No. 827,411. PATENTED JULY 31, 1906.

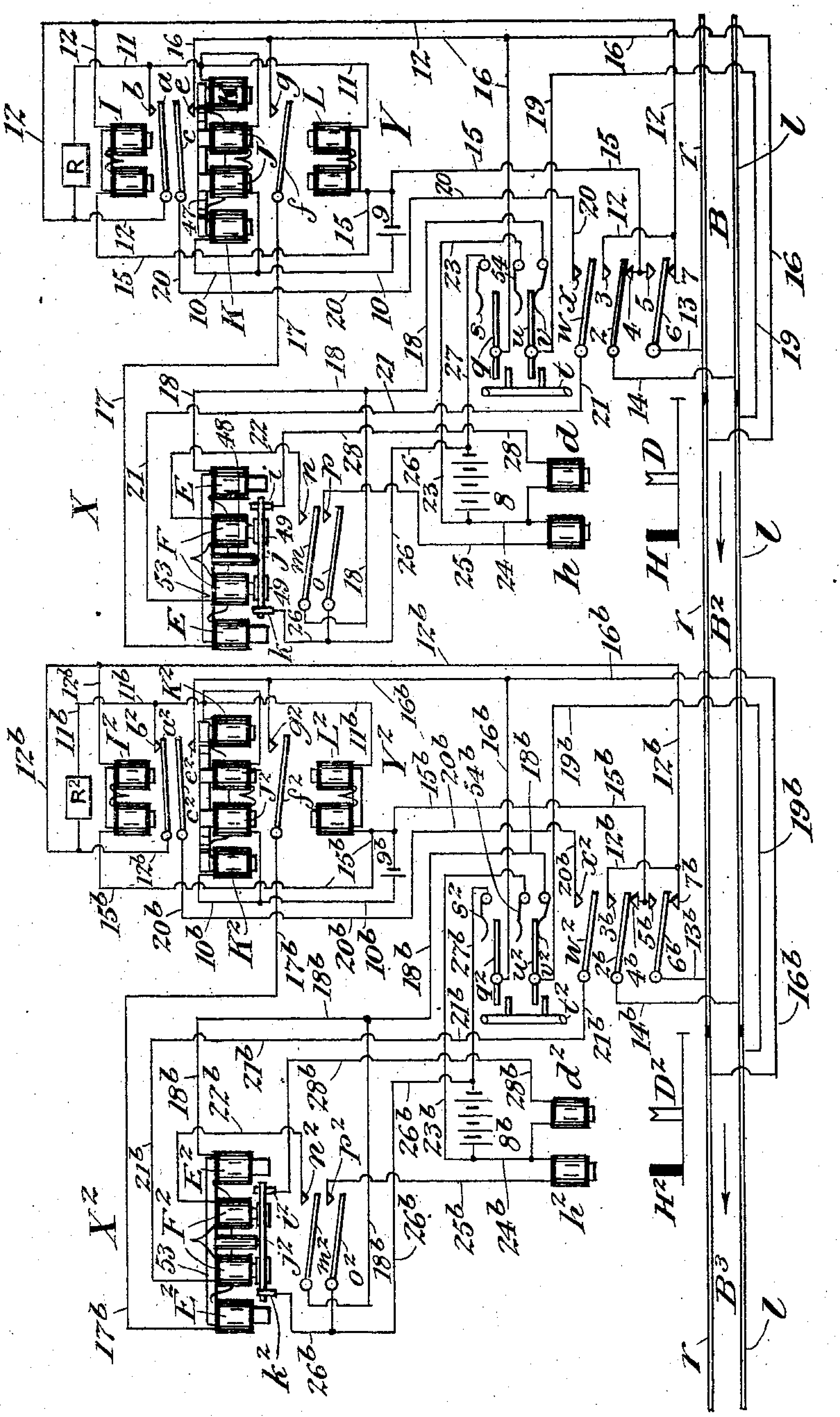
H. BEZER.

RAILWAY TRAFFIC CONTROLLING APPARATUS AND SYSTEM.

APPLICATION FILED JAN. 23, 1905.

2 SHEETS—SHEET 1.

Fig. 1



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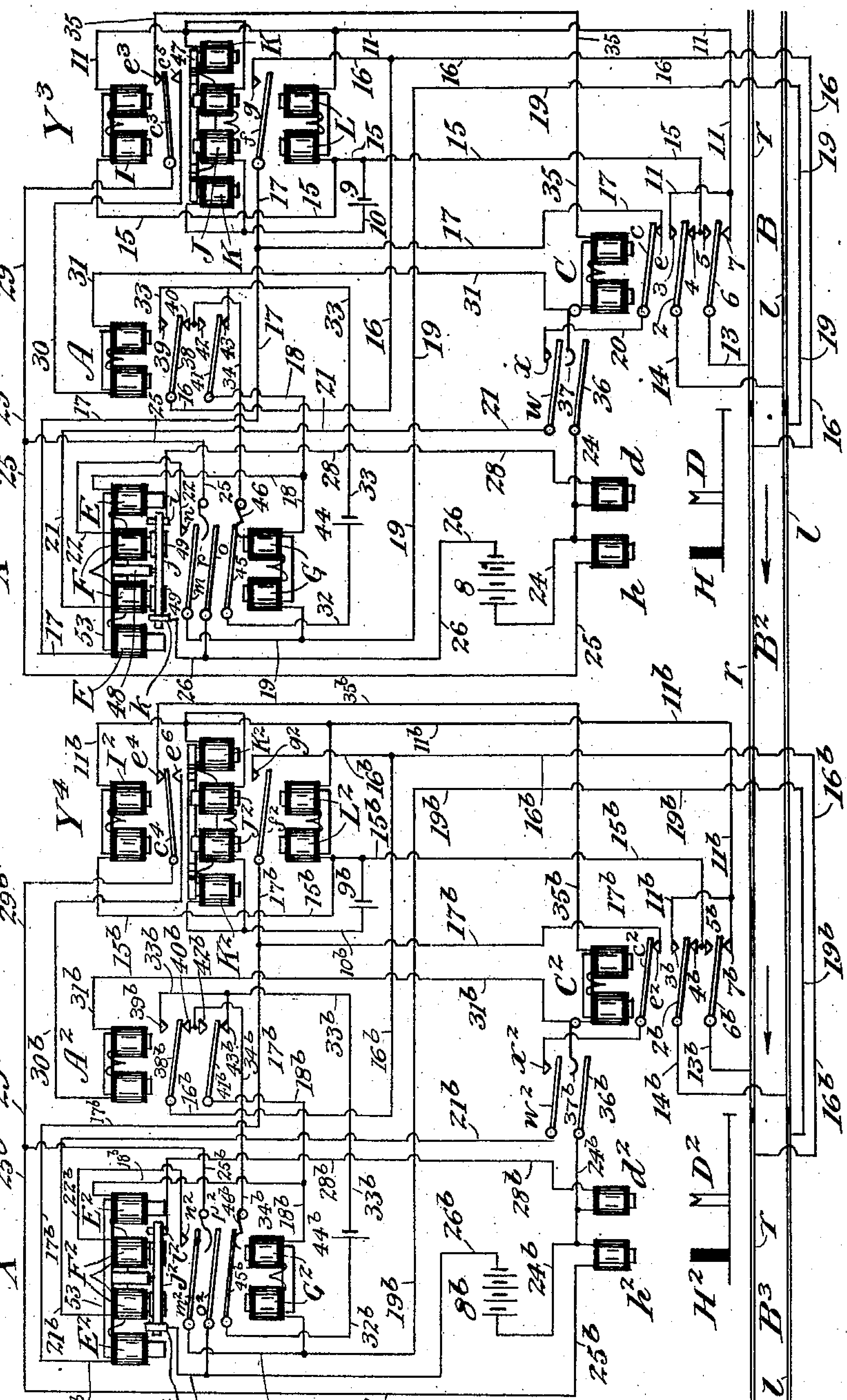

Fig. 2

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RAILWAY TRAFFIC-CONTROLLING APPARATUS AND SYSTEM.

No. 827,411. Specification of Letters Patent. Patented July 31, 1906.

Application filed January 23, 1905. Serial No. 242,303.

To all whom it may concern:

Be it known that I, Henry Bezer, a subject of the King of Great Britain, residing at Westfield, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Railway Traffic-Controlling Apparatus and Systems, of which the following is a specification, reference being had therein to the accompanying drawings, forming a part thereof.

My invention relates, broadly, to railway traffic-controlling apparatus and systems, and may be embodied in traffic-controlling apparatus and systems which control railway traffic upon a railway-line by the display of visual signals, as in the instance of railway block-signaling apparatus and systems, such as illustrated in the accompanying drawings, representing two embodiments of my invention.

With regard to certain particular embodiments of my invention and certain component features thereof my invention relates to normal blocking or normal danger railway traffic-controlling or railway signaling apparatus and systems which are maintained normally in blocking or danger condition effective to arrest the movement of trains or railway-vehicles—for instance, in the case of a visual-signal system by the display of one or more danger or blocking indications.

Also certain embodiments and certain features of my invention relate particularly to that class of railway traffic-controlling apparatus and systems which employ directional variations of controlling electric current in a controlling-circuit to govern and determine the condition or indication of the apparatus.

My invention also includes certain features relating particularly to that class of railway traffic-controlling apparatus and systems wherein variations in resistance or conductance of a controlling electric circuit are employed to actuate or govern actuation of the traffic-controlling apparatus.

Broadly set forth, the objects of my invention are reliability of operation to insure the safety of traffic upon the railway-line and economy and simplicity of construction and maintenance in the greatest degree compatible with such safety. For the attainment of these broad ends my invention is capable of embodiment in various forms of construction and arrangement of its component elements and comprehends many particular features and many objects subservient to the foregoing broad ends, but capable of more particular designation, and all these features and objects appear in the light of the particular description of those two embodiments of my invention which are illustrated in the accompanying drawings, although I will at this point separately mention various but not all of these particular objects and features.

In its application to home and distant railway block-signaling systems or apparatus responsive to and controlled by directional variation of controlling-current in a signal-controlling circuit it is one object of my invention to maintain the signaling apparatus in normal danger or normal blocking portion or condition, this being much safer practice than the normal clear or unblocking condition in which such home and distant directionally-responsive signals have heretofore been maintained. To this end my invention comprehends the combination of a railway signaling or signal-controlling circuit which will generally be controlled automatically by the presence of railway-vehicles upon the railway-line, a suitable source of reversible signal-controlling current for the signaling-circuit, a railway signaling apparatus responsive to directional variation of signaling-current and controllable by the signaling-circuit to give both home and distant signal indications, and means—such, for instance, as another signal-controlling circuit—governable by approach of a railway train or vehicle for maintaining the signaling apparatus normally in its danger condition to arrest traffic and for clearing the signals as the train or railway-vehicle approaches them—in other words, the combination of a signal-controlling circuit including a source of reversible signaling-current and normal danger home and distant electrically-controllable directionally-responsive railway signaling apparatus subject to control of the signaling-circuit.

In its adaptation to railway traffic-controlling systems wherein certain apparatus is controlled by conductance or resistance variations in an electric traffic-controlling circuit my invention has the further object of compensating or counteracting the effects of such conductance or resistance variations upon certain other apparatus of the system also subject to the influence of the traffic-controlling circuit, but required to be non-responsive to such variations. To this end my invention comprehends the combination of a railway traffic-controlling electric circuit of variable conductance or resistance, a railway traffic-controlling apparatus controllable by such traffic-controlling circuit and responsive to variations in its conductance or resistance, another railway traffic-controlling apparatus also controllable by the traffic-controlling circuit and responsive to traffic-controlling current therein, and means for effecting the conductance or resistance variations required to actuate the first traffic-controlling apparatus and for compensating the effects of such conductance or resistance variations upon the second traffic-controlling apparatus. The illustrated embodiments of the foregoing feature of my invention consist in a railway traffic-controlling system including a railway traffic-controlling apparatus located at a given traffic-controlling point in proximity to a railway-line, a traffic-controlling electric circuit in control of the traffic-controlling apparatus and in these particular instances including the traffic-rails of the railway-line, and another or second traffic-controlling apparatus located at another traffic-controlling point in proximity to the railway-line and comprising two traffic-controlling electrotranslative conductors—that is to say, conductors adapted to respond to a traffic-controlling current or current impulse from the traffic-controlling circuit, so as to give rise to another impulse of energy, such as another current impulse or a mechanical movement for controlling or actuating the traffic-controlling apparatus—and means for including a given one of the traffic-controlling electrotranslative conductors in the traffic-controlling circuit after the other traffic-controlling conductor has been included therein, such given electrotranslative conductor last introduced into circuit being adapted by such introduction to vary the conductance or resistance of the traffic-controlling circuit, so as to actuate the first traffic-controlling apparatus, and such given conductance-varying electrotranslative conductor also being coöperative with the other traffic-controlling electrotranslative conductor to compensate or counteract the effects thereon of current perturbation due to such conductance variation, so that the first traffic-controlling apparatus may be controlled and actuated without affecting the second traffic-controlling apparatus.

In its adaptation to that class of railway traffic-controlling systems wherein an electric traffic-controlling circuit is employed to control traffic-controlling apparatus at two traffic-controlling points in proximity to the railway-line and wherein one or more electrotranslative conductors are introduced into the traffic-controlling circuit at one of the traffic-controlling points in order to vary the conductance or resistance of such circuit, so as to actuate the traffic-controlling apparatus at the other point, a further object of my invention is to utilize such an electrotranslative conductor not only as a means for varying the conductance or resistance of the traffic-controlling circuit, so as to actuate the traffic-controlling apparatus at the other traffic-controlling point, but also to utilize such an electrotranslative conductor for responsiveness to directional variation of traffic-controlling current in the traffic-controlling circuit in order to control the traffic-controlling apparatus at the point where such translative conductor is located. To this end my invention comprehends the combination of a railway traffic-controlling apparatus located at a given traffic-controlling point in proximity to a railway-line and connected with a traffic-controlling electric circuit and responsive to conductance or resistance variation therein, a second railway traffic-controlling apparatus located at a second traffic-controlling point in proximity to the railway-line and including an electrotranslative conductor responsive to directional variation of traffic-controlling current and arranged in controlling relation to such second apparatus and means for connecting such electrotranslative conductor in the traffic-controlling circuit so as to vary its conductance or resistance and actuate the first-mentioned traffic-controlling apparatus.

In its application to railway traffic-controlling systems wherein railway traffic-controlling apparatus is controlled by conductance variation in a traffic-controlling electric circuit it is a further object of my invention to compensate the variation in influence of an electrotranslative conductor or magnet due to an operation of the traffic-controlling apparatus effected by response of such electrotranslative conductor to a given conductance variation in the traffic-controlling circuit. For instance, the illustrated embodiments of my invention employ a traffic-controlling electrotranslative magnet in connection with the traffic-controlling circuit and responsive to a conductance variation in such circuit, so as to move its armature, thereby varying the air-gap between such magnet and armature so as to vary the influence of the magnet on the armature with a given strength of current, and hence require an inverse conductance variation greater than the initial conductance variation in order to return the armature to its initial position, and it is therefore necessary to compensate the variation in the influence of the electrotranslative magnet due to movement of its armature in order that the same may be returned to initial position. In the illustrated embodiments of my invention this variation in the influence of the magnet, due to movement of its armature, is compensated by a compensative conductance variation in the traffic-controlling circuit which is inverse to the actuative conductance variation producing such armature movement, so that the compensative inverse conductance variation, together with another conductance variation which is inverse and, if desired, equal to the first actuative conductance variation, will aggregate an inverse conductance variation which exceeds the first actuative conductance variation in a degree sufficient to effect retractive movement of the armature.

Those objects and features of my invention which have not been particularly and separately mentioned in the foregoing preamble will clearly appear in the light of the following more detailed description of my invention embodied in two railway traffic-controlling systems, which I have illustrated in the accompanying drawings.

