit made up of the rails of the track and controlled by the axles and wheels of a car or train. It will be understood that I have used this term because the rails and the wheels and axles of the train are at the present time generally used for this broad purpose and it is usually desirable to avoid extra conductors and circuit closers, while, moreover, my system is such as to permit of the use of the rails both for the signaling current and as the return for traction current. It is to be understood, however, that my broad invention might be embodied without resorting to these specific conductors and bridging devices as the controlling means.

Figure 1 shows in diagram one embodiment of my invention, with home signals only.

Fig. 2 is a similar diagram showing another embodiment of the invention.

Fig. 3 is a diagram showing the control of both home and distant signals in accordance with my invention.

Fig. 4 is a diagram similar to Fig. 2 but showing how certain features of my invention may be employed in connection with a system wherein the energy for operating the signal controlling relays is obtained by induction from the track circuit.

In Fig. 1 the track consists of two parallel, electrically continuous lines of rails 11 and 12; along the track are a series of signal spaces or block sections, each section having a signal *h*. The sections are provided each with a source of alternating current all of substantially identical characteristics and so connected with the rails 11, 12, that a condition of no effective current flow exists, normally, in the sections between the successive points of connection, that is, the rails are normally on open circuit. As shown, these separate sources each consists of a coil *s* having its terminals connected respectively to the rails 11 and 12. In inductive relation to each coil *s* is a coil 17 in circuit with an alternating current generator *a*. A resistance or impedance 16 is in series with each coil 17, and this gives the source a markedly drooping characteristic. The signal operating relay magnets *m* each have a coil 30 in a branch 18, 19, from the circuit 9, 10. The movable member of each of said relays comprises a coil 31 supplied by a coil 29 which is in inductive relation to the coil sections 27, 28, connected in shunt respectively to portions of the rails 11, 12. The object of dividing this coil into two sections 27, 28, is to prevent magnetization by the propulsion current in the rails 11, 12, which is assumed to be a current flowing in the same direction in both parallel rails. The primary section 28 is connected by conductor 24 to the points 25, 26, in the rail 11 and the primary section 27 is connected by the conductor 21 with points 22, 23, in the rail 12; the latter connection is reversed with respect to the former and the impedances of the coils 27, 28, and their conductors 21 and 24 are so arranged that a definite portion of the current is shunted from the rails 11, 12, respectively, and the effect of the propulsion current is neutral. The contact finger of the relay *m* engages fixed contacts 32, 33, to close a branch signaling circuit including the conductors 15, 51, and the signal operating mechanism 50.

Normally there is no effective current in the rails 11, 12, between successive sources of alternating current, for there is no path for current flow. The sources being like sources connected in parallel, neither can form a path for a flow of current from the other. Normally, therefore, there is no current in the coil 31 of the relay, so that the relay is in a gravity position, in which the signaling circuit including the mechanism 50 is open, and the signal stands at danger.

When a car *c* approaches the point of connection of a source of alternating current *s*, it short-circuits said source and substantially lowers its electro-motive-force (the coils 16 being provided as one way to give

the source *s* a drooping characteristic) so that current from the next source in advance flows through the coils 27, 28 which are between the two said sources. This is effective to induce current in the coil 29 and from it to the armature coil 31 of signal operating relay *m*. The relay is so designed that a current in this direction in the coil 31 causes the coil to shift its position in the magnetic field embracing it, and by its contact arm to complete the signal circuit at 32, 33, so that the home signal *h* is drawn to its clear position. When the car *c* is between two signaling current sources it closes two rail circuits, one through each source and the car wheels and axles. The car *c* thus forms the dividing line between these two rail circuits and this dividing line travels with the car *c*. When the car *c* passes the point of connection of the electro-responsive signal-controlling coil 27, 28, it carries with it the dividing line between two rail circuits formed by its presence and the said coil is electrically transferred from one rail circuit t othe other, and as the currents in these two rail circuits flow in opposite directions the current is reversed in direction through coils 27, 28 and therefore through the relay. This reversed current causes a negative movement of the relay coil 31, the signal circuit is opened and the signal *h* resumes the danger position. If danger conditions exist in advance of the car, in the block or in the early part of the next block beyond, the current from the source in advance is shunted or its electro-motive-force is lowered so that current will not flow from it to actuate the relay and clear the signal. The signal will, therefore, maintain its danger position. It will be seen from the foreging description that each relay is operatively responsive only to a current flow from a source or sources forward of the relay and is inoperatively or negatively responsive to any current flow from any source in the rear of the relay.