The normal danger railway block-signaling system diagrammed in Figure 1 comprises normal danger railway signaling apparatus located in proximity to the adjacent ends of successive railway-blocks, and the diagram indicates three such railway-blocks (marked B, B^2, and B^3) in the order in which a railway-train passes through them. The adjacent ends of the rails of successive railway-blocks are insulated from each other in a well-known manner, as indicated. The normal danger signaling apparatus located in proximity to the advance end of the block B and the rear end of the next block in advance B^2 is characteristic of the apparatus similarly located throughout the system and may be taken as an example. Each such normal danger railway signaling apparatus comprises normal danger railway signaling means proper, such as the normal danger home-signal semaphore H and distant-signal semaphore D at the advance end of the block B.

As is well known in the art, each home-signal semaphore, such as H, indicates the condition of the railway-block immediately in advance thereof, and each distant-signal semaphore, such as D, indicates the condition of the railway-block second in advance thereof. Normally—that is to say, when no railway train or vehicle is passing through any railway-block affecting the signal-semaphores—the home-signal and distant-signal semaphores are in their danger positions—that is to say, their positions indicating the non-clear conditions of their respective railway-blocks. The home-signal and distant-signal semaphores, such as H and D, are controlled, respectively, by home and distant semaphore-actuating magnets, such as *h* and *d*, by means of any one of various forms of actuative mechanism well known to the signaling art and not shown in the diagram, such actuative mechanism being coöperative with the semaphore-actuating magnets and their signal-semaphores, so as to move the home-signal and distant-signal semaphores H and D to their clear positions when their respective semaphore-actuating magnets are energized and such mechanisms further coöperating to cause the home-signal and distant-signal semaphores to be moved by counterweights or other suitable means to their danger positions when their respective semaphore-actuating magnets are deënergized. Such actuative mechanism or its home semaphore-actuating magnet is preferably designed for slow-acting operation, according to well-known principles, so that a momentary cessation of current in the home-semaphore-actuating magnet will not cause its home-signal semaphore to assume danger position so long as the duration of such cessation does not exceed a certain period of retention during which the semaphore will be retained from assuming its danger position.

In the embodiment of my invention diagrammed in Fig. 1 each signaling apparatus located in proximity to the adjacent advance and rear ends of two successive railway-blocks comprises a semipolarized rear track relay or translating apparatus (generally designated by X) and a non-polarized advance track relay or translating apparatus (designated generally by Y.) The semipolarized rear track relay or translating device X comprises two outer coils or home clearing coils E in series with each other, and two inner coils or home and distant clearing coils F in series with each other, all four coils being mounted upon magnetic cores secured to a common back iron or yoke, such as 53. The cores and their coils are preferably placed all in line, as indicated in the diagram, in order to present the polar extremities of all four cores toward a common straight-bar armature which may be located beneath the polar extremities and subjected to the attractive forces of all four of the coils jointly. This armature is termed the "main" armature, and for the sake of clearness it has been omitted from the diagram. It is suitably connected with contact-fingers *m* and *o* in such manner that when the armature is attracted toward the coils of the relay X it will move these contact-fingers into positions of contact with their respective contact-stops *n* and *p*. The main armature is normally retracted by gravity or other suitable retractive force away from its position of nearest approach to the magnet, so as to maintain its contact-fingers *m* and *o* normally in non-contacting positions. The polar ends of the cores of the inner relay-coils F are provided with horizontal polar extensions 49, extending at right angles to the cores of the coils and, as seen in Fig. 1, toward the observer. A permanently-polarized magnetic core, such as 48, secured to the middle of the back iron 53, extends downward in parallelism with the cores of the relay-coils and constitutes the permanent magnet of the semipolarized relay. Upon the lower end of this permanently-magnetized core 48 a polarized armature j is pivotally mounted, so as to swing close to the extremities of and in the plane of the horizontal polar projections 49, such plane being normal to the plane of the relay-coils E and F and substantially normal to the plane of movement or direction of movement of the main armature of the relay. When the horizontal polar projections 49 are magnetized with one certain direction of polarity by energization of the cores of the home and distant clearing coils F, due to passage of current through such coils in one certain direction, which may be termed the "distant clearing" direction, the polarized armature j is caused by such magnetizing effect of the home and distant clearing coils F to oscillate about its pivotal center, so as to bring its opposing ends into contact with their respective contact-stops k and i. Current in the opposite direction through the home and distant clearing coils F only tends to swing the polarized armature j in the opposite direction and out of position of contact with its contact-stops. Such non-contacting position is the normal position of the polarized or distant-signal clearing-armature j and is further assured by suitable retractive means which are not shown in the diagram, but which tend always to move the polarized armature into its non-contacting position.

The home and distant clearing advance track-relay or translating device Y comprises a home and distant clearing front magnet including two home and distant clearing front coils J and two home clearing front coils K, and such advance track-relay Y comprises also a home-signal retractive magnet or back magnet L and a distant-signal retractive magnet or back magnet I. The home clearing front coils K and the home and distant clearing front coils J are arranged all in line with one another and with the two home and distant clearing front coils J between the home clearing front coils K, so that the latter occupy the extreme or outer positions of the set of coils. The cores of the home clearing front coils K are secured in the extreme ends of a common back iron, such as 47, which does not connect with the cores of the home and distant clearing front coils J, but is curved so as to pass around the cores of such home and distant clearing front coils. The cores of the home and distant clearing front coils J have no fixed back iron, but on the contrary present polar extremities at both ends of their respective coils.

A home clearing relay-armature, which is not shown in the diagram, is interposed between the coils J K of the home and distant clearing front magnet and the coils of the home-signal retractive magnet or back magnet L. This home clearing relay-armature is of such shape as to be presented to the polar ends of the cores of all four coils J K of the home and distant clearing front magnet, so as to be attracted by all of them jointly, while being oppositely attracted by the home-signal back magnet L. The home clearing relay-armature is unbiased—that is to say, it is provided with no retractive means or positioning means other than the attractive forces of the magnets between which it is interposed—and it will therefore be moved in the direction of preponderating magnetic attraction from the magnet on either side of the armature and will remain in the position effected by such movement until it is oppositely moved by an opposing preponderance of magnetic attraction from the magnet on the opposing side of the armature. It is suitably connected with its contact-finger f in such manner that when the armature moves toward its front coils J K the contact-finger f will be moved into position of contact with its contact-stop g, while the opposite movement of the armature will cause the contact-finger f to move out of its position of contact with such stop.

A distant clearing relay-armature (not shown on the diagram) is interposed between the home and distant clearing front magnet and the distant-signal retractive magnet or back magnet I in a manner similar to that described with respect to the home clearing relay-armature, excepting that the distant clearing relay-armature is only subjected to the magnetic attraction of the home and distant clearing front coils J of the home and distant clearing front magnet and to the opposing attraction of the distant-signal back magnet I and is not influenced by the magnetism of the home clearing front coils K. The distant clearing relay-armature, like the home clearing relay-armature, is unbiased and moves in response to preponderance of magnetic attraction from either of the magnets between which it is interposed. It is suitably connected with its contact-fingers a and c, so that movement of the armature toward the front coils J moves the contact-finger a out of position of contact with its contact-stop b, while moving the contact-finger c into position of contact with its contact-stop e, and vice versa.

Each signaling apparatus comprises a battery-switching device—such, for instance, as that indicated in the diagram and including two pivotally-mounted contact-levers, such as q and u, coöperative with an actuating-rod, such as t, which is connected to the home-signal semaphore H, so as to move in one direction with the movement of the semaphore to clear position and in the other direction with the movement of the semaphore to danger position. The contact-lever u is normally in position of contact with its contact-spring v and out of position of contact with its contact-spring 54, while the contact-lever q is normally out of position of contact with its contact-spring s. The actuating-rod t is provided with actuating fingers or projections which engage the ends of the contact-levers q and u, so that when the actuating-rod is moved by the movement of the home-signal semaphore to clear position the contact-lever u is merely shifted farther toward its position of contact with the contact-spring v, while the spring yields to permit such movement, and the contact-lever q is merely shifted farther from its position of contact with the contact-spring s, and when the actuating-rod t is moved in the opposite direction by the movement of the home-signal semaphore to its danger position the contact-lever u is momentarily moved out of position of contact with its contact-spring v and into position of contact with its contact-spring 54, while the contact-lever q is simultaneously and momentarily moved into contact with its contact-spring s. The parts are so arranged and positioned that when the home-signal semaphore has completely finished its movement to its danger position the actuating fingers or projections of the actuating-rod t will have passed beyond positions of engagement with the ends of the contact-levers q and u, thus permitting such levers to return to their normal positions, such return being assured by any suitable retractive means—for instance, by effort of gravity unbalanced with respect to the pivotal centers of the contact-levers. Each signaling apparatus also comprises three additional contact-levers, such as w, 2, and 6, the first of which coöperates with a contact-stop to close the circuit of the home and distant clearing coils F of the rear track-relay X, while the two contact-levers 2 and 6, together with their coöperating contact-stops, constitute a pole-changing device for reversing the connection of the advance track-battery 9 to the advance end of its track-circuit. The three contact-levers w, 2, and 6 are all actuated by the movement of the home-signal semaphore in such manner that when the semaphore goes to clear position the contact-levers are moved into contact with their respectively coöperating contact-stops x, 3, and 5, and when the semaphore is moved to danger position the contact-lever w is moved to normal position and out of contact with its stop x, while the contact-levers 2 and 6 of the pole-changer are also moved to their normal positions out of contact with their respective contact-stops 3 and 5 and in contact with their respective contact-stops 4 and 7, thereby restoring the normal connection of the advance track-battery 9 with its track-circuit.

The home clearing front coils K of the advance track-relay Y and the home and distant clearing front coil J thereof, as well as the home-signal back coils L and the distant-signal back coils I of such relay, are energized by the advance track-battery 9 through the following circuit: from one pole of the advance track-battery—for instance, the positive pole thereof—through a positive battery-conductor 10 to a terminal of one of the home clearing front coils K, and also to a terminal of one of the home and distant clearing front coils J, thence from the battery-conductor 10 through both the front coils K in series with each other to the conductor 11, and likewise from the battery-conductor 10 through both the front coils J in series with each other to the conductor 11, the coils J being in parallel with the coils K, and from the conductor 11 through the two coils of the home-signal back magnet L in series with each other to and through the opposite or negative battery conductor 15, leading back to the opposite or negative pole of the battery, and also from the conductor 11 normally around the resistance R by way of the contact-stop b and its coöperating contact-finger a normally in contact with the stop b, so as to form a short circuit around the resistance R to the conductor 12 and from the conductor 12 through the two coils of the distant-signal back magnet I in series with each other to the opposite battery-conductor 15, leading back to the opposite or negative pole of the battery, the last-mentioned branch of the circuit leading from the conductor 11 to the battery-conductor 15, and including the distant-signal back coils I, being in parallel with the first-mentioned branch leading from the conductor 11 to the battery-conductor 15, and including the home-signal back coils L. The back coils L and I normally preponderate in their magnetic attractions for their respective relay-armatures, so that the contact-finger f of the home clearing relay-armature is normally held out of contact with its contact-stop g, while the contact-finger c of the distant clearing relay-armature is normally held out of contact with its contact-stop e, and the contact-finger a of such distant clearing relay-armature is normally held in contact with its contact-stop b, so as to normally close the short-circuiting path which has already been traced around the resistance R. It will be noted that there is still another branch of the circuit of the advance track-battery 9, which shall be designated as the "track" branch or "track-circuit" of that battery and which leads from the resistance R and the contact-finger a through the conductor 12 and from the conductor 12 normally through the contact-stop 7 and contact-lever 6 of the semaphore-actuated pole-changer and thence through the conductor 13 to the advance end of the outer or right-hand rail r of the railway-block B and from the right rail r to the left rail l of the block B through various branches not indicated in the diagram of this particular track-circuit, but which will later be mentioned and which will be made clear by tracing their respectively-corresponding branches of the track-circuit of the block B², but normally from rail to rail only through the railway-ties and through the ground, such branch through the ties and ground being termed the "leakage" branch of the track-circuit, and from the left rail *l* through the conductor 14, connected to the advance end thereof, and thence through the contact-lever 2 of the pole-changer and normally to and through its contact-stop 4 and thence through the negative battery-wire 15 back to the negative pole of the advance track-battery 9. It will be noted that the track branch of the circuit of the advance track-battery 9, or what may be briefly termed the "track-circuit" of the block B, is in parallel with both the home-signal back coils L and the distant-signal back coils I of the advance track-relay Y, but is in series with both the home clearing front coils K and the home and distant clearing front coils J of that relay, so that as the resistance of the track branch or track-circuit decreases it will have the effect of decreasing the current in the back coils L and I and increasing the current in the front coils K and J, while increasing the current in the track-circuit, and of course an increase in the resistance of the track-circuit will have opposite effects upon all of the coils. However, the normal resistance of the track branch or track-circuit of the advance track-battery 9, which normal resistance is the resistance of its leakage branch from rail to rail through the ground and ties is such as will only permit passage of an amount of current insufficient to cause the front coils K and J of the advance track-relay to preponderate in attraction upon their relay-armatures, so that both relay-armatures will be normally held in positions of nearest approach toward their respective back coils and by preponderance of attraction of such back coils. It will also be noted that the normal connection of the track-rails of the railway-block with its advance track-battery through the semaphore-actuated pole-changer is such that the battery-current flows from the positive pole of the battery to the advance end of the right rail of the block and flows from the advance end of the left rail of the block back to the negative pole of the battery, this being termed the "home clearing" direction of current in the track-rails for reasons which will plainly appear hereinafter.

The further connections and structural features of the system diagrammed in Fig. 1 will now be developed in the course of a description of the sequence of actions constituting the operation of the system and following the movement or movements of one or more railway trains or vehicles along the railway-line.

We may first assume that a railway train or vehicle is approaching along the railway-line from a point in rear of the block B and that it has entered the block in rear of the block B. Such entrance of the train into the block in rear of the block B effects an actuation of the advance track-relay at the advance end of the block in rear of the block B, which advance track-relay corresponds to the advance track-relay Y and which actuation of such advance track-relay causes all the coils of the rear track-relay at the rear end of the block B and corresponding to the rear track-relay X at the rear end of the block B² to be connected to the rails of the block B at the rear end thereof, so as to form a conductive path from rail to rail at the rear end of the block, and thus to increase the conductivity of its track-circuit sufficiently to weaken the relative strength or magnetic attraction of the home-signal back coils L of the advance track-relay Y in a measure which shall cause the combined attraction of the home-clearing front coils K and the home and distant clearing front coils J of that relay to preponderate in their combined magnetic attraction upon the home clearing armature of that relay. The manner in which entrance of the train into the block in rear of the block B effects the foregoing actuation of the advance track-relay at the advance end of the block thus entered, so as to throw into connection with the track-circuit of the block B the rear track-relay at the rear end thereof, and thus to increase the conductivity of such track-circuit, will all be described later in connection with the entrance of the train into the block B and the effect thereof upon the advance and rear track-relays Y and X. Upon such increase in conductivity of the track-circuit of the block B and upon the consequent preponderance of the magnetic attraction of the front coils K and J of the advance track-relay Y at the advance end of the block B, the home clearing armature of such advance track-relay is attracted toward the front coils of the relay and is held in its position of nearest approach to such front coils, so as to close and maintain contact between its contact-finger *f* and coöperating contact-stop *g*. Such closure of contact between the contact-finger *f* and its stop *g* places the home clearing coils E of the rear track-relay X in connection with the rear end of the track-circuit of the block B² through the following branch of such track-circuit from the right rail *r* leading normally from the positive pole of the advance track-battery 9ᵇ comprised in the apparatus at the advance end of the block B² through the conductor 16, connected to the rear end of such right rail and leading to the contact-stop *g*, thence through such contact-stop, its coöperating contact-finger *f*, conductor 17, both of the home clearing coils E of the rear track-relay X, conductor 18, contact-spring v, its coöperating semaphore-actuated contact-lever u normally in contact with the spring, and from the contact-lever u by way of the conductor 19 to the rear end of the left rail of the block B^2, which left rail leads back to the negative pole of the advance track-battery 9^b. All the branches of the circuit of the advance track-battery 9^b correspond, of course, to the branches of the circuit of the advance track-battery 9, which have been already described. If the block B^2 is not occupied by a train or any railway-vehicle, current in the home clearing direction now flows from the advance track-battery 9^b through its track-circuit and through the home-clearing coils E of the rear track-relay X by way of the branch which has just been closed at the contacts f g. Such home-clearing current enegizes the home clearing coils E sufficiently to cause them to attract the main armature of the rear track-relay X. Thereupon the main armature moves to its position of nearest approach to the magnets of the relay and closes its contacts m n and o p.