Referring to Fig. 2, in which certain features of my invention are shown in modified form, the main signaling circuit is shown provided with additional means for normally dividing it into signaling blocks or sections; these consist of the bonds *b* of conducting material with opposite ends connected to the opposite rails. These bonds are of practically negligible resistance or impedance. Each source *s* of alternating current is here placed substantially in the middle of the block, and these bonds *b* are placed substantially at the ends of the block. The home signal operating mechanism 50 is in a circuit 51, 52, 53 and there are two controlling relays *m* and *n* for each signal. The stationary coils of the relays *m* and *n* are each connected by conductors 18, 19, with the alternating current circuit 9, 10. The movable coil 31 of each relay is operatively related to the rails precisely as in Fig. 1. The rail circuit is normally closed and has normally an effective current flow due to the presence of the bond *b*. When a car *c* enters a signal section it shunts the bond and the portions of rails between its wheels and the bond, and deprives the primary coil sections 27, 28, of current and the relay *m* opens the normally closed signaling circuit 51, 52, and sets the signal at danger. Where the main circuit is arranged as shown in Fig. 2 it is necessary to employ two relays *m* and *n* for each signal section. Whatever the position of the car or train in the block, it will act upon at least one of the two relays that control the signal for that block, to open the signaling circuit for that block and set the signal to danger. As the car *c* leaves a block, under normal conditions, the relays of that section *m* and *n* close the signaling circuit 51, 52, and the signal assumes its normal clear position.

It will be noted that this system as shown in Fig. 2 is a normal safety or normal clear system and that there are normally closed signaling circuits and normally closed rail circuits, whereas the arrangement of Fig. 1 is a normal danger system and the signaling circuits and rail circuits are all normally open. In case, however, one of the bonds *b* of Fig. 2 should break, unsafe conditions would arise if the relays were such as to operate to close the circuit regardless of the direction of the signaling current in the track rails. By my invention, however, if a bond is broken that part of the system becomes a normal danger system. A car approaching the signal at the broken bond will clear the signal by reason of current flowing from the signaling current source in the block guarded by the signal, to the car wheels. When the car passes the signal the signal relay responds negatively to current flowing to the car from the next source in the rear and the signaling circuit is opened and the signal goes to danger. The system shown in Fig. 4 is like that of Fig. 2 in construction and operation except that the movable coils 31 of the relays *m* and *n* receive their current from coils 40 which are in inductive relation to a short length of track, instead of from coils 29 in inductive relation to coils 27 and 28 arranged in shunt to a short length of track.

In the system shown in Fig. 3 the rail circuit and main signal circuit arrangement is the same as shown in Fig. 1, but novel means for controlling the distant signal are also included.

Here there are three signal blocks or sections *x*, *y*, and *z*. A car or vehicle *c* is shown approaching the end of section *x* moving in the direction of the arrow. At

or about this point which is assumed to be at a proper clearing distance to the rear of the section x, the presence of car c should cause the home signal h of section y and the distant signal d on the same pole to show respectively the condition of section y and of the home signal at the entrance of the next section in advance, section z, and this latter home signal should at this time indicate the condition of the section which it guards. When car c arrives at the point shown it reduces the potential of the source s at the entrance of section y and current from the source s at the opposite end of section y flows through coils 27, 28 at the entrance of that section and reverses the normal position of the movable member 31 of relay m thus closing local circuit 51 with its source of current e at the points 32, 33. The signal actuating mechanism 50 draws signal h at the entrance of section y to the clear position shown and at the same time a magnet o is energized and attracts its armature 62 and thus closes the distant signal circuit at 63. This distant signal circuit may be traced from conductor 9 via the conductor 60 at the entrance of block y, magnet f, conductor 61, circuit breaker 62, 63, conductor 64, resistance or impedance i, (circuit breaker p, operated by home signal h, at the entrance of section z, being open) conductor 65, magnet g conductor 66, magnet j, at the exit of block z, to point 67, where it joins circuit 14 at a point between resistance or impedance 16 and coil 17; the distant signal circuit is completed through conductor 14 to conductor 10. This completion of the distant signal circuit does not, however, at this stage, clear the distant signal for the resistance i prevents the passage of sufficient current to operate the distant signal actuating mechanism. The armature 69 of magnet j and the contact stop 68 are connected to the terminals of resistance 16 and when magnet j is energized resistance 16 is short circuited, so that when relay m at the entrance of section y energizes magnet o and closes the distant signal circuit at 62, 63, as described, magnet j at the exit end of block z is also energized and short circuits resistance 16. The shunting of resistance 16 from this signaling circuit increases the potential at the terminals of the coil 17 of the source s at the exit end of signal section z. This increase of potential causes an effective current to flow from the last named source s through the rails to and through coils 27 and 28 at the entrance of section z in the same direction that it would flow if a car was on the clearing portion of section y. This effective current induces a current in the movable member 31 of relay m at the entrance end of section z in a suitable direction to cause it to close the circuit and clear the home signal h guarding section z. When the home signal h is thus shifted to clear, the circuit closer p short circuits resistance or impedance i through the conductors 70, 71. Resistance i is thus shunted from the circuit of the distant signal d of section y. This shunting of resistance i so far increases the strength of current in the said circuit that the signal actuating mechanism f at the entrance to section y is sufficiently energized to clear distant signal d at the entrance of block y.

Thus the car in block x clears the home signal of block y, provided block y is clear, by lowering the electro-motive-force of the source s at the entrance to block y; and also clears the home signal at the entrance of block z (provided block z is clear) by raising the electro-motive-force of the source s at the exit end of block z. The clearing of the home signal at the entrance to block z, and the consequent short-circuiting of resistance i in block y, clears the distant signal at the entrance of block y.

The function of magnet g is to prevent the clearing of any home signals by the approaching train except the two immediately in advance of the train. Thus the movement of the relay armature 31, at the entrance of block y clears the home signal h at that point and also closes the distant signal circuit at 62, because the current in magnet o is effective, whereas the opposing magnet g is without current, as it is a part of the distant signal circuit extending forward from block x, which circuit is open at 62 in that block by reason of the fact that there is no current in the coil o of block x. On the other hand when, through the distant signal circuit, the relay at the entrance to block z has moved to close its circuit, the next distant signal circuit is not closed because the force of magnet o of block z is opposed by the force of magnet g in that block, the latter magnet being energized by the current in the active distant signal circuit.

In Fig. 3, the source of current for the local circuit of the magnet 50 operating the home signal h is shown as a generator e in the form of a primary battery, or as a generator e' in the form of a transformer acting inductively from the supply circuit 14, 15. Where the car c has been referred to it is to be understood that a train or vehicle of any description is included. The sources may be independent generators of alternating currents having the same phase and frequency, or they may be transforming devices supplied from one or more generators. A car at the extreme left in Fig. 3 approaching section x while a car c, is on that section is unable to shift the signal h to clear because car c short circuits the track and prevents an effective current flow from the source in advance of the signal to that portion of the track to which the relay for

the said signal normally responds to clear the signal. Wherever in the specification and claims I have referred to, or mentioned a track-relay or a coil as being in shunt to a short length of rail, it is to be understood that the relay or coil, and the short length of rail are to be of such relative impedance as to produce a substantial working current in the relay or coil.