Although the closure of the foregoing branch of the track-circuit of the block B^2 through the home clearing coils E of the rear track-relay X adds somewhat to the conductivity of the track-circuit, it does not sufficiently increase the conductivity of the track-circuit to cause the front coils K^2 and J^2 of the advance track-relay Y^2 at the advance end of the block B^2 to preponderate in their magnetic attraction upon either of the relay-armatures of that advance track-relay, so that the closing of the contacts f g of the advance track-relay Y does not immediately produce any movement or operation of any portion of the signaling apparatus located at the advance end of the block B^2.

Immediately upon closure of the contacts o p the home-signal semaphore-actuating magnet h is energized through the following circuit: from one pole—for instance, the positive pole—of the semaphore-actuating battery 8 through the positive battery-conductor 24, semaphore-actuating magnet h, conductor 25, contact-stop p, contact-finger o, and thence through the negative-battery conductor 26 back to the opposite or negative pole of the battery 8. Immediately upon energization of the home-signal-semaphore-actuating magnet h the home-signal semaphore H commences its movement to clear position. Such movement of the home-signal semaphore to its clear position brings the contact-lever w into contact with its coöperating contact-stop x and also reverses the semaphore-actuated pole-changer so as to bring the contact-lever 2 thereof into contact with the contact-stop 3 in lieu of the contact-stop 4, while bringing the contact-lever 6 of the pole-changer into contact with the contact-stop 5 in lieu of the contact-stop 7. This reversal of the semaphore-actuated pole-changer at the advance end of the block B brings the advance end of the right rail into connection with the negative pole of the advance track-battery 9 in lieu of the positive pole thereof and brings the advance end of the left rail into connection with the positive pole of the advance track-battery 9 in lieu of its negative pole, the circuit of the advance track-battery 9 then leading through the track-circuit of the block B as follows: from the positive pole of such advance track-battery 9 through its positive battery-conductor 10, and thence through the home clearing front coils K of the advance track-relay Y and through the home and distant clearing front coils J of such relay in parallel with the coils K, and from the front coils K J through conductor 11, and thence around the resistance R by way of contact-stop b and its coöperating contact-finger a to the conductor 12, thence through the conductor 12 and the contact-stop 3 and its coöperating contact-finger 2 of the semaphore-actuated pole-changer, thence through conductor 14 to the advance end of the left rail l of the block B, thence rearwardly along such left rail to and through the coils of the rear track-relay at the rear end of the block B and corresponding to the rear track-relay X at the rear end of the block B^2, and from such rear track-relay of the block B to the rear end of the right rail r of such block, and thence forwardly along such right rail to the advance end thereof and to and through the conductor 13, and thence through the contact-lever 6 and its coöperating contact-stop 5 of the semaphore-actuated pole-changer, and from such contact-stop 5 through the opposite or negative battery-conductor 15 and back to the opposite or negative pole of the advance track-battery 9.

Prior to the foregoing reversal of the semaphore-actuated pole-changer by the clearing movement of the home-signal semaphore H current flowed from the advance track-battery 9 through its entire track branch or track-circuit in home clearing direction corresponding in direction and in results to the home clearing current which is now flowing in the block B^2 and which has just effected the clearing of the home-signal semaphore H and the reversal of its semaphore-actuated pole-changer; but now, however, current passing through the track-circuit of the block B, which has just been traced, flows through the rails of such block and through the rear track-relay connected to the rear ends thereof in the direction opposed to the home clearing direction of current which flowed in the track-circuit prior to the reversal of its pole-changer. This reversed current in the rails and rear track-relay of the block B is termed the "distant clearing" current, because it effects the clearing of the distant-signal semaphore at the rear end of the block B in a manner which we are about to consider with reference to the clearing of the distant-signal semaphore D at the rear end of the block B^2 and when the train shall have entered the block B immediately in rear of such distant-signal semaphore D. The home-signal semaphore at the rear end of the block B was cleared prior to the clearing of the distant-signal semaphore at that place, and when the train was present in the second block in rear of such signals and in a manner corresponding to the clearing of the home-signal semaphore H, which clearing operation has just been described as effected by presence of the train in the second block in rear of such home-signal semaphore H, which second block is the block in rear of the block B. As the train now proceeds through the block in rear of the block B and approaches the signals at the rear end of the block B it is assumed that the engineer notes that both the home and distant signals at the rear end of the block B are in their clear positions indicating that the two blocks successively in advance of the signals are "clear." Upon noting such clear-signals the engineer may proceed at full speed into the block B.

The exit of the train from the block first in rear of the block B, provided there is no other train in such first rear block or in the block second in rear of the block B, actuates the advance track-relay at the advance end of such first rear block to open the two rear branches of the track-circuit of the block B, which lead through the home clearing coils and through the home and distant clearing coils of its rear track-relay, such opening of such branch circuits being accomplished in a manner which will shortly be described with reference to the exit of the train from the block B and the effect thereof upon its advance track-relay Y and upon the rear track-relay X, controlled by such advance track-relay. Such opening of the rear branches of the track-circuit of the block B is not effected, however, until the railway-train or the advance cars or wheel-trucks thereof have entered the rear end of the block B, and when the train or the advance end thereof has entered the block B its wheels and axles constitute a short circuit of great conductivity from rail to rail thereof, so that the total conductance of the track branch or track-circuit of the advance track-battery 9 is greatly increased, or, in reciprocal terms, the resistance thereof is greatly decreased, and with the result that still more current is shunted from the back coils L and I of the advance track-relay Y, while the current in its front coils K and J is correspondingly increased, and in consequence the relative attractive forces exerted by the front coils upon their respective armatures are greatly increased. Such increase in the relative forces of attraction exerted by the front coils can only affect the home clearing relay-armature to draw it more strongly toward such front coils, so as to more firmly press its contact-finger *f* against its coöperating contact-stop *g*; but the distant clearing relay-armature, which is so adjusted that up to the present instant it has not been attracted by the home and distant clearing front coils J, now moves to its position of nearest approach toward such front coils, and thereby breaks contact between its contact-finger *a* and coöperating stop *b* and makes contact between its contact-finger *c* and coöperating stop *e*. The breaking of contacts *a b* opens the short-circuiting shunt around the resistance R, and thereby throws this resistance in series with the track branch or track-circuit of the advance track-battery 9 and also in series with the distant-signal back coils I, which are in parallel with such track branch; but such breaking of contacts *a b* throws the resistance R into parallel with the home-signal back coils L, one result being to reduce the current flowing through the track branch or track-circuit, and thus avoid excessive intensity of current due to the short-circuiting effect of the railway-train as it approaches the front end of the block B and gradually cuts out more and more of the rail length and rail resistance leading through the track-circuit to such short-circuiting train. At the same time the introduction of the resistance R, together with the progressive reduction of rail resistance in the track-circuit as the train advances, still further reduces the intensity of current in the distant-signal back coils I; but such further reduction of current in the distant-signal back coils can only have the effect of still further weakening their retractive effort upon the distant clearing relay-armature, so as to permit the armature to be drawn still more forcibly toward its front coils J. The introduction of the resistance R is, however, opposite in its effect upon the home-signal back coils L, because such resistance is introduced in parallel with the home-signal back coils and in series with all the other circuit branches which are in parallel with the home-signal back coils, and must therefore increase the joint resistance of all such branches or paths parallel with the home-signal back coils, so as to reduce their total or joint conductance, which tends to shunt current around or take current from the home-signal back coils and by so reducing such conductance to cause more current to flow through the home-signal back coils L. At the same time, since the resistance R is introduced in the circuit of the advance track-battery 9 in series with the front coils K J the current in these front coils will be somewhat reduced by such introduction of the resistance, the whole result as regards the attractive forces of the front coils K J relative to attractive force of the home-signal back coils L being to reduce the preponderance of magnetic attraction of the front coils upon the home clearing relay-armature. The relative attractive force of the combined front coils K J is not, however, at this instant reduced sufficiently to permit the attraction of the home-signal back coils L to preponderate upon the home clearing relay-armature and retract the same. The effect of the introduction of the resistance R is rather merely to partially compensate or neutralize an increase in the preponderance of magnetic attraction of the front coils J K over and above the critical actuative preponderance thereof, which was required to draw the home-clearing relay-armature toward them and which increase in front-coil preponderance now exists because of reduction in the air-gap between the front coils and the home clearing relay - armature occurring simultaneously with a corresponding increase in the air-gap between such armature and its back coils L, such changes in the air-gaps being due to movement of the armature toward its front coils and away from its back coils and which increase in front-coil preponderance exists further because of the considerable reduction in the resistance of the track branch of the circuit in series with the front coils and in parallel with the home-signal back coils. The object of thus partially neutralizing the preponderance of magnetic attraction of the front coils K J is to facilitate retraction of the home-clearing relay-armature by its back coils L when the latter shall be required to again preponderate and retract the home clearing relay-armature to its normal position upon exit of the train from the block B.

The closing of the contacts *c e*, due to attraction of the distant clearing relay-armature by the home and distant clearing front coils J, causes the home and distant clearing coils F of the rear track-relay X to be included in the rear end of the track-circuit of the block B^2 and in parallel with the home clearing coils E and through a branch traceable as follows: from the rear end of the right rail *r* of the block B^2 through the conductor 16, connected thereto, and thence through contact-stop *e*, its coöperating contact-finger *c*, conductor 20, contact-stop *x*, its coöperating semaphore-actuated contact-lever *w*, which has already been moved into position of contact with the stop *x* by clearing movement of the home-signal semaphore H, and from the contact-lever *w* through conductor 21, home and distant clearing rear track-relay coils F, conductor 22, contact-stop *n*, its coöperating contact-finger *m*, already brought into contact with the stop *n* by attraction of the main armature of the rear track-relay X, and from the contact-finger *m* through conductor 18, contact-spring *v*, its semaphore-actuated contact-lever *w*, and the conductor 19 to the rear end of the left rail of the block B^2. Current is still flowing through the rails of the block B^2 in home clearing direction, and it is the home clearing direction of current which now flows through the home and distant clearing coils F of the rear track-relay, and this home clearing direction of current in such home and distant clearing coils F only forces their pivoted polarized armature *j* more firmly out of or away from its position of contact with its coöperating contact-stops *k* and *i*. The parallel or multiple introduction of the home and distant clearing rear coils F reduces the joint resistance of all the branches of the track-circuit of the block B^2, or, in other words, increases the total conductance of such track-circuit in such a degree as to initially actuate the advance track-relay Y^2, connected to the advance end of the block B^2. Such initial actuation of the advance track-relay Y^2 is effected in the manner which has already been described with reference to the corresponding initial actuation of the advance track-relay Y, such initial actuation of the advance track-relay Y^2 consisting in the movement of its home clearing relay-armature away from its home-signal back coils L^2 and toward its front coils K^2 J^2 of the relay, such movement being due to preponderance of magnetic attraction of such front coils upon the home clearing armature and being caused by the increase in total conductance of the track-circuit of the block B^2. Such attraction of the home clearing relay-armature of the advance track-relay Y^2 brings its contact-finger f^2 into contact with its contact-stop g^2, and thereby introduces the home clearing coils E^2 of the rear track-relay X^2 in the rear end of the track-circuit of the block B^3, whereupon the block B^3, being clear of trains, &c., the home clearing coils E^2 of its rear track-relay X^2 are energized and attract the main armature of such relay, and thus close their contacts m^2 n^2 and o^2 p^2, all in the manner which has already been described with respect to the corresponding operation of the relays Y and X at the advance end of the block B and at the rear end of the block B^2. Upon closure of the contacts o^2 p^2, which are included in the local circuit of the home semaphore-actuating magnet h^2 at the rear end of the block B^3, such semaphore-actuating magnet is energized and causes its home-signal semaphore H^2 to move to clear position, thus reversing the positions of the contact-levers 2^b and 6^b of its semaphore-actuated pole-changer and causing a reversal of the home clearing current through the rails of the block B^2, all in the manner which has already been described with respect to the corresponding operation of the home-signal semaphore H and its semaphore-actuated pole-changer at the rear end of the block B^2. As the home clearing current in the rails of the block B^2 is reversed there is of course a momentary cessation of current, during which the rear track-relay X of such block may release its main armature and permit the same to be momentarily retracted, so as to momentarily open at its contacts *m n* and *o p*, respectively, the distant clearing rear branch of the track-circuit of the block B^2 and the local circuit of the home-semaphore-actuating magnet *h*, controlling the home-signal semaphore H at the rear end of such block. The consequent momentary deënergization of the home-semaphore-actuating magnet *h* does not, however, result in moving its home-signal semaphore H to danger position, since the duration of such deënergization is less than the period of retention of the signal. Immediately after the foregoing momentary cessation of current in the rails of the block B^2 as the home clearing current therein is reversed the current is reëstablished in reversed or distant clearing direction, and the main armature of the rear track-relay X, being responsive to current in either direction in the home clearing coils E of the relay, is reattracted by distant clearing current in such coils, so as to reclose at its contacts *m n* and *o p*, respectively, the distant clearing rear branch of the track-circuit of the block B^2 and the local circuit of the home-semaphore-actuating magnet *h* at the rear end of such block. Now that such distant clearing rear branch of the track-circuit of the block B^2 is reclosed, so as to again include in such track-circuit its home and distant clearing rear coils F, distant clearing current will pass through such home and distant clearing coils and their cores will be magnetized with a distant clearing polarity or polarity opposite to that produced by the home clearing current, so that such home and distant clearing coils F will cause their pivotally-mounted polarized armature *j* to swing into its position of contact with its coöperating contact-stops *k* and *i*, thus closing the local circuit of the distant-semaphore-actuating magnet *d*, which local circuit is traceable as follows: from one pole of the semaphore-actuating battery 8—for instance, the positive pole thereof—through the positive battery-conductor 24, distant-semaphore-actuating magnet *d*, conductor 28, contact-stop *i*, polarized armature *j*, contact-stop *k*, and negative battery-conductor 26, back to the opposite or negative pole of the battery. The distant-semaphore-actuating magnet *d* is energized by such closure of its local circuit and immediately causes its distant-signal semaphore D to move to clear position, thus indicating the clear condition of the block B^3, second in advance of such distant-signal semaphore D.

Now proceeding onward through the block B, the train comes upon clear-signals at the advance end thereof and continues into the next block B^2, leaving the block B behind. When the train has entered the block B^2, its wheels and axles short-circuit the rails thereof and effect the second operation of the advance track-relay Y^2, connected to the rails of the block at the advance end thereof, all in the manner already described with reference to the second or distant clearing operation of the advance track-relay Y at the advance end of the block B and when the train had entered such block B. This second or distant clearing operation of the advance track-relay Y^2 connects the home and distant clearing coils F^2 of the rear track-relay X^2 in the rear end of the track-circuit of the block B^3 and in parallel with the home clearing coils E^2 of such rear track-relay. Thereupon the advance track-relay at the advance end of the block B^3 is actuated to clear the home-signal semaphore at the advance end of such block, providing, of course, that the block in advance of such home signal is clear. Such clearing of the home signal at the advance end of the block B^3 effects a reversal of the semaphore-actuated pole-changer at the advance end of such block and a consequent change of home clearing current in such block to distant clearing current therein, which actuates the polarized armature j^2 of the rear track-relay x^2 at the rear end of such block, and thereby closes the local circuit of the distant-semaphore-actuating magnet d^2 and clears the distant-signal semaphore D^2, all in the manner which has been hereinbefore described relative to the similar operations occurring, respectively, one block in rear. Thus the train proceeds along the railway-line, and, assuming that it at no time approaches another train in either of the two blocks successively in advance, it continues to cause the signals to clear as it approaches them, each home-signal semaphore being cleared when the train has entered the block second in rear thereof, and each distant-signal semaphore being cleared when the train has entered the block immediately in rear thereof.

When the train leaves the block B, such exit of the train opens the short-circuit which has been maintained from rail to rail of such block by the wheels and axles of the train, and providing there is no other train present in such block nor in the block in rear thereof the conductance of the track-circuit of the block B is reduced below the value of the first actuative conductance of such track-circuit or its conductance which was necessary to effect the initial operation of its advance track-relay Y, which initial operation consisted in the attraction of its home clearing relay-armature toward the front magnet of such relay, and obviously this reduced conductance of the track-circuit which is below such first actuative conductance must be still farther below the second actuative conductance which was necessary in order to effect the second operation of the advance track-relay Y, consisting in the attraction of its distant clearing relay-armature toward the front coils of such relay, because, as we have already seen, such second actuative conductance of the track-circuit must be even higher than the first actuative conductance thereof. Therefore such reduction of the conductance of the track-circuit upon exit of the train from the block B will under all conditions be sufficient to restore preponderance of magnetic attraction in the distant-signal back magnet I and notwithstanding the fact that the preponderance of the home and distant clearing front coils J upon their distant clearing relay-armature has already been considerably increased over and above the critical actuative preponderance necessary to attract the distant clearing armature, such increase over the critical actuative preponderance of the front coils J being due to the introduction of the resistance R into the relay-circuit at a point where it decreases the current in the back coils I more than it decreases the current in the front coils J and, further, being due to the reduction in the air-gap between the front coils J and their distant clearing armature caused by the movement of such armature toward the front coils and occurring simultaneously with a corresponding and similarly-caused increase in the air-gap between such armature and its back coils I. The fact that the preponderance of attraction by the home clearing front coils K and home and distant clearing front coils J upon the home clearing relay-armature has been similarly increased by movement of such armature toward the front coils and over and above its critical actuative value requires that the value of track-circuit conductance necessary to effect retraction of the home clearing relay-armature by its back magnet L shall be considerably less than the critical value of the first actuative conductance of the track-circuit which effects the attraction of the home clearing relay-armature toward its front coils, and although the reduction in track-circuit conductance effected by exit of the train from the block would ordinarily be sufficiently below such critical actuative conductance to readily effect retraction of the home clearing relay-armature, even without employing the resistance R, such retraction of the home clearing relay-armature might not be assured under extreme wet-weather conditions when the leakage branch of the track-circuit would add very considerably to its conductance; but when the resistance R is employed in the manner which has already been explained the retraction of the home clearing relay-armature upon exit of the train from the block is assured even under such extreme wet-weather conditions, because, as has already been pointed out, the introduction of the resistance R into the relay-circuit by the attraction of its distant clearing relay-armature and after attraction of its home clearing relay-armature toward the front coils of the relay effects a preliminary increase of resistance in series with the track-circuit and has the effect of a preliminary reduction of its conductance tending to compensate or neutralize the air-gap increase in preponderance of the front coils of the advance track-relay Y upon their home clearing armature. Since both the home clearing and distant clearing relay-armatures of the advance track-relay Y start simultaneously on their retractive movements toward their respective back magnets when the train makes its exit from the block B under the conditions which have already been mentioned, it is apparent that the retractive swing or movement of the home clearing relay-armature may be so adjusted and determined that such retractive movement will be completed not later than the completion of the retractive movement of the distant clearing relay-armature, which distant clearing relay-armature at the end of its retractive movement short-circuits the resistance R at the contacts a b, so that the resistance R will be in circuit and will be effective in insuring the retractive movement of the home clearing relay-armature until such retractive movement theeof has been completed.

We may now go back to the point where the train under consideration was just about to enter the rear end of the block B^2 and from the block B in rear thereof and may consider further results of the progressive movement of the train which as yet have not been considered. As soon as the forward part of the train enters the block B^2 and its wheels and axles establish a short circuit across the rails thereof both the home clearing relay-coils E and the home and distant clearing relay-coils F of the rear track-relay X of such block are deënergized because the short circuit made by the train takes substantially all the current transmitted from the advance track-battery 9^b rearwardly along the rails of the block B^2, and thereby deprives these rear relay-coils of current. Immediately upon such deënergization of the coils of the rear track-relay X both its main armature and its polarized armature j are released from the magnetic forces which retain them in contact-making positions, and the armatures are immediately retracted, so as to break the local circuits of the home-semaphore-actuating magnet h and the distant-semaphore-actuating magnet d, which they respectively control, whereupon the home and distant signal semaphores H and D immediately go to their danger positions. At the same time incidentally the dropping or retraction of the main armature reopens at its contacts m n the rear branch of the track-circuit B^2, which includes the home and distant coils F of the rear track-relay of such block. As the home-signal semaphore H goes to its danger position its semaphore-actuated pole-changer is reversed, so as to again reverse direction of current in the rails of the block B, and thereby reëstablish in such rails the home clearing direction of current; but since the rails of the block B are still short-circuited by the rear portion of the train, which has not yet left the block B, this home clearing direction of current would produce no immediate effect upon the apparatus at the rear end of the block B even though the home clearing relay-coils or both the home clearing and the home and distant clearing coils of the rear track-relay of such block were placed in circuit by the approach of another train toward the block B and from the rear thereof in the manner which has already been described with respect to the initial approach of the train the progress of which we are considering. The same danger movement of the home-signal semaphore H at the rear end of the block B^2 reopens at still another point the rear branch of the track-circuit of the block B^2, which includes the home and distant clearing coils F, this second point at which such branch is reopened being at the semaphore-actuated contact-lever *w* and its coöperating contact-stop *x*. The same danger movement of the home-signal semaphore H at the rear end of the block B^2 operates the semaphore-actuated contact-levers *q* and *u*, permanently connected, respectively, with the right and left rails *r* and *l* of the block B^2 by means of the conductors 16 and 19, leading to the rear end of such rails, respectively, so as to first break the circuit of the home clearing relay-coils E at the contact between the semaphore-actuated lever *u* and its contact-spring *v* and then to bring the right and left rails, respectively, into connection with the negative and positive poles, respectively, of the local semaphore-actuating battery 8, or what will be hereinafter designated also as the "relay-restoring" battery, such connection of the relay-restoring battery 8 with the rear ends of the rails being made through a branch of their track-circuit traceable as follows: from the rear end of the right rail *r* of the block B^2 through connecting-wire 16, semaphore-actuated contact-lever *q*, its coöperating contact-spring *s*, and conductor 27 to the negative pole of the relay-restoring battery 8, and thence through such battery to the positive pole thereof, and thence through conductor 23, contact-spring 54, its coöperating semaphore-actuated contact-lever *u*, and thence through conductor 19 to the rear end of the left rail *l* of the block B^2. As has already been explained, the semaphore-actuated contact-levers *q* and *u* are only brought momentarily into contact with their respective coöperating contact-springs *s* and 54 during the movement of the home-signal semaphore H to its danger position, so that current flows from the relay-restoring battery 8 only momentarily through the branch of the track-circuit which has just been traced from rail to rail and through the short-circuiting wheels and axles of the front portion of the train at this time making its entrance upon the block B^2, and of course the short-circuiting effect of such wheels and axles prevents such momentary current from being transmitted forwardly along the block B^2, thereby affecting or actuating the advance track-relay Y^2 at the advance end of such block in the manner in which such advance track-relay Y^2 should and would be actuated by such momentary or relay-restoring current if the train were to leave the block B by a siding or by a branch railway-line in lieu of passing out of the block B into the block B^2. When the home-signal semaphore H has reached its danger position, the actuating-rod *t* of the pair of semaphore-actuated contact-levers *q* and *u* has passed beyond its position of engagement with such levers, and the latter have been retracted from positions of contact with their respective contact-springs *s* and 54, while such retractive movement of the contact-lever *u* has moved it into contact with its coöperating contact-spring *v*, so as to reëstablish at such point the rear branch of the track-circuit of the block B^2 including the home clearing coils E of its rear track-relay. The train now proceeds farther into the block B^2 until it has left the block B in rear thereof, whereupon the short-circuiting effect of the train is removed from the block B and the back coils L and I of its advance track-relay Y retract their home clearing and distant clearing relay-armatures, respectively, as has been already pointed out, thereby opening at the contacts *f g*, controlled by the home clearing relay-armature, the rear branch of the track-circuit of the block B^2, which includes the home clearing coils E of its rear track-relay, and still further opening at the contacts *c e*, controlled by the distant clearing relay-armature, the rear branch of such track-circuit, which includes the home and distant clearing relay-coils F of such rear track-relay and which latter branch was already open at the semaphore-actuated contacts *w x* and at the contacts *m n*, controlled by the main armature of such rear track-relay X. Thus the train has passed from the block B into the block B^2 and in so passing has restored both the home and the distant signal semaphores H and D to their normal danger conditions or positions, while at the same time restoring the armatures of both the rear track-relay X and the advance track-relay Y to their normal or retracted positions ready to be again actuated by the approach of another train and all in the manner hereinbefore set forth.

Should the train leave a block of the system—for instance, the block B—by way of a siding or branch line and in lieu of passing out into the next block, such as B², in advance, the coils of the rear track-relay, such as X, of such advance block would of course not be deënergized by the short-circuiting effect of the train, which effect has been described as resulting from entrance of the train upon such advance block; but both the home clearing and the distant clearing armatures of the advance track-relay, such as Y, of the block from which the train would make exit under these conditions would be retracted in the manner which has already been described as resulting from exit of a train from the block. The retraction of the home clearing relay-armature thus effected would of course break at the contacts *f g*, controlled by such armature, the rear branch of the track-circuit of the advance block B², including its rear home clearing coils E, while the retraction of the distant clearing relay-armature would simultaneously break at the contacts *c e* controlled thereby, the rear branch of such track-circuit including its home and distant clearing relay-coils F. Upon such breaking of the branches including the coils of the rear track-relay X at the rear end of the block B² such rear track-relay will of course be deënergized and will release both its armatures, all the results of such deënergization and release being the same as the results following such deënergization and release when produced in the manner already described by the short-circuiting effect of the entrance of the train into the block B², excepting the result of the momentary flow of relay-restoring current from the relay-restoring battery 8 and through the rails of the block B², which momentary relay-restoring current in the present instance has for its object to insure retraction of the home clearing relay-armature of the advance track-relay Y² at the advance end of the block B², and thereby to insure return of the home-signal semaphore H² at the advance end of the block B² to its danger position, assuming, of course, that the home clearing relay-armature of such advance track-relay has been attracted toward its front coils, so as to clear the home signal at the advance end of the block B² in the manner which has already been described as resulting from presence of a train in the second block in rear of such home signal. If the home signal semaphore H² at the advance end of the block B² has been thus cleared, its semaphore-actuated pole-changer will of course have been reversed, so that the contact-levers 2ᵇ and 6ᵇ thereof will be in contact, respectively, with their coöperating contact-stops 3ᵇ and 5ᵇ, so as to send current over the track-circuit in distant clearing direction from the advance track-battery 9ᵇ, controlled by such pole-changer. Under these conditions the relay-restoring battery 8 at the rear end of the block B² will be momentarily connected in and will momentarily be effective throughout the following circuit: from the positive pole of such relay-restoring battery 8 through the conductor 23, contact-spring 54, semaphore-actuated contact-lever *u*, conductor 19, left rail *l* of the block B², conductor 14ᵇ, connected to the advance end of such left rail, semaphore-actuated contact-lever 2ᵇ, its coöperating contact-stop 3ᵇ, thence through conductor 12ᵇ and from the conductor 12ᵇ to the conductor 15ᵇ through three parallel branches, as follows: one branch leading from the conductor 12ᵇ through the coils I² of the distant-signal back magnet and to the conductor 15ᵇ, the second branch leading from the conductor 12ᵇ around the resistance R² by way of contact-finger *a*² and its coöperating contact-stop *b*² and thence through conductor 11ᵇ and coils L² of the home-signal back magnet to the conductor 15ᵇ, and the third branch also leading from the conductor 12ᵇ around the resistance R² by way of the contacts *a*² *b*² and to the conductor 11ᵇ, but from such conductor branching through the front coils K² J² of the advance track-relay Y², such front coils K² and J² being of course in parallel with each other, and from such front coils through the conductor 10ᵇ to the positive pole of the advance track-battery 9ᵇ and thence through such battery to the conductor 15ᵇ, wherein the three foregoing parallel branches are reunited, it being noted that in this third branch of the circuit of the relay-restoring battery 8 the direction of the electromotive force of the advance track-battery 9ᵇ is opposed to the direction of the electromotive force of such relay-restoring battery 8, and from such rejuncture of the three foregoing parallel branches the circuit continues through the conductor 15ᵇ and from such conductor through the contact-stop 5ᵇ, its coöperating semaphore-actuated contact-lever 6ᵇ, conductor 13ᵇ, connected to the advance end of the right rail *r* of the block B², thence through such right rail, conductor 16, connected to the rear end thereof, semaphore-actuated contact-lever *q*, its coöperating contact-spring *s*, and conductor 27 back to the negative pole of the relay-restoring battery 8. It will be noted that although the relay-restoring battery 8 thus momentarily connected in the rear end of the track-circuit of the block B² and the advance track-battery 9ᵇ, connected to the advance end of such track-circuit, are opposed to each other in the direction in which they tend to induce flow of current through the front coils K² J² of the track-relay Y² at the advance end of such track-circuit such batteries commonly tend to induce flow of current in one direction through the back coils L² and I² of such advance track-relay, so that although the effects of the two batteries are opposed and tend to neutralize each other as regards energization of the front coils of the advance track-relay they are, on the contrary, united or coördinate in energizing the back coils L^2 and I^2 thereof, the result being that the distant-signal back coils I^2, which already preponderate in their attraction upon the distant clearing relay-armature, are merely caused to more strongly preponderate, while the home-signal back coils L^2 are likewise caused to strongly preponderate in their magnetic attraction upon their home clearing relay-armature, so as to retract the same positively. Of course under ordinary conditions these home-signal back coils L^2 would be caused to preponderate upon and to retract their home clearing relay-armature merely by reduction in conductance of the track-circuit of the block B^2 due to opening both its rear branches including its rear home clearing coils E and its rear home and distant clearing coils F, such branches having been opened, as already stated, by retraction of the armatures at the advance track-relay Y upon exit of the train from the block B onto a siding or branch; but should extreme wet-weather conditions prevail, so as to greatly increase the conductance of the leakage branch of the track-circuit, and thereby tend to prevent proper retraction of the home clearing relay-armature of the advance track-relay Y^2 by its back coils L^2, then the momentary flow of relay-restoring current from the relay-restoring battery 8 would be effective in the manner which has just been described to insure the proper retraction of such home-clearing relay-armature.

It will be noted that should the train under consideration approach another train occupying any block in advance of such train the progress of which we have been considering the wheels and axles of such advance train would short-circuit the rails of the block entered thereby and would thus effectually prevent transmission of signal-clearing current through such block from its advance track-battery to its rear signal-clearing track-relay, such as X, thereby effectually preventing energization of either the home clearing coils or the home and distant clearing coils of such rear track-relay when such coils are connected in the rear end of the track-circuit of such block and by attraction of the home clearing relay-armature or both the home clearing and distant clearing relay-armatures of the advance track-relay, such as Y, at the advance end of the block in rear of such block entered by the advance train. Such prevention of energization of the coils of the rear track-relay of the block entered by such advancing train will of course effectually prevent clearing of either the home-signal or distant-signal semaphore at the rear end of such block, while such prevention of clearing of such home-signal semaphore will of course prevent reversal of its semaphore-actuated pole-changer, thus preventing the sending of a distant clearing current to the signaling apparatus at the rear end of the block in rear of the block entered by such advance train, or if a train from a siding or branch suddenly enters a block of the system after the home signal or both the home and distant signals at the rear end of such block have been cleared by the advance of another train toward them it is of course obvious that either or both of such signals will immediately go to their danger positions because of complete deënergization of all the coils of the track-relay at the rear end of the block thus entered and consequent opening of the circuits of the semaphore-actuating magnets controlled by such relay, such deënergization of the rear relay-coils being caused by short-circuiting effect of the entering train, which effectually prevents transmission of signal-clearing current from the advance to the rear end of the block which the train enters. If only the home-signal semaphore is cleared at the time the train thus enters the block from a siding or branch and if the clearing of such home-signal semaphore has already effected the reversal of signal clearing current in the block in rear thereof, so as to clear the distant-signal semaphore at the rear end of such rear block, such home-signal semaphore at the rear end of the block thus entered will of course immediately go to danger position, so as to reverse its semaphore-actuated pole-changer and reëstablish home clearing current in the track-circuit of the block in rear thereof, so as to retract the distant clearing relay-armature or polarized armature, such as *j*, comprised in the track-relay at the rear end of such rear block, and thereby open the local circuit of the distant semaphore-actuating magnet, such as *d*, in order to restore such rear distant-signal semaphore to its danger position.