In Figs. 2, 3 and 4 there is shown a trolley wire *t* and a current generator *u* for traction power. The rails 11, 12 are the return conductors for the traction current.

I have described various specific embodiments of my invention in some detail but I desire it to be understood that my invention is broader than such details, and is not limited to any particular embodiment, nor to any mere details of construction or arrangement.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent, is:—

1. In a railway signaling system, a track with electrically continuous rails, two sources of signal controlling current feeding the same, a coil, means for completing, independently of said coil, a rail circuit supplied by each of said sources, signal controlling apparatus arranged to be actuated in response to current in said coil and in a direction dependent upon the direction of current in said coil, and means for supplying to said coil a current that, in direction and intensity, is determined by the current in a portion of a rail between the points at which said sources feed the track.

2. In a railway signaling system, a track, two like sources of signal controlling current with like poles connected to like rails of the track, a coil, signal controlling apparatus arranged to be actuated in response to the current in said coil and in a direction dependent upon the direction of current in said coil, means for completing independently of said coil a track circuit and for supplying a current to said coil corresponding in direction and intensity to the current in a given portion of the track between the points at which said sources feed the track.

3. In a railway signaling system, a track having electrically continuous rails, two like sources of signal controlling current in similar operative relation to said track, a coil, signal controlling apparatus arranged to be actuated in response to the current in said coil and in a direction dependent upon the direction of current in said coil, means for completing, independently of said coil, a rail circuit and for supplying a current to said coil corresponding in direction and intensity to the current in a given portion of a rail between the points at which said sources feed the track.

4. In a railway signaling system, a signal, a coil, means acted upon by said coil to shift said signal to danger only when the current in said coil is in one given direction, signal controlling current sources in operative relation to a continuous length of track rail, and means for supplying current to said coil corresponding in direction and intensity to current in a portion of the track between said sources.

5. In a railway system, an electrically continuous track, a source of traction current with one pole connected to both rails of the track, sources of signal controlling current of a different character from the traction current connected across the track at intervals, coils each arranged to receive a current responsive in direction and intensity to the current from a signal controlling source in a portion of the track between two of said sources, and signal controlling apparatus operated responsively to signal controlling current in said coils in a direction dependent upon the relative direction of the current in said coils.

6. In a railway signaling system, a plurality of sources of signaling current, each having a markedly drooping characteristic, a pair of continuous rails extending between said sources and connected to like poles thereof, but otherwise normally insulated from each other, a plurality of signals, signal controlling apparatus for each of the same, and means for actuating the signal controlling apparatus to clear the signal when current is passing through a portion of the track from a source forward of the signal.

7. In a railway signaling system, a plurality of sources of signaling current each having a markedly drooping characteristic, a pair of continuous rails extending between said sources and connected to like poles thereof, but otherwise normally insulated from each other, a plurality of signals, signal controlling apparatus for each of the same, and means for actuating the signal controlling apparatus in one direction or the other according to the relative direction of a current in a given portion of the track.

8. In a railway signaling system, a plurality of signals normally at danger position, a plurality of sources of signal controlling current, a normally open continuous track circuit connected to said sources and arranged to be closed through the car or train, electro-responsive apparatus for each signal adapted to clear the same, and means for energizing the same determined by current flow through a given portion of the track from a source in advance of a car or train to and through said car or train.

9. In a railway signaling system, a plurality of signals normally at danger, an electrically continuous track and sources of supply therefor, the opposite rails of the track being normally unconnected except by said

sources, and means for each signal acting to clear the same when a current is established in a given relative direction through a given portion of the track.

10. In a railway signaling system, the signals, sources of supply connected to a continuous track circuit normally open, and means for clearing each signal when current flows through the rails in a given portion of the track from a source forward of said portion to and through said car or train.