It will be noted that when the home and distant clearing coils, such as F, of one of the rear track-relays, such as X, are connected in the track-circuit of the block in advance thereof and in parallel with the home clearing coils, such as E, and by attraction of the distant clearing relay-armature of the advance track-relay, such as Y, of the block in rear of such rear track-relay and due to entrance of a train upon such rear block such introduction of the home and distant clearing coils, such as F, not only serves to reduce the resistance or increase the conductance of their advance track-circuit in order to actuate the advance track-relay, such as Y^2, at the advance end of such track-circuit, and thereby establish in such track-circuit a distant clearing current to energize such home and distant clearing-coils F with a polarity which shall attract their polarized armature and clear their distant signal D, but such home and distant clearing-coils F when they are thus connected in the circuit also assist the home clearing coils E in maintaining their common main armature in its position of attraction, so that although the magnetic attraction of the home clearing coils upon such main armature is weakened by subtraction of current from such home clearing coils when the home and distant clearing coils are connected in parallel therewith to take part of the current from the track-circuit such weakening of the attractive force of the home clearing coils is compensated by establishment of current and consequent attractive force in the home and distant clearing coils, whereby the total attractive force effective upon the main armature of the rear track-relay, such as X, may not be weakened when the resistance of its track-circuit is reduced in order to actuate the signaling apparatus at the advance end thereof.

That embodiment of my invention diagrammed in Fig. 2 is a normal-danger, home, and distant railway block-signaling system similar in its general features to the system diagrammed in Fig. 1, but differing therefrom in various particulars, which will now be set forth in a description of its structure and operation. In the following description of the system of Fig. 2 those elements and features of such system which are obviously the same as corresponding elements or features in the system of Fig. 1 and those elements and features of the system of Fig. 2 which are so similar to corresponding elements and features of the system of Fig. 1 that their structure and their coöperation in the system are obvious from the foregoing description of Fig. 1 will not be set forth in detail.

Fig. 2 shows three successive railway-blocks B, B^2, and B^3, named in the order in which they are normally traversed by the railway-trains and similar to the three railway-blocks diagrammed in Fig. 1, being similarly insulated from each other and also being equipped with railway signaling apparatus located in proximity to the adjacent ends of the successive blocks. The advance track-relays Y^3 and Y^4, located, respectively, at the advance ends of the railway-blocks B and B^2, in construction, operation, and in their electrical connections to the advance ends of the track-circuits of their respective blocks are the same as the advance track-relays of the system of Fig. 1, excepting in the following particulars: The advance track-relays of the system at present under consideration do not employ resistances such as R and R^2 of Fig. 1, inserted in the advance ends of the track-circuits and controlled by and coöperating with the advance track-relays. As to this feature, the advance track-relays of Fig. 2 are in structure, connections, and operation the same as the advance track-relays of Fig. 1 if it be assumed that the resistances R and R^2 of Fig. 1 are constantly short-circuited, and since these resistances are dispensed with in the system of Fig. 2 the advance track-relays thereof also dispense with the contacts, such as *a b* of Fig. 1, which are therein employed to control such resistances. The advance track-relays, such as Y^3 of Fig. 2, actuate their home clearing armatures in the manner which has already been described with reference to the advance track-relays of the system of Fig. 1, and, as in the case of Fig. 1, the advance track-relays in attracting such home clearing relay-armatures toward their front coils bring the home clearing contact-fingers, such as *f* thereof, into contact with their coöperating home clearing contact-stops, such as *g*; but although the operation of the distant clearing relay-armatures of the advance track-relays of the system of Fig. 2 is electrically and magnetically the same as the corresponding operation of the distant clearing armatures of the advance track-relays of Fig. 1 in the present instance these distant clearing relay-armatures when attracted toward their front coils move their distant clearing contact-fingers, such as c^3, corresponding to the contact-fingers such as *c* of Fig. 1, out of contact-making positions with their coöperating distant clearing contact-stops, such as e^3, corresponding to the contact-stops such as *e* of Fig. 1, in lieu of moving such contact-fingers into contact with such distant clearing stops when the distant clearing armatures are attracted toward their front coils. Such attraction of the distant clearing armature of the advance track-relays also moves their contact-fingers, such as c^3, into positions of contact with their respective contact-stops, such as e^5, and for a purpose which will hereinafter be developed.

Since the apparatus at the advance end of the block B is characteristic of apparatus correspondingly located throughout the system, it may be taken as an example.

The system of Fig. 2 comprises semipolarized rear track-relays, such as X^3, including home clearing coils E and home and distant clearing coils F, organized together, and with a common main armature and a pivotally-mounted polarized armature *j*, such coils and armatures being organized and operating and coöperating all in the manner hereinbefore set forth in the description of the semipolarized rear track-relays of the system of Fig. 1; but the rear track-relays of Fig. 2 differ from those of Fig. 1 in that they comprise back magnets, such as the back magnet G of the rear track-relay X^3, which back magnet is disposed in attractive proximity to the main armature of the relay, but on the opposite side from the home clearing coils E and the home and distant clearing coils F thereof, which may now be termed collectively the "front" coils of the relay in contradistinction to its back coils G. This disposition of the back magnet makes its attraction upon the main armature opposed to the attraction exerted thereupon by the front coils E and F. The pivotally-mounted polarized armature j is normally retracted away from contact-making position, as in the system of Fig. 1, while the main armature tends always to fall by gravity or other suitable constant retractive force away from its front coils E F and toward its back magnet G, so that such main armature is not wholly dependent upon the back magnet G for its retractive force, although such back magnet G when energized reinforces the constant retractive force tending to retract the main armature. The main armature controls its contact-fingers m o and 45, so as to move the contact-fingers m and o into contact, respectively, with the contact-stop n and the contact-spring p, while moving the contact-finger 45 out of position of contact with its coöperating contact-spring 46. Reversely, the retractive movement of the main armature breaks the contacts m n and o p, while closing the contacts 45 46.

Each signaling apparatus interposed between successive blocks comprises a relay-restoring battery, such as 44, the current of the battery through its external circuit being directionally controlled by a rear pole-changer including contact-fingers 38 and 41, actuated by a rear pole-changer armature, not shown in the diagram, but controlled by a slow-acting rear pole-changer magnet A, so that after the magnet has been energized it will attract its armature so as to move its contact-fingers 38 and 41 into contact with their respective coöperating contact-stops 39 and 42, and after the magnet has been deënergized for a short period of time it will release its rear pole-changer armature, which will then be retracted by gravity or any other suitable constant retractive force so as to reverse the positions of its contact-fingers 38 and 41 and bring them into contact, respectively, with their coöperating contact-stops 40 and 43 in lieu of their respective contact-stops 39 and 42. The rear pole-changer magnets are normally deënergized and their armatures and pole-changer contact-fingers are therefore normally in retracted positions.

The track-circuit pole-changers of Fig. 2, which may now be termed the "advance" pole-changers in contradistinction to the rear pole-changers of the system of Fig. 2, correspond in connections, functions, &c., to the semaphore-actuated pole-changers of Fig. 1; but in the present instance such track-circuit pole-changers or advance pole-changers are operated by advance pole-changer armatures, not shown in the diagram, but actuated by advance pole-changer electromagnets, such as C, normally deënergized, but controlled by a local circuit in a manner which is to be fully described hereinafter. In addition to operating the contact-fingers 2 and 6 of its pole-changer at the advance end of the block B the armature of the advance pole-changer magnet also operates an additional contact-finger c, coöperating with the contact-stop e. Normally—that is to say, when the pole-changer magnet C is deënergized—this contact-finger c makes contact with its contact-stop e, while the contact-fingers 2 and 6 of the advance pole-changer make contact, respectively, with their coöperating contact-stops 4 and 7. The contact-fingers c, 2, and 6 are normally held in such normal positions by suitable retractive means, not shown in the diagram, but effective to draw such contact-fingers into their normal positions when the advance pole-changer magnet is deënergized. When the advance pole-changer magnet is energized, its armature is attracted thereby so as to move its contact-finger c out of position of contact with its coöperating stop e, while moving its pole-changer contact-fingers 2 and 6 out of contact with their respective stops 4 and 7 and into contact with their respective stops 3 and 5.

Each signaling apparatus interposed between successive railway-blocks of the system diagrammed in Fig. 2 comprises two semaphore-actuated contact-levers, such as w and 36, coöperating, respectively, with a contact-stop x and a contact-spring 37. Normally—that is to say, when the home-signal semaphore H is in its danger position—these semaphore-actuated contact-levers are out of contacting positions; but as the home-signal semaphore is moved to its clear position the semaphore-actuated contact-levers 36 and w are moved into contacting positions, the contact-levers 36 first making contact with its coöperating contact-spring 37, and the contact-lever w making later contact with its coöperating contact-stop x, so that when the home-signal semaphore has attained its extreme clear position both of its semaphore-actuated contact-levers are in contacting positions. Of course when the home-signal semaphore is moved again to its danger position its semaphore-actuated contact-levers are by such movement of the semaphore retracted from their contacting positions.

We may now consider the circuits and circuit branches which coöperate with or are comprised in the track-circuit of any block of the system, taking, for example, the block B^2, since all of the circuits and circuit branches of this block are illustrated in the diagram. An advance track-battery, such as 9^b, is located at the advance end of each block and corresponds in all respects to the advance track-batteries of the system of Fig. 1. Excepting, of course, the connections dispensed with pursuant to dispensing with the resistances, such as R of Fig. 1, as has been already explained, the advance track-battery 9^b and its advance track-relay Y^4 are connected together and through the advance pole-changer to the advance ends of the rails of the block B^2, all in the manner which has already been described with respect to the corresponding connections of the system of Fig. 1, and such advance track-battery and advance track-relay and advance pole-changer and all the connections thereof also correspond in operation and coöperation to the corresponding elements of the system of Fig. 1, so that the advance end of the left rail l of the block B^2 normally leads through the advance pole-changer to the negative pole of the advance track-battery, while the positive pole thereof leads through the front coils K^2 J^2 of the advance track-relay Y^4 and thence through the advance pole-changer and normally to the advance end of the right rail r of such block, the advance ends of the rails of the block B^2 being thereby normally charged by the advance track-battery 9^b with electromotive force, having the home clearing direction or polarity. The connections at the rear end of the block B^2 are, however, different from the rear end connections of the blocks of the system of Fig. 1. In the present instance the track-circuit of each block comprises a rear branch, which is normally closed and which is traceable as follows: from the rear end of the right rail r of the block—for instance, the block B^2—through conductor 16, connected to such rear end of the right rail and to the contact-finger 38 of the rear pole-changer of the block B^2, thence through such contact-finger and its coöperating contact-stop 40, with which the finger is normally in contact, thence through conductor 34, contact-spring 46, contact-finger 45, normally in contact with such spring and controlled by the main armature of the rear track-relay X^3 of the block B^2, and from such contact-finger 45 through conductor 32 to the positive pole of the rear track-battery or relay-restoring battery 44, thence through such battery to its negative pole, and from the negative pole thereof through conductor 33, contact-stop 43 of the rear pole-changer, its contact-finger 41, normally in contact therewith, conductor 18, the two back coils G of the back magnet of the rear track-relay X^3, the circuit leading through such back coils in series with each other, and thence leading through conductor 19 to the rear end of the left rail l of the block B^2, with which rear end such conductor 19 is connected. It will be noted that the foregoing rear branch of the track-circuit of the block B^2 includes its rear track-battery or relay-restoring battery 44 with the rear end of the right rail of the block leading normally through the rear pole-changer into the positive pole of such relay-restoring battery, while the negative pole thereof leads normally through such rear pole-changer and the back coils G to the rear end of the left rail, so that the rear track-battery or relay-restoring battery 44 normally charges the right and left rails positively and negatively, respectively, and tends to force current through its rear branch of the track-circuit and through such rails thereof in a direction opposed to the direction in which the advance track-battery 9^b tends to force current through such rails. Thus the rear or relay-restoring battery 44 constitutes a counter or opposed electromotive force in the track-circuit or track branch of the advance track battery 9^b, the result being to reduce the effective conductance of the track-circuit of the block B^2, and thus maintain in retracted positions both the home clearing and the home and distant clearing armatures of the advance track-relay Y^4 of such block and in a manner which has already been clearly described with respect to the retractive effect of the momentary relay-restoring current employed in the system of Fig. 1 and derived from the semaphore-actuating or relay-restoring batteries, such as 8, thereof. The advance track-battery 9^b and the rear track-battery or relay-restoring battery 44 may be so balanced in their electromotive forces that neither battery forces any considerable amount of current through the track-circuit of the block B^2 in opposition to the other battery, the effect as regards consumption of current being that of the normally open track-circuit of the system of Fig. 1. Of course some current may flow from either or both batteries through the leakage branch of their common track-circuit, but such current will not be sufficient to effect any attraction of their armature of the advance track-relay Y^4, nor will it in any wise affect the rear track-relay X^3, since any current passing through the rear branch of the track-circuit, which has just been described as including its back coils G, can only have the effect of energizing such back coils and causing them to hold the main armature of the rear track-relay X^3 still more firmly in its normal retracted position.

We may now consider the operation of the system diagrammed in Fig. 2, commencing with an investigation of the sequence of actions resulting from the progressive movement of a railway-train along the railway-line and toward the block B and from a point in rear thereof.