11. In a railway signaling system, signals having a normal bias toward danger position, electro-responsive devices therefor adapted to move the signals to clear position, relays in the circuits thereof, an electrically continuous track, sources of signal controlling current supplying said track, and means for actuating each relay to close its signal circuit only when signal controlling current from points forward of a given portion of the track traverses said portion.

12. In a railway signaling system, signals having a normal bias toward danger position, electro-responsive devices therefor adapted to move the signal to clear position, relays in the circuits thereof, an electrically continuous track, sources of signal controlling current supplying said track, and means for causing signaling current traversing a given portion of the track from a source or sources at one side of said portion to actuate a corresponding relay to clear the signal and for causing signaling current traversing said portion from a source or sources at the other side thereof to tend to actuate the relay in the opposite direction.

13. In a railway signaling system, an electrically continuous track, a plurality of sources of signal controlling current connected to said track, said track and sources being arranged so that the track circuits are completed through the car or train, signals, and means for successively controlling the same by currents flowing through the train from a point or points ahead of the train.

14. In a railway signaling system, an electrically continuous track, a plurality of sources of signal controlling current connected to said track, said track and sources being arranged so that the track circuits are completed through the car or train, signals normally at danger position, and means for shifting the same to clear position, said means being responsive to currents flowing through the train from a point or points ahead of the train.

15. In a railway signaling system, an electrically continuous track, a plurality of sources of signal controlling current connected to said track, said track and sources being arranged so that the track circuits are completed through the car or train, signals normally at danger position, and means for shifting the same to clear position, said means being responsive to current flowing through the train from a point or points ahead of the train and for maintaining each of them at danger position when no current is traversing a given portion of the track or when current is traversing said portion to a train ahead thereof.

16. In a railway signaling system, a signal, an electrically continuous track, two similar sources of signaling current supply connected to the rails of the track on normally open circuit, each source having a drooping characteristic and one of said sources being forward of the signal, means actuated by a flow of current from the latter source through a portion of the track intermediate the two sources, for actuating said signal.

17. In a railway signaling system, a source of signaling current, a track circuit therefor comprising the rails and the car or train, and an electro-responsive device supplied by current inductively from said circuit and actuated responsively to current flow therein.

18. In a railway signaling system, an electrically continuous track, sources of supply for the same, and electro-responsive devices at intervals, means for moving each electro-responsive device to one position dependent upon a flow of current in a given portion of a track circuit completed by a car or train and supplied from a source at one side of said track portion, and means for moving each electro-responsive device to another position dependent upon either the absence of current in said track portion or upon a current therein completed by the car or train and supplied by a source at the other side of said track portion.

19. In a railway signaling system, a track, a source of signal controlling current in operative relation thereto, a coil in shunt to a short length of one of the rails, and an electro-responsive device in operative relation to said coil to receive a substantially working current therefrom.

20. In a railway signaling system, a track, a source of signal controlling current in operative relation thereto, a coil in shunt to a given portion of one of the rails, and an electro-responsive device in such operative relation to said coil as to be actuated in one direction or the other according to the presence of a current in said coil of a given relative direction or to either the presence of a current in said coil in the relatively opposite direction or an absence of current in said coil.

21. In a railway signaling system, a track, a source of signal controlling current in operative relation thereto, a coil in shunt to a given portion of one of the rails, and an electro-responsive device having relatively movable coils, one supplied by current of a fixed direction relative to said source, and the

other having a current corresponding in direction to that of the first mentioned coil.

22. In a railway signaling system, a track, a source of signal controlling current in operative relation therewith, a transformer having its primary composed of two windings each in shunt with a given portion of one of the rails of the track, and an electro-responsive device in operative relation to the secondary of said transformer.

23. In a railway signaling system, a track, a source of signal controlling current in operative relation therewith, a transformer having its primary composed of two windings each in shunt with a given portion of one of the rails of the track, said windings being oppositely connected to the respective rails, and an electro-responsive device in operative relation to the secondary of said transformer.