It may be assumed that a railway train or vehicle is present in the block in rear of the block B and is proceeding toward the block B. The presence of such train or vehicle in the block in rear of the block B will have short-circuited the rails of such rear block and will have actuated the advance track-relay at the advance end of such rear block, so that the home clearing coils and the home and distant clearing coils and the back coils of the rear track-relay at the rear end of the block B, corresponding, respectively, to the home clearing coils E and the home and distant clearing coils F and the back coils G of the rear track-relay X^3 at the rear end of the block B^2 will all be connected to the rails at the rear end of the block B, so as to be included in the rear end of the track-circuit of such block and all in a manner which will later be developed with respect to the presence of a train in the block B and the effect thereof upon the advance track-relay Y^3 and the rear track-relay X^3, located at the advance and rear ends of the blocks B and B^2, respectively. Such connection of all the coils of the rear track-relay of the block B in the rear end of its track-circuit so increases the conductance of such track-circuit that the home clearing relay-armature of the advance track-relay Y^3 at the advance end of such block is attracted toward the front coils K J of such advance track-relay, all in the manner and for the electrical and magnetic reasons already set forth in connection with the corresponding operation of the advance track-relays of the system diagrammed in Fig. 1. Such attraction of the home clearing-armature of the advance track-relay Y^3 brings its contact-finger f into contact with its coöperating contact-stop g, and thereby closes a circuit local to the signaling apparatus at the advance end of the block B, such local circuit being a local circuit of the relay-restoring battery or rear track-battery 44, including the home clearing coils E of the track-relay X^3, connected to the rear end of the track-circuit of the block B^2. Such local circuit is traceable as follows: from the positive pole of the relay-restoring battery 44, through the conductor 32, contact-finger 45, its coöperating contact-spring 46, with which the contact-finger is normally in contact, conductor 34, rear pole-changer contacts 40 38, conductor 16, contact-stop g, its coöperating contact-finger f, which has just been moved into contact therewith, conductor 17, the two home clearing coils E in series with each other, conductor 18, normal pole-changer contacts 41 43, and conductor 33, back to the negative pole of the relay-restoring battery. Such closing of the contacts f g, which introduces the home clearing relay-coils E into a local circuit of the relay-restoring battery 44, also introduces such home clearing coils E into the rear end of the track-circuit or track branch of the advance track-battery 9^b of the block B^2, such rear home clearing coils E being introduced in parallel with the relay-restoring battery 44 as regards the circuit relationship of such coils and battery to the track-circuit of the block B^2, the rear branches of such track-circuit being now traceable as follows: from the rear end of the right rail of the block B^2, which right rail leads from the positive pole of the advance track-battery 9^b, through the conductor 16, and thence through two parallel branches to the conductor 18, one of such parallel branches leading from the conductor 16, through contacts g f, conductor 17 and rear home clearing coils E to the conductor 18, and the other branch leading from the conductor 16, through the normally closed rear pole-changer contacts 38 40, wire 34, normally closed contacts 46 45, controlled by the rear track-relay X^3, wire 32, to the positive pole of the relay-restoring battery 44, and thence through such relay-restoring battery in a direction opposed to the direction of its own polarity and to the conductor 33, and thence through the normal rear pole-changer contacts 43 41, to the conductor 18, where the two branches reunite and from whence the track-circuit of the block B^2 continues through the back coils G of its rear track-relay and through conductor 19 to the rear end of the left rail l of the block. From the foregoing it will be apparent that the home clearing coils E of the rear track-relay X^3 of the block B^2 are included both in a circuit of the relay-restoring battery 44 and in a circuit of the advance track-battery 9^b and that both these batteries coördinately or conjunctively tend to induce current in one common direction in such home clearing coils or front coils E, although the two batteries are still opposed in the respective directions in which they tend to induce current in the back coils G of the rear track-relay X^3, wherefore the home clearing front coils E of such rear track-relay preponderate in their magnetic attraction upon the main armature thereof and raise the main armature to its attracted position or position of nearest approach to such home clearing front coils E and to the home and distant clearing front coils F. Such attraction of the main armature of the rear track-relay X^3 closes its contacts m n o p and after the main armature has passed through a portion of its movement toward the front coils opens its contacts 45 46. The spring-contact 46 follows the first portion of the movement of its coöperating contact-finger 45, so that the rear branch of the track-circuit of the block B^2, including such contacts 45 46 and including the rear track-battery 44, will not be broken until the main armature of the relay has been moved a considerable distance away from its back coils and toward its front coils. After such rear branch of the track-circuit, including its rear track-battery 44, is broken the home clearing front coils E of the rear track-relay X^3 and the back coils G thereof remain connected in series with each other in a single rear branch of the track-circuit traceable as follows: from the rear end of the right rail r of such track-circuit, through the conductor 16, contacts g f, conductor 17, home clearing front coils E, conductor 18, back coils G and conductor 19, to the rear end of the left rail l of such track-circuit. The rear track-battery 44 now being completely out of circuit, the advance track-battery 9^b induces current throughout its track-circuit of the block B^2 and through the rear branch thereof which has just been traced, so that both the home clearing front coils E and the back coils G, included in such branch in series, are energized and exert opposing magnetic attractions upon the main armature which is interposed between them; but these opposing coils are so constructed and adjusted and their respective distances from their common main armature at the instant of breaking the circuit of the rear track-battery 44 are so determined that the magnetic attraction of the home clearing front coils E due only to energization from the advance track-battery 9^b will preponderate over the combined retractive effort of the back coils G, likewise due only to energization by the current from the advance track-battery, together with the constant retractive effort of gravity or other suitable force upon the main armature. Such preponderance of the magnetic attraction of the home clearing front coils E upon the main armature of the rear track-relay after it has cut the rear track-battery 44 out of circuit, together with the momentum of such armature at the instant of cutting out such rear track-battery 44, continues to move the main armature toward the front coils of the relay until it reaches its position of nearest approach thereto, where it is held by such preponderance of the home clearing front coils E.

It will be clearly apparent that if a train were present in the block B^2 prior to closure of the home clearing contacts *f g* by attraction of the home clearing armature of the advance track-relay Y^3, which has already been explained and which introduces the home clearing front coils E of the rear track-relay X^3 into the rear end of the track-circuit of the block B^2 and also into a local circuit of the rear track-battery 44 of such block, then prior to such closure of the home clearing contacts *f g* of the advance track-relay Y^3 the rear track-battery 44 of the track-circuit of the block B^2 would be discharging current through its normally closed rear branch of such track-circuit, including such rear track-battery 44, in series with the back coils G of the rear track-relay of such block, because the circuit of the rear track-battery 44 through such rear branch of its track-circuit would be closed by the short-circuiting effect of the wheels and axles of the train which is assumed to have entered the block B^2. Such current, passing from the rear track-battery 44 through the short-circuited rails of the block B^2 and through the back coils G of the rear track-relay of such block, would of course energize such back coils above their normal strength and cause them to hold their main armature in its normal or retracted position even more firmly than in the absence of any train from the block B^2. When under these conditions instant to the presence of a train in the block B^2 the advance relay-contacts *f g* are closed by presence of a train in the block in rear of the block B, so as to introduce the home clearing front coils E of the rear track-relay X^3 into the circuits already traced, the rear track-battery 44 will commence to discharge current through its local circuit, including such home clearing front coils E and will thus energize them; but it will continue to discharge current also through the back coils G by way of the rear branch of the track-circuit of the block B^2 and its short-circuited rails, whereby the home clearing front coils E and the back coils G of the rear track-relay X^3 will oppose each other in their attractive efforts upon their common main armature, although the attraction of the back coils G, combined with the constant retractive force continuously exerted on the main armature, will preponderate over the magnetic attraction of the home clearing front coils E, thereby preventing such home clearing front coils from attracting their main armature in the manner which has already been described as resulting from presence of a train in the block in rear of the block B, providing the block B^2 is not occupied. When the main armature of the rear track-relay X^3 is attracted toward its front coils by such presence of a train in the block in rear of the block B, the closing of the contacts *m n*, resulting from such attraction of the main armature, preliminarily closes at such contacts still another rear branch of the track-circuit of the block B^2, which may be designated the "distant" clearing rear branch thereof and which yet remans, however, completely closed at other contact-points. This distant clearing rear branch will later be traced and described, together with the purpose thereof. The closing of the contacts *o p* preliminarily connects the distant clearing contact-finger c^3 of the advance track-relay Y^3 with one pole—in this instance the negative pole—of the semaphore-actuating battery 8, such connection being made through the following conductors: the conductor 26, connected to the negative pole of such semaphore-actuating battery, contacts *o p*, conductor 25, and conductor 29, connected to such contact-finger. The closing of contacts *o p* also closes the local circuit of the home semaphore-actuating magnet *h*, such local circuit being as follows: from one pole of the semaphore-actuating battery—in this case the positive pole thereof—through the conductor 24, home semaphore-actuating magnet *h*, conductor 25, contacts *p o*, and conductor 26 back to the opposite or negative pole of the battery.

As soon as the home semaphore-actuating magnet *h* is energized its home-signal semaphore H moves to clear position and during such movement brings its semaphore-actuated contact-lever 36 into contact with its coöperating contact-spring 37, thereby immediately closing the following local circuit of the advance pole-changer magnet C: from the positive pole of the semaphore-actuating battery 8 through conductor 24, semaphore-actuated contact-lever 36, its coöperating contact-spring 37, advance pole-changer magnet C, conductor 35, contact-stop e^3, and its coöperating contact-finger c^3 normally held in contact with such stop e^3 by retractive effort of the distant signal back magnet I and then from the contact-finger c^3 back to the opposite or negative pole of the semaphore-actuating battery 8, through the succession of conductors already traced and forming a connection preliminarily closed at the contacts *o p*. The advance pole-changer magnet C is immediately energized by closure of its foregoing local circuit and immediately attracts its armature, so as to move the contact-finger *c* thereof out of position of contact with its coöperating contact-stop *e*, thereby opening at the contacts *c e* the distant clearing rear branch of the track-circuit of the block B², which has already been mentioned and which is yet to be completed. Such opening of the contacts *c e* of the distant clearing rear branch occurs immediately after the semaphore-actuated contact-lever 36 contacts with its spring 37 during the clearing movement of the home-signal semaphore H and occurs, therefore, before the further clearing movement of such home-signal semaphore H has carried its semaphore-actuated contact-lever *w* into contact with the contact-stop *x*, so as to close at such contacts *w x* such distant clearing rear branch, but not until the same has been opened at its other contacts *c e*.

The attraction of the advance pole-changer armature by its pole-changer magnet C reverses the advance pole-changer controlled by such armature, so as to send distant clearing current over the rails of the block B, and thereby clear the distant-signal semaphore at the rear end thereof and all in a manner which is shortly to be described with reference to the clearing of the distant-signal semaphore D at the rear end of the block B² and when the train shall have entered the block B from the block in rear thereof, wherein the train is now located in its approach toward the signals at the rear end of the block B. The train now proceeds nto the block B and short-circuits the rails thereof, so as to greatly increase the conductance of the track-circuit of that block, and thereby cause the attraction of the distant clearing relay-armature of its advance track-relay Y³ toward the home and distant clearing front coils J of such advance relay. Such attraction of the distant-clearing relay-armature moves its contact-finger c^3 out of contact with the stop e^3, and thereby breaks the local circuit of the advance pole-changer magnet C, so as to deenergize the latter and cause its armature to be retracted, thus restoring its advance pole-changer to position for sending home-clearing current through its track-circuit and at the same time reëstablishing contact between the contact-finger *c*, actuated by such pole-changer armature and its coöperating contact-stop *e*. The same attraction of the distant-clearing armature of the advance track-relay Y³ toward its front coils, which is caused by presence of the train in the block B and which has moved its contact-finger c^3 out of contact with its coöperating contact-stop e^3, also serves to bring such contact-finger c^3 into contact with its opposing contact-stop e^5, thereby closing the following local circuit of the rear pole-changer magnet A: from the positive pole of the semaphore-actuating battery 8 through conductor 24, semaphore-actuated contacts 36 37, conductor 31, rear pole-changer magnet A, conductor 30, contact-stop e^5, its coöperating contact-finger c^3, and thence through the connection already traced to the opposite or negative pole of the semaphore-actuating battery 8. After such local circuit of the rear pole-changer magnet A has been closed such magnet is energized and attracts its armature, thereby reversing the rear pole-changer controlled by such armature; but since such pole-changer is at the moment included in the open branch of the track-circuit which comprises its rear track-battery or relay-restoring battery 44, together with the rear relay-contacts 45 46, controlling such battery and open at the moment, such reversal of the rear pole-changer has no immediate effect upon any circuit of the system.

As the train enters the block B the signals at the rear end thereof move to their danger positions, for reasons which will clearly appear in the description of the corresponding movements of the home and distant signals H D at the rear end of the block B² upon future entrance of the train into such block.

The foregoing reëstablishment of the contacts *c e*, controlled by the advance pole-changer magnet C and closed by deënergization thereof upon entrance of the train into the block B, completely closes the distant clearing rear branch of the track-circuit of the block B², which is now traceable as follows: from the rear end of the right rail *r* of such block through the conductor 16, advance relay home clearing contacts *g f*, conductor 17, distant clearing contacts *e c*, controlled by advance pole-changer magnet C, conductor 20, home-signal semaphore-actuated distant clearing contacts *x w*, conductor 21, distant clearing front coils F of the rear track-relay X³, conductor 22, rear relay distant clearing contacts *n m*, and thence through conductor 19 to the rear end of the left rail *l* of the block B². Current in the home clearing direction now flows from the rails of the block B^2 through the distant clearing rear branch of its track-circuit, which has just been closed, and through the distant clearing front coils F thereof; but such current being in home clearing direction does not energize the cores of the distant clearing coils F with the proper polarity to actuate their pivotally-mounted polarized armature *j*, which therefore remains in non-contacting position.

The foregoing closure of the distant clearing rear branch of the track-circuit of the block B^2 increases the total conductance of such track-circuit sufficiently to cause the attraction of the home clearing armature of its advance track-relay Y^4 toward the front coils K^2 J^2 thereof, so as to close its contacts f^2 g^2, and thereby clear the home signal H^2 at the advance end of the block B^2 and at the rear end of the block B^3 and in the manner which has already been described with respect to the corresponding clearing of the home signal H, such clearing of the home signal H^2 depending, of course, upon a clear condition of the block B^3. Such clearing of the home signal H^2 results in reversing the track-circuit pole-changer at the advance end of the block B^2, so as to send distant clearing current in lieu of home clearing current over the rails of such block and through all the rear branches of its track-circuit which are closed at the moment of establishment of such distant clearing current; but this reversal of current in the track-circuit of the block B^2 involves a momentary cessation of current therein between discontinuance of home clearing current and establishment of distant clearing current, and during such cessation of current in the track-circuit all the coils of its rear relay X^3 will of course be deenergized, so that the main armature thereof may be released and retracted toward its back magnet G, thereby breaking at its contacts *m n* the distant clearing rear branch of the track-circuit, which rear branch has just been closed at the contacts *c e*, controlled by the pole-changer magnet C. The same retraction of the main armature of the rear track-relay X^3 will momentarily break at its contacts *o p* the local circuits of the home semaphore-actuating magnet *h* and the rear pole-changer magnet A; but such momentary opening of the local circuit of the rear pole-changer magnet A cannot effect retraction of its armature, and therefore the rear pole-changer controlled thereby cannot be reversed, because the armature and pole-changer controlled by the rear pole-changer magnet A are retained in their attracted positions a certain considerable period of time after deënergization of such magnet. If the rear pole-changer magnet were not reënergized before the expiration of such period of retention, the rear pole-changer armature and its pole-changer would be reversed by their constant retractive force at the expiration of the period of retention. The structural and electrical features of the rear pole-changer magnet A, by means of which is effected the foregoing retention of its armature and pole-changer, are not illustrated in the diagram, since they are in various forms well known to the art. Also the foregoing momentary breaking of the circuit of the home semaphore-actuating magnet *h* at the contacts *o p* by falling of the main armature of the rear track-relay X^3 is not equal to the period of retention of the home signal H, and the main armature will be reattracted toward its front coils and will thus reclose its contacts *o p* and the circuits of the home semaphore-actuating magnet *h* and rear pole-changer magnet A before the home signal H can start toward danger position and before such rear pole-changer magnet A can drop its armature to restore normal position of its rear pole-changer.

The foregoing momentary falling or retraction of the main armature of the rear track-relay X^3, due to momentary cessation of its energizing-current as such current is reversed by clearing of the home signal H^2 at the advance end of its track-circuit, not only momentarily opens the distant clearing rear branch of such track-circuit and the local circuits of the home semaphore-actuating magnet *h* and the rear pole-changer magnet A, but also closes at its contacts 45 46 the rear branch of such track-circuit of the block B^2, which rear branch includes the relay-restoring battery 44. Thus such battery is momentarily introduced in multiple with the home clearing coils E of such rear track-relay X^3 as regards the circuit relations of such battery and coils of the track-circuit of the block B^2 and its advance track-battery 9^b, while at the same time such battery is also introduced in series with the same home clearing coils in a local circuit of the signaling apparatus located at the rear end of the block B^2 and which local circuit has been traced hereinbefore. Now since the advance and rear pole-changers controlling the currents of the advance and rear track-batteries, respectively, are both reversed, such two batteries will oppose each other in their efforts to energize the back coils G of the rear track-relay X^3 and will assist each other in their concurrent efforts to energize the front home clearing coils E of the same relay, so as to effect reattraction of the main armature in the manner and for the reasons already set forth regarding the initial attraction of the main armature by corresponding coaction of the same advance and rear track-batteries when the home clearing rear coils E were first introduced into circuit by entrance of the train into the block in rear of the block B and when both the advance and rear pole-changers of the block B^2 were in their normal positions.

The foregoing reattraction of the main armature of the rear track-relay X^3 immediately reopens the rear branch of its track-circuit, including the rear track-battery 44, and at the same time recloses the local circuits of the home semaphore-actuating magnet h and the rear pole-changer magnet C and before the home signal H has had time to assume danger position and before the rear pole-changer has been restored to normal position, so that such home signal is still held clear and such rear pole-changer is still held reversed. The same reattraction of the main armature recloses at its contacts m n the distant clearing rear branch of the track-circuit of the block B^2, in which track-circuit a current in distant clearing direction is now flowing. Now, therefore, distant clearing current flows through such distant clearing rear branch of the track-circuit of the block B^2 and through the distant clearing front coils F included in such distant clearing rear branch, and such distant clearing current in the distant clearing coils F effects the actuation of their distant clearing polarized armature j, so as to swing such armature into position of contact with its coöperating contact-stops k i, thereby closing the following local circuit of the distant semaphore-actuating magnet d: from one pole, in this instance the positive pole, of the semaphore-actuating battery 8, through conductor 24, distant semaphore-actuating magnet d, conductor 28, contact-stop i, polarized distant clearing armature j, contact-stop k, and conductor 26 back to the opposite or negative pole of the battery. Upon such closure of the local circuit of the distant semaphore-actuating magnet d the latter is energized and effects the clearing of its distant-signal semaphore D, so that when the train reaches the advance end of the block B it will come upon clear signals for both the home and distant blocks B^2 and B^3, respectively. The train now proceeds into the rear end of the block B^2, and as the advance trucks of the train enter such block their wheels and axles short-circuit the rails thereof and deprive all the rear branches of its track-circuit of current, so that all the coils of the rear track-relay X^3 become immediately deënergized. The immediate result is that both the main armature and the distant clearing armature of that relay are retracted to their normal positions, so as to open all their contacts excepting the contacts 45 46, controlled by the main armature, these latter contacts being closed by the retractive movement of such main armature. The opening of contact between the distant clearing polarized armature j and its contact-stops k i opens the local circuit of the distant semaphore-actuating magnet d and causes the distant-signal semaphore D to go to "danger." The opening of the contacts m n, controlled by the main armature, opens the distant clearing rear branch of the track-circuit, which is the branch including the distant clearing front coils F. The opening of the contact o p, also controlled by the main armature of the relay, opens the local circuit of the home semaphore-actuating magnet h, and thereby deënergizes such semaphore-actuating magnet and causes its home-signal semaphore H to go to danger position. Such danger movement of the home-signal semaphore H opens its semaphore-actuated contacts w x and 36 37. Thereby the distant clearing rear branch of the track-circuit of the block B^2 is opened at its semaphore-actuated contacts w x in addition to its opening at its rear relay-contacts m n, while the opening of the semaphore-actuated contacts 36 37 opens the local circuit of the rear pole-changer magnet A, which local circuit has, however, been also opened at the rear relay-contacts o p included therien, and as soon as the period of retention of the rear pole-changer magnet expires its armature and pole-changer will be restored by their constant retractive force to normal positions.

The reëstablishment of contact between the contact-spring 46 and its coöperating contact-finger 45, controlled by the main armature of the rear track-relay X^3 of the block B^2, recloses the rear branch of the track-circuit of that block, including the rear track-battery or relay-restoring batery 44 in its own local circuit as well as in such track-circuit. Thereupon such rear track-battery 44 is reëstablished in its two parallel local and track circuits, including, respectively and in parallel with each other, the home clearing front coils E of the rear track-relay X^3 and the back coils G thereof, the circuits of the rear track-battery 44 being now traceable as follows: from the positive pole of such rear track-battery through the conductor 32, rear relay-contacts 45 46, conductor 34, rear pole-changer contact-stop 42, its coöperating contact-finger 41, which is to remain in contact with such contact-stop during the period of retention of the rear pole-changer armature in its attracted position or position for reversing the rear pole-changer, and from such rear pole-changer contact-finger 41 to the conductor 18, and thence to the conductor 16 and through the two parallel branches, including the home clearing front coils E and the back coils G, respectively, the first branch leading through such home clearing front coils E, conductor 17, and advance relay home clearing contacts f g to the conductor 16, and the other branch leadign from the conductor 18 through the back coils G, conductor 19, left rail l of the block B^2, short-circuiting wheels and axles of the train which is entering such block, and right rail r of such block to the conductor 16, wherein the two branches reunite and from whence the circuit continues through the rear pole-changer contact-finger 38, its contact-stop 39, with which such contact-finger is to remain in contact during its period of reversed retention, and thence through conductor 33 back to the opposite or negative pole of the rear track-battery 44. Current from the rear track-battery 44 continues to flow through its rear pole-changer and through its circuits which have just been traced and in the reverse direction determined by the reversed position of such pole-changer and until the period of retention thereof has elapsed, whereupon the pole-changer is reversed so as to reverse the direction in which current flows from the battery through such parallel branches; but the period of pole-changer retention is short as compared with the movement of the train, so that the pole-changer and the current from its rear track-battery are restored to normal position and direction shortly after the advance end of the train has entered the block B^2. Therefore in this particular instance when the train enters the block B^2 from the block B the reversed direction of current from the rear track-battery 44 of the block B^2 is short-circuited by the wheels and axles of the train present in the block B^2, and therefore has no effect upon the track-relay at the advance end of the block B^2. The reversed current from the rear track-battery 44 through its track-circuit has a relay-restoring function, which will clearly appear hereinafter in the description of the operation of the system resulting from the exit of a train from the block B and into a branch or siding in lieu of the block B^2. Under the foregoing conditions established by entrance of the train into the block B^2 current from the rear track-battery 44 flows through its rear pole-changer both before and after such pole-changer has been restored to normal position, and through both the home clearing front coils E and the back coils G of the rear track-relay X^3, so that these coils oppositely attract their common main armature, although the back coils, together with the constant retractive force upon the armature, preponderate and retain the armature in retracted position. It will be noted that the current which flows from the rear track-battery 44 through its rear pole-changer and after the same has been restored to normal position by deënergization of the rear pole-changer magnet A is in its normal relay-restoring direction through the track-circuit of the block B^2—that is to say, such current flows into the rear end of the right rail of such block and returns from the rear end of the left rail thereof, although such current can produce no immediate effect upon the relay Y^4, connected to the advance end of the track-circuit, since the short-circuiting effect of the train now present in the block B^2 prevents any transmission of current from its rear track-battery or relay-restoring battery forwardly along the rails of such block. The rear end of the train now leaves the block B, whereupon both the home clearing armature and the distant clearing armature of the advance track-relay Y^3 of that block are retracted for reasons which will appear in describing the retraction of the armatures of the advance track-relay Y^4 of the block B^2 upon exit of the train from such latter block. The retraction of the distant clearing advance relay-armature moves its contact-finger c^3 out of contact with its coöperating contact-stop e^5, thereby still further opening at such contacts c^3 e^5 the local circuit of the rear pole-changer magnet A, in which local circuits such contacts are included. The same retractive movement of the distant clearing armature reëstablishes contact between such contact-finger c^3 and its coöperating contact-stop e^3, thereby at this point reestablishing the local circuit of the advance pole-changer magnet C, although such local circuit of the pole-changer magnet is at this moment of course open at the semaphore-actuated contacts 36 37 and also at the rear relay-contacts o p. The retractive movement of the home clearing advance relay-armature reopens its contacts f g, thereby reopening the rear branch of the track-circuit of the block B^2, which rear branch includes the home clearing coils E of its rear track-relay X^3. Such reopening of such branch through the home clearing coils E leaves in circuit with the rails of the block B^2 only the normally closed rear branch of its track-circuit, which has hereinbefore been traced and which the rear pole-changer having been restored to its normal position leads from the rear end of the left rail l of the block B^2 through the conductor 19, back coils G of the rear track-relay, conductor 18, pole-changer contacts 41 43, conductor 33, relay-restoring battery 44, and from the positive pole thereof through the conductor 32, rear relay-contacts 45 46, conductor 34, rear pole-changer contacts 40 38, and conductor 16 to the rear end of the right rail r of the block B^2. So long as the train is present in the block B^2 the relay-restoring battery 44 thereof continues to force current through the normally closed rear branch of its track-circuit and in the direction in which such rear branch has just been traced—that is, from the rear end of the left rail of the block through the battery and to the rear end of the right rail, and thence forward along such right rail and through the short-circuiting wheels and axles of the train and to the left rail, and thence rearwardly along the left rail and back to the battery. The existence and direction of this current should be kept in mind, since it is to assist in effecting retraction of the armatures of the advance track-relay Y^4 of the block B^2 when the train shall leave such block.

The presence of the train in the block B^2 so increases the conductance of the track-circuit of that block that the distant clearing relay-armature of its advance track-relay Y^4 is attracted toward the home and distant clearing front coils J^2 thereof, so as to result in the clearing of the distant-signal semaphore D^2 at the advance end of the block B^2 and at the rear end of the block B^3 and in the manner already described with reference to the clearing of the distant signal D, but providing, of course, that there is no train present in the block in advance of the block B^3—that is to say, the block second in advance of the distant signal D^2. The train now proceeds forward through the block B^2 and enters the block B^3 in advance thereof, producing all the results which have just been described as resulting from the entrance of the train into the block B^2.

The presence of the train in the block B^2 has of course effected deënergization of the advance pole-changer magnet C^2 at the advance end of such block, so as to restore the advance pole-changer thereof to normal position or position for sending home clearing current through the rails of the block B^2, and so long as the train remains present in the block B^2 such home clearing current therein is short-circuited by the train, as is also the normal relay-restoring current which continues to flow from the rear track-battery 44 through the rails of the block B^2; but the instant the rear end of the train leaves the block B^2 this short circuit is broken, so that the normal relay-restoring current comes immediately into opposition with the home clearing current tending to flow through the rails of the block B^2 and from the advance track-battery 9^b at the advance end of such block, whereupon such normal relay-restoring current immediately insures retraction of the home clearing and distant clearing armatures of the advance track-relay Y^4 at the advance end of the block B^2 and with all the results which accompanied the corresponding retractive movements of the relay-armatures of the advance track-relay Y^3.

Thus the train proceeds throughout successive blocks of the system, causing the signals in advance to be cleared and causing the signals in rear to return to their normal danger positions.

We may now learn how the signals in advance of a train having been cleared by the approach of such train are returned to their normal danger position when the train leaves the raliway-line whereon its presence has caused such clearing of such advance signals. For instance, if a train leaves the block B by way of a branch or siding and after having entered such block B from the rear thereof and after having reversed the rear pole-changer of the block B^2 and cleared the home and distant signals at the rear end thereof, and hence, of course, having effected attraction of the advance home clearing armature of the block B^2 so as to clear the home signal at the advance end thereof, and thereby reverse the advance pole-changer of such block B^2 and maintain therein the distant clearing current necessary to clear the distant signal D at its rear end, the exit of the train from the block B under such conditions will effect the retraction of the home clearing and distant clearing armatures of its advance track-relay Y^3 in the same manner and for the same reasons that such armatures are retracted when the train leaves such block in entering the block B^2, the reasons for such retraction of the advance relay-armatures having been explained in connection with the retraction of the advance relay-armatures of the block B^2 upon exit of a train from such block. The retraction of the advance distant clearing armature of the block B immediately breaks its contacts c^3 c^5, thereby immediately opening at such contacts the local circuit of the rear pole-changer magnet A of the block B^2, so that the period of retention of such rear pole-changer magnet A immediately commences. The retraction of the advance home clearing armature of the block B breaks its contacts f g, thereby opening the distant clearing rear branch of the track-circuit of the block B^2, including the distant clearing front coils F of its rear track-relay X^3, and simultaneously opening the other rear branch of such track-circuit, which includes in series the home clearing front coils E and the back coils G of such rear track-relay X^3. Thereupon both the main armature and the distant clearing armature j of such rear track-relay are retracted, so that both the home signal and the distant signal at the rear end of the block B^2 go to their danger positions. The opening of the main armature-contacts m n of the rear track-relay of the block B^2 still further opens at such contacts the distant clearing rear branch of its track-circuit, which is still further opened at its semaphore-controlled contacts w x, which are broken by the movement of the home-signal semaphore H to its danger position. The breaking of the main armature-contacts o p still further opens at such contacts the local circuit of the rear pole-changer magnet A, while such local circuit is still further opened at the semaphore-actuated contacts 36 37, also broken by movement of the home-signal semaphore H to its danger position.

The reëstablishment of the main armature-contacts 45 46 of the rear track-relay X^3 reestablishes the rear track-battery or relay-restoring battery 44 in the normally closed rear branch of the track-circuit of the block B^2, including such relay-restoring battery and the contacts of the rear pole-changer magnet A in series with the back coils G of the rear track-relay X^3; but since this reëstablishment of the normally closed rear branch of the track-circuit occurs before the expiration of the period of retention of the rear pole-changer included in such rear branch and controlling the relay-restoring battery 44 such relay-restoring battery will be momentarily introduced—that is, during the period of retention of the rear pole-changer—in reverse direction into such normally closed rear branch of the track-circuit, so that it will tend to force current during such period of retention of the pole-changer through the rails of the block B^2 in opposition to the reverse or distant clearing current, at the same moment tending to flow in reversed direction through the rails of the block B^2 from its advance pole-changer, which is now held in reversed or distant clearing position by energization of its advance pole-changer magnet C^2. Now since the rear track-battery or relay-restoring battery 44 opposes flow of current from the advance track-battery 9^b through its track branch or track-circuit it will have the effect of reducing the effective conductance of such track-circuit, so as to insure retraction of its advance home clearing armature in the same manner and for the same reasons already set forth with respect to the opposition of the advance and rear track-batteries when the same are connected to their common track-circuit in their normal directions. Such retraction of the advance home clearing armature of the block B^2 opens its contacts f^2 g^2, thereby of course opening the rear branch of the track-circuit of the block B^3, which at the moment includes in series its rear home clearing front coils E^2 and its rear back coils G^2 of its rear track-relay X^4, the main armature of such rear track-relay being at the moment in its position of nearest approach to the front coils E^2 and being held in such position by preponderance of their attraction. However, upon breaking such rear branch of the track-circuit of the block B^3 such coils of its rear track-relay X^4 are deënergized, and its main armature is retracted, so as to open at its contacts o^2 p^2 the local circuit of the home semaphore-actuating magnet h^2, and thereby return to its normal danger position the home-signal semaphore H^2 at the rear end of such block B^3. The opening of the contacts o^2 p^2 also of course opens at such contacts the circuit of the advance pole-changer magnet C^2, controlling the advance pole-changer of the track-circuit of the block B^2, such circuit of the advance pole-changer magnet C^2 being also further opened at its semaphore-actuated contacts 36^b 37^b by the movement of the home-signal semaphore H^2 to its danger position. Such opening of the circuit of the advance pole-changer magnet C^2 of course deënergizes such magnet and causes the advance pole-changer of the block B^2 to be restored to its normal position, so as to restore home clearing direction of current in the rails of the block B^2 and from their advance track-battery 9^b.

The period of retention of the rear pole-changer magnet A of the block B^2 may be so adjusted and determined that it expires at substantially the same time that the advance pole-changer magnet C^2 is deënergized, so that the rear pole-changer of the block B^2 is reversed at substantially the same instant as its advance pole-changer, whereby the advance and rear track-batteries of the block B^2 are still maintained in opposition to each other in their common track-circuit of such block even after the advance pole-changer of such block B^2 has been restored to its normal or home clearing position.

Although I have illustrated but two particular systems in which my broad invention may be embodied, it must be understood that the same may be embodied also in various other structures and arrangements of coöperating elements and in various other arrangements and combinations of circuits, all within the principles and scope of my invention.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A railway signaling-circuit, a source of signal-controlling current therefor, means for changing the direction of the signal-controlling current, and normal danger home and distant dual indication railway block-signaling apparatus controllable by the signaling-circuit and located at a common signaling-point on the railway-line and responsive to directional changes in its signal-controlling current.

2. A railway signaling-circuit, a source of signal-controlling current therefor, means for varying the direction of the signal-controlling current in the signaling-circuit, and normal danger dual indication home and distant railway block-signaling apparatus controllable by the railway signaling-circuit and located at a given common signaling-point on the railway-line and responsive to signal-controlling current of one direction in the signaling-circuit to give the one-block-clear indication and responsive to a reversal of such current to give the two-blocks-clear indication.

3. A railway signaling-circuit, a source of signal-controlling current therefor, means for changing the direction of the signal-controlling current, and normal danger home and distant dual indication railway block-signaling apparatus located at one given signaling-point in proximity to the railway-line and comprising controlling polarized translating apparatus controllable by the signaling-circuit and responsive to directional changes in its signal-controlling current.

4. A railway signaling-circuit, a source of signal-controlling current therefor, means for varying the direction of the signal-controlling current in the signaling-circuit, and normal danger home and distant dual-signaling apparatus comprising controlling polarized translating apparatus controllable by the railway signaling-circuit and responsive to signal-controlling current of one direction therein to give the one-block-clear indication and responsive to a reversal of such current to give the two-blocks-clear indication.

5. Normal blocking railway traffic-controlling apparatus including electric translating apparatus comprising an electromagnet, one or more movable translating devices coöperative with the magnet and subject to influence of its energization in either direction of polarity, and a polarized armature also coöperative with the magnet but responsive to energization of the magnet in one direction only.