24. In a railway signaling system, a track, a source of signal controlling current in operative relation therewith, a transformer having its primary composed of two windings each in shunt with a given portion of one of the rails of the track, an electro-responsive device in operative relation to the secondary of said transformer, and a signal circuit controlled by said electro-responsive device.

25. In a railway signaling system, an electrically continuous track, three sources of current supplying the track at three points along the same, and means for causing an approaching train to lower the electromotive-force of the nearer source and raise the electromotive-force of the most distant source.

26. In a railway signaling system, an electrically continuous track, three sources of current each having a drooping characteristic supplying the track at three points along the same, and means for causing an approaching train to lower the electro-motive-force of the nearer source and raise the electro-motive-force of the most distant source.

27. In a railway signaling system, an electrically continuous track, three sources of current supplying the track at three points along the same, means for causing an approaching train to lower the electro-motive-force of the nearer source and thereby cause a current flow from the next source, an electro-responsive device actuated responsively to said current flow, and means actuated responsively to the actuation of the electro-responsive device for increasing the electro-motive-force of the most distant source.

28. In a railway signaling system, an electrically continuous track, three sources of current supplying the track at three points along the same, means for causing an approaching train to lower the electro-motive-force of the nearer source and thereby cause a current flow from the next source, an electro-responsive device actuated responsively to said current flow, means actuated responsively to the actuation of the electro-responsive device for increasing the electro-motive-force of the most distant source and thereby producing a current flow from the most distant source, an electro-responsive device actuated responsively to said current flow, a pair of signals, and means for operating them by the actuation respectively of said electro-responsive devices.

29. In a railway signaling system, an electrically continuous track, three sources of current supplying the track at three points along the same, means for causing an approaching train to lower the electro-motive-force of the nearer source and raise the electro-motive-force of the most distant source, signals, coils each arranged to receive a current flow responsive to the current flow in a given portion of the rail between a pair of sources, and electro-responsive devices each actuated by current flow in one of said coils and each controlling the movement of one of said signals.

30. In a railway signaling system, an electrically continuous track, sources of signal controlling current each having a drooping characteristic in operative relation to said track at intervals, said sources and track being arranged so that the rails are normally on open circuit, coils each arranged to receive a current determined in direction and intensity by the current in a portion of the rail between two of said sources, signals having a normal bias to danger position, electro-responsive devices each in operative relation to one of said coils and each adapted to actuate one of said signals to clear when current from a source forward of said coil is traversing the corresponding portion of the rail, and means actuated by one electro-responsive device for raising the electro-motive-force of the source forward of the next forward electro-responsive device.

31. In a railway signaling system, an electrically continuous track and sources of signal controlling current having a drooping characteristic in similar operative relation to the same at intervals, electro-responsive devices in operative relation to given portions of the rail between succeeding pairs of sources, means for causing the operation of one electro-responsive device to raise the electro-motive-force of a source forward of the next forward electro-responsive device, and means governed by the operation of the first electro-responsive device for preventing the operation of the next forward electro-responsive device from similarly raising the electro-motive-force of another source.

32. In a railway signaling system, an electrically continuous track and sources of signal controlling current having a drooping characteristic in similar operative relation

to the same at intervals, electro-responsive devices in operative relation to given portions of the rail between succeeding pairs of sources, means for causing the operation of one electro-responsive device to raise the electro-motive-force of a source forward of the next forward electro-responsive device, and means for permitting only one of any two successive electro-responsive devices to thus raise the electro-motive-force of a forward source.

33. In a railway signaling system, sources of signal controlling current at intervals, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, and means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source in advance of the train.

34. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, and means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source in advance of the train.

35. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source in advance of the train, and means controlled by the approaching train for raising the electro-motive-force of the third source in advance of the train.

36. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source in advance of the train, and means, controlled by the signal controlling means for causing a current flow to the train from the third source in advance of the train.

37. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source forward of the train, and means, controlled by the signal controlling means for raising the electro-motive-force of the third source forward of the train.

38. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source in advance of the train, means controlled by the signal controlling means for causing a current flow to the train from the third source in advance of the train, and means also controlled by the signal controlling means for preventing the next forward signal controlling means from similarly causing a current flow to the train from the fourth source in advance of the train.

39. In a railway signaling system, sources of signal controlling current at intervals, each source having a drooping characteristic, a continuous circuit in operative relation therewith and normally open but adapted to be completed through the train, normal danger signals, means for clearing each of the same, said means comprising apparatus governed by the flow of current to the train from a source forward of the train, means, controlled by the signal controlling means for raising the electro-motive-force of the third source forward of the train, and means also controlled by the signal controlling means for preventing the next forward signal controlling means from similarly raising the electro-motive-force of another source.

40. In a railway signaling system having blocks, a signal at the entrance of each block, a pair of continuous conductors, a source of signal controlling current in each block connected to the conductors which are normally on open circuit, means for causing circuits from said conductors to be closed by the car or train, and means in each block for actuating the signal for said block by current flowing through the conductors of the block to a car or train rearward of said block.

41. In a railway signaling system having blocks, a signal at the entrance of each block, a pair of continuous conductors, a source of signal controlling current in each block connected to the conductors which are normally on open circuit, means for causing circuits from said conductors to be closed by the car or train, and means in each block for actuating the signal for said block, said means being responsive to move said signal from its normal position only by current flowing

through the conductors of the block to a car or train rearward of said block.

42. In a railway signaling system having blocks, a signal at the entrance of each block, a pair of continuous conductors, a source of signal controlling current in each block connected to the conductors which are normally on open circuit, means for causing circuits from said conductors to be closed by the car or train, a relay for each block having relatively movable coöperating coils and controlling the actuation of the signal for said block, one of said coils having a fixed direction of current flow relative to said sources while the other is arranged to receive a current flow responsive in direction to the direction of current in the conductors of the block which its relay controls.

43. In a railway signaling system having blocks, a signal at the entrance of each block, a pair of continuous conductors, a source of signal controlling current having a drooping characteristic in each block connected to the conductors which are normally on open circuit, means for causing circuits from said conductors to be closed by the car or train, and means in each block for actuating the signal for said block by current flowing through the conductors of the block to a car or train rearward of said block.

44. In a railway signaling system having blocks, a home and distant signal guarding each block, a pair of continuous conductors, a source of signal controlling current in each block connected to the conductors which are normally on open circuit, means for closing the circuits of said conductors through the car or train, electro-responsive devices for each block governing the actuation of the home and distant signal respectively, a relay in each block arranged to control a local circuit controlling the home signal electro-responsive-device thereof and actuated responsively to a current flow through the conductors in the block in advance of the train in the circuit completed by said train, a separate circuit extending forward also controlled by said relay, and means in the latter circuit for causing a current flow to the train in the conductors of the block forward of the first mentioned block.

45. In a railway signaling system, a track with electrically continuous rails, a series of sources of signal controlling current feeding the same, means for establishing complete track circuits from each of said sources, a series of coils placed in such operative relation with the complete track circuits that the relative direction of the current in each coil varies according to whether the track circuit is supplied by a source at one or other side of a given portion of the track circuit, a series of signals, and means for affecting said signals responsively to the intensity and relative direction of current in said coils.

46. In a railway signaling system, a track with electrically continuous rails, a series of sources of signal controlling current feeding the same, means for establishing complete track circuits from each of said sources, a series of coils placed in such operative relation with the complete track circuits that the relative direction of the current in each coil varies according to whether the track circuit is supplied by a source at one or other side of a given portion of the track circuit, a series of signals, and means for clearing the signals only when current in the coils is in a given relative direction.

47. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, track relays each having two coöperating windings, one connected in shunt to a short length of rail and the other supplied with alternating current independently of the track circuits, the relative impedance of the shunt paths being such as to enable a substantial working current to be developed in the first mentioned winding, and signals controlled by said relays.

48. In a railway signaling system, a series of coils, a track with electrically continuous rails, a series of sources of signal controlling current feeding the same, and means for placing said coils in such operative relation with the rails and sources that the coils are normally without substantial current but receive energy from a source ahead or a source in rear according to the position of a moving train.

49. In a railway signaling system, a series of coils, a track with electrically continuous rails, a series of sources of signal controlling current feeding the same, means for placing said coils in such operative relation with the rails and sources that the coils are normally without substantial current but receive energy from a source ahead or a source in rear according to the position of a moving train, a series of signals, and means for affecting said signals responsively to the intensity and relative direction of current in said coils.

50. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, signaling devices for controlling the signals, each having two coöperating windings, one energized by connections in shunt to a short portion of the rail of a track circuit and the other supplied with alternating current independently of the track circuits, the rela-

tive impedance of the shunt paths being such as to enable an effective voltage to be applied to the signaling device, and signals controlled by said signaling devices.

51. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current connected across the rails at intervals, signaling devices for controlling the signals, each having two coöperating windings, one energized by connections in shunt to short lengths of rail and the other supplied with alternating current independently of the track circuits, the relative impedance of the shunt paths being such as to enable an effective voltage to be applied to the signaling device, and signals controlled by said signaling devices.

52. In a block signal system, in combination with an electric railway a track composed of two continuous rails, sources of alternating current connected across the rails at intervals, signaling devices for controlling the signals, each having two coöperating windings, one energized by connections in shunt to a short portion of the rail of a track circuit and the other supplied with alternating current independently of the track circuits, the relative impedance of the shunt paths being such as to enable an effective voltage to be applied to the signaling device, and signals controlled by said signaling devices.

53. In a block signal system, in combination with an electric railway a track composed of two continuous rails, sources of alternating current connected across the rails at intervals, signaling devices for controlling the signals, each having two cooperating windings, one energized by connections in shunt to short lengths of rail and the other supplied with alternating current independently of the track circuits, the relative impedance of the shunt paths being such as to enable an effective voltage to be applied to the signaling device, and signals controlled by said signaling devices.

54. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating-current connected across the rails at intervals, translating devices each having a member comprising a pair of coils connected in shunt respectively to two short lengths of rail approximately opposite each other in the track, the said lengths of rail being sufficient to provide the drop in voltage necessary to energize the translating device and signals controlled by said devices.

55. In a block signal system, in combination with a railway having both rails conductively continuous for all currents, sources of alternating-current connected across the rails at intervals, translating devices each having a member comprising a pair of coils connected in shunt respectively to two short lengths of rail approximately opposite each other in the track, said lengths of rail being sufficient to provide the drop in voltage necessary to energize the translating device, and each device having a winding supplied with current independently of the track circuits and coöperating with the said member to actuate the device and signals controlled by said devices.

56. In a block signal system, in combination with an electric railway having both rails conductively continuous for all currents, sources of alternating current, connected across the rails at intervals, bonds connected across the rails at points between said sources, translating devices, transformers each having a plurality of coils, one of the coils being connected to a translating device, another of the coils being connected in shunt to a short length of one track rail adjacent one of said bonds, another of said coils connected in shunt to a short length of the other track rail adjacent the same bond, the rail lengths alone being together sufficient to provide the necessary drop in potential for operating the translating devices, and signals controlled by said relays.

57. In an electric railway signal system, means to divide the railway into blocks, means to create a difference of potential between the rails of the railway within the blocks, means to utilize the difference of potential produced for governing a signal, said means comprising a plurality of relatively stationary coils in inductive relation to each other, one of said coils being connected directly to one rail, and another of said coils being connected directly to the other rail.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HERBERT A. WAGNER.

Witnesses:
RICHARD EYRE,
EDWIN SEGER.