6. Normal blocking railway traffic-controlling apparatus comprising an electro-translating magnet, one or more movable translating devices controllable by magnetization of the magnet in either direction of polarity, and a polarized translating-armature responsive to change in the polarity of the magnet.

7. Railway traffic-controlling electric translating apparatus comprising a translating-magnet including two magnetic circuits, a movable translating device subject to attractive force of the magnetic flux of both magnetic circuits, and a translating device operatable by the magnetic flux of one of the magnetic circuits.

8. Railway traffic-controlling electric translating apparatus comprising a translating-magnet including two magnetic circuits, a movable translating device subject to attractive force of the magnetic flux of both magnetic circuits, and a translating device operatable by the magnetic flux of one of the magnetic circuits and not subject to influence of the magnetic flux of the other magnetic circuit.

9. Railway traffic-controlling electric translating apparatus comprising two translating-magnets, one or more movable translating devices subject to influence of magnetic attraction of both magnets, and a polarized armature responsive to magnetization of one of the magnets.

10. Railway traffic-controlling electric translating apparatus comprising two translating-magnets, one or more movable translating devices subject to influence of magnetic attraction of both magnets, and a polarized armature responsive to magnetization of one of the magnets but free from influence of magnetism of the other magnet.

11. Railway traffic-controlling electric translating apparatus comprising two translating-magnets, a translating device controllable by both magnets, and a translating device controllable by one of the magnets separately and free from influence of the other magnet.

12. Railway traffic-controlling electric translating apparatus comprising two translating-magnets, a translating device controllable by both magnets jointly, and a translating device controllable by one of the magnets separately and free from influence of the other magnet.

13. Railway traffic-controlling electric translating apparatus comprising three translating-magnets, a movable translating device controllable by two of the magnets jointly, and one or more other movable translating devices controllable jointly by one of the two magnets controlling the first-mentioned translating device and by the third magnet.

14. Railway traffic-controlling electric translating apparatus comprising three translating-magnets, a movable translating device controllable by two of the magnets, and one or more other movable translating devices controllable by one of the two magnets controlling the first-mentioned translating device and by the third magnet.

15. Railway traffic-controlling electric translating apparatus comprising two translating-magnets, a translating device movable by magnetic attraction of both magnets, one or more other translating devices movable by magnetic attraction of one of the aforesaid magnets, a retractive magnet for retracting the first said translating device, and still another retractive magnet for retracting the said one or more other translating devices.

16. A railway traffic-controlling system comprising a traffic-controlling electric circuit, a source of traffic-controlling current therefor, traffic-controlling electric translating apparatus including a translative conductor and responsive to directional variations of current therein, means for connecting the translative conductor in the traffic-controlling circuit so as to vary the resistance of the traffic-controlling circuit, and railway traffic-controlling apparatus controllable by the traffic-controlling circuit and responsive to such variation in its resistance to reverse the traffic-controlling current in the traffic-controlling circuit and thereby actuate the electric translating apparatus.

17. A railway traffic-controlling system comprising a traffic-controlling circuit, a source of traffic-controlling current therefor, and traffic-controlling electric translating apparatus controllable by traffic-controlling current from the traffic-controlling circuit and including two translating-conductors for receiving such traffic-controlling current and the translating apparatus being responsive to current in one of its translating-con-

ductors and responsive to directional variations of current in the other of its translating-conductors.

18. A railway traffic-controlling system comprising a traffic-controlling circuit, a source of traffic-controlling current therefor, and traffic-controlling electric translating apparatus controllable by the traffic-controlling circuit and including two translating-conductors and being governable by current in both of its translating-conductors jointly and also responsive to directional variation of current in one of its translating-conductors.

19. A railway traffic-controlling system including a traffic-controlling circuit, a source of reversible traffic-controlling current for the traffic-controlling circuit, and traffic-controlling electric translating apparatus comprising two electrotranslative conductors and governable to maintain one traffic-controlling condition by traffic-controlling current in both such translative conductors jointly and also responsive to directional variation of traffic-controlling current in one of such translative conductors to establish another traffic-controlling condition.

20. A railway traffic-controlling system comprising a traffic-controlling circuit, a source of traffic-controlling current therefor, and traffic-controlling electric translating apparatus controllable by the traffic-controlling circuit and including two translating-conductors and being responsive to traffic-controlling current in one of its translating-conductors to perform one traffic-controlling operation and responsive to traffic-controlling current in its second translating-conductor to maintain the traffic-controlling condition effected by the first traffic-controlling operation and being responsive also to reversal of traffic-controlling current in its second translating-conductor to effect a second traffic-controlling operation.

21. Railway traffic-controlling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given traffic-controlling positions by traffic-controlling current in one of the translating-conductors and in such positions subject to retentive influence of traffic-controlling current in the other translating-conductor.

22. Railway traffic-controlling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given traffic-controlling positions by traffic-controlling current in one of the translating-conductors and in such positions subject to retentive influence of traffic-controlling current in the other translating-conductor, and another translating device movable to perform a traffic-controlling operation by traffic-controlling current in the second translating-conductor.

23. Railway traffic-controlling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given traffic-controlling positions by traffic-controlling current in one of the translating-conductors and in such positions subject to retentive effort of traffic-controlling current in the other translating-conductor, and another movable translating device responsive to directional variation of traffic-controlling current in the second translating-conductor and to perform a traffic-controlling operation.

24. Railway traffic-controlling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given traffic-controlling position by traffic-controlling current in one of the translating-conductors and in such position subject to retentive influence of traffic-controlling current in the other translating-conductor, and another movable translating device responsive to traffic-controlling current in the second translating-conductor in one direction only and to perform a traffic-controlling operation.

25. A railway signaling system including normal danger home and distant indication railway block-signaling apparatus located in proximity to a railway-line and responsive to directional changes in signal-controlling current, a source of signal-controlling current communicating with the signaling apparatus through suitable conductive current-transmitting means, and means for reversing the signal-controlling current transmitted from the source of current to the signaling apparatus, the traffic-rails of the railway-track comprising all the conductive current-transmitting means extending from point to point along the line of traffic.

26. A railway signaling system including normal danger home and distant indication railway block-signaling apparatus located in proximity to a railway-line and responsive to signal-controlling current of one direction to give the one-block-clear indication and to a reversal of such current to give a two-block-clear indication, a source of signal-controlling current communicating with the signaling apparatus through suitable conductive current-transmitting means, and means for reversing the signal-controlling current transmitted from the source of current to the signaling apparatus, the traffic-rails of the railway-track comprising all the conductive current-transmitting means extending from point to point along the line of traffic.

27. A railway signaling system including normal danger home and distant indication railway block-signaling apparatus located in proximity to a railway-line and comprising controlling polarized electric translating apparatus responsive to directional variations of signal-controlling current, a source of sig-

nal-controlling current communicating with the polarized electric translating apparatus through suitable conductive current-transmitting means, and means for varying the direction of signal-controlling current transmitted from the source thereof to the polarized electric translating apparatus, the traffic-rails of the railway-track including all the conductors of the current-transmitting means which extend from point to point along the line of traffic.

28. A railway signaling system including normal danger home and distant indication railway block-signaling apparatus located in proximity to a railway-line and comprising controlling polarized electric translating apparatus responsive to signal-controlling current of one direction to give the one-block-clear indication and responsive to reversal of such current to give the two-blocks-clear indication, a source of signal-controlling current communicating with the polarized electric translating apparatus through suitable conductive current-transmitting means, and means for varying the direction of signal-controlling current transmitted from the source thereof to the polarized electric translating apparatus, the traffic-rails of the railway-track including all the conductors of the current-transmitting means which extend from point to point along the line of traffic.

29. A railway traffic-controlling system comprising a traffic-controlling electric circuit, a source of traffic-controlling-current therefor, railway traffic-controlling apparatus located in proximity to the railway-line and including an electrotranslative conductor responsive to directional variations of current and in control of the raiiway traffic-controlling apparatus, means for connecting the electrotranslative-controlling conductor in the traffic-controlling circuit so as to vary the conductance of such circuit, a second railway traffic-controlling apparatus located at a traffic-controlling point in proximity to the railway-line but distant from the first-mentioned traffic-controlling apparatus and controllable by the traffic-controlling circuit and responsive to its variation in conductance both to perform a traffic-controlling operation and to reverse the traffic-controlling current flowing in the traffic-controlling circuit and thereby to actuate the first-mentioned traffic-controlling apparatus through responsiveness of its electrotranslative conductor to indicate the performance of such traffic-controlling operation of the second traffic-controlling apparatus.

30. A railway traffic-controlling system comprising a traffic-controlling electric circuit, a source of traffic-controlling current therefor, traffic-controlling apparatus located at a traffic-controlling point in proximity to the railway-line and including an electrotranslative conductor in controlling relation to the traffic-controlling apparatus and communicating with the traffic-controlling circuit and responsive to traffic-controlling current therein to effect one traffic-controlling operation of the traffic-controlling apparatus and such apparatus also including a second electrotranslative conductor also in controlling relation to the apparatus and responsive to directional variation of traffic-controlling current to effect a second operation of the apparatus, means for introducing the second translative conductor into the traffic-controlling circuit so as to vary its conductance, a second traffic-controlling apparatus located at a second traffic-controlling point in proximity to the railway-line and controllable by the traffic-controlling circuit and responsive to its variation in conductance both to perform a traffic-controlling operation and to reverse the current in the traffic-controlling circuit and thereby actuate the first-mentioned traffic-controlling apparatus through responsiveness of its second translative conductor to perform its second traffic-controlling operation.

31. A railway traffic-controlling system including a traffic-controlling circuit, a source of traffic-controlling current therefor, a traffic-controlling apparatus located at a given traffic-controlling point in proximity to the railway-line and including a controlling electrotranslative conductor communicating with the traffic-controlling circuit and responsive to traffic-controlling current therein to effect one traffic-controlling operation of the traffic-controlling apparatus and such apparatus comprising also a second electrotranslative conductor in control of the apparatus jointly with the first-mentioned electrotranslative conductor to maintain the traffic-controlling condition effected by the traffic-controlling operation already mentioned, and such second electrotranslative conductor being also responsive to directional variation of traffic-controlling current to effect a second operation of the traffic-controlling apparatus, means for including the second electrotranslative conductor in the traffic-controlling circuit so as to vary the conductance thereof, a second traffic-controlling apparatus located at a second traffic-controlling point in proximity to the railway-line and controllable by the traffic-controlling circuit and responsive to the variations of conductance therein both to perform at such second traffic-controlling point a traffic-controlling operation and to reverse the traffic-controlling current in the traffic-controlling circuit and thereby to effect the second operation of the first-mentioned traffic-controlling apparatus through directional responsiveness of its second electrotranslative conductor.

32. A railway traffic-controlling system including a traffic-controlling electric circuit, a source of traffic-controlling current therefor,

a traffic-controlling apparatus located at a given traffic-controlling point in proximity to the railway-line and controllable by the traffic-controlling circuit and responsive to a variation in the conductance thereof, a second traffic-controlling apparatus located at a second traffic-controlling point in proximity to the railway-line and also controllable by the traffic-controlling circuit and responsive to traffic-controlling current therein, and means both for varying the conductance of the traffic-controlling circuit to actuate the first-mentioned traffic-controlling apparatus and for compensating the effect upon the second traffic-controlling apparatus of current perturbation caused by such variation in conductance.

33. Railway traffic-controlling apparatus comprising a traffic-controlling circuit including a portion of variable conductance, a source of traffic-controlling current for the traffic-controlling circuit, a traffic-controlling electromagnet included in the traffic-controlling circuit in series with its portion of variable conductance, a second traffic-controlling electromagnet also included in the traffic-controlling circuit but in parallel with its portion of variable conductance, a third traffic-controlling electromagnet also included in the traffic-controlling circuit in parallel with its portion of variable conductance, one or more movable traffic-controlling translating devices controllable jointly by the two electromagnets first mentioned and arranged in controlling relation to the traffic-controlling apparatus and responsive to a conductance variation in the variable portion of the traffic-controlling circuit, one or more other movable traffic-controlling translating devices controllable by the first-mentioned and last-mentioned electromagnets jointly and also in controlling relation to the traffic-controlling apparatus and also responsive to a conductance variation in the variable portion of the traffic-controlling circuit, means for effecting one variation in the conductance of the variable portion of the traffic-controlling circuit whereby to actuate the one or more first-mentioned traffic-controlling devices, and means for effecting another variation in such conductance whereby to actuate the one or more traffic-controlling devices mentioned second.

34. A railway traffic-controlling system comprising a traffic-controlling electric circuit, a source of traffic-controlling current therefor, a traffic-controlling apparatus located in proximity to the railway-line and controllable by the traffic-controlling circuit and responsive to a variation in conductance thereof, a second traffic-controlling apparatus located at another point in proximity to the railway-line and comprehending an electrotranslative controlling-conductor included in the traffic-controlling circuit and responsive to traffic-controlling current therein and the second traffic-controlling apparatus comprehending also a second electrotranslative conductor in control of such second apparatus jointly with the first controlling-conductor, and means for including the second controlling-conductor in the traffic-controlling circuit so as to vary the conductance thereof and actuate the first-mentioned traffic-controlling apparatus responsive to such conductance variation, the second electrotranslative controlling-conductor of the second traffic-controlling apparatus being also coöperative with the first controlling-conductor thereof to compensate the effect upon such first controlling-conductor of current perturbation due to introduction of the second controlling-conductor in the traffic-controlling circuit to vary its conductance.

35. A railway traffic-controlling system comprising a traffic-controlling circuit including a portion of variable conductance, a source of traffic-controlling current for the traffic-controlling circuit, traffic-controlling apparatus located at a given point in proximity to the railway-line and comprehending a traffic-controlling electromagnet included in the traffic-controlling circuit in series with its portion of variable conductance and comprehending also a second traffic-controlling electromagnet likewise included in the traffic-controlling circuit but in parallel with its portion of variable conductance and further comprehending a third traffic-controlling electromagnet also included in the traffic-controlling circuit in parallel with its portion of variable conductance, and such traffic-controlling apparatus comprehending also one or more movable traffic-controlling translating devices controllable jointly by the two electromagnets first mentioned and arranged in controlling relation to the traffic-controlling apparatus and responsive to a given conductance variation in the variable portion of the traffic-controlling circuit to perform a traffic-controlling operation and to reverse the traffic-controlling current in such variable portion, and the traffic-controlling apparatus comprehending also one or more other movable traffic-controlling translating devices controllable jointly by the first-mentioned and the last-mentioned electromagnets and also arranged in controlling relation to the traffic-controlling apparatus and responsive to a second conductance variation in the variable portion of the traffic-controlling circuit to perform a second traffic-controlling operation, a second traffic-controlling apparatus located at another point in proximity to the railway-line and including a controlling electrotranslative conductor responsive to directional variation of traffic-controlling current to perform a traffic-controlling operation, means governable by the approach of a train along the railway-line for

introducing the directionally-responsive controlling electrotranslative conductor in the variable portion of the traffic-controlling circuit so as to produce the conductance variation therein necessary to effect the first-mentioned traffic-controlling operation of the first-mentioned traffic-controlling apparatus and reverse the traffic-controlling current in the variable portion of the traffic-controlling circuit whereby to actuate the second-mentioned traffic-controlling apparatus through directional responsiveness of its controlling-conductor, and means governable by the further approach of the railway-train for producing the second conductance variation of the variable portion of the traffic-controlling circuit to effect the second operation of the first-mentioned traffic-controlling apparatus.

36. Railway traffic-controlling apparatus comprising a traffic-controlling electric circuit of variable conductance, traffic-controlling electrotranslative means controllable by the traffic-controlling circuit and responsive to a given conductance variation in the traffic-controlling circuit to perform a given traffic-controlling operation and responsive to a greater but inverse conductance variation in such circuit to perform a reverse traffic-controlling operation, means for producing the given conductance variation to effect the given traffic-controlling operation, and means for producing the greater inverse conductance variation to effect the reverse traffic-controlling operation.

37. Railway traffic-controlling apparatus comprising an electric traffic-controlling circuit of variable conductance, an electrotranslative traffic-controlling magnet controllable by the traffic-controlling circuit, one or more movable translating devices controllable by the magnet and responsive to a given conductance variation in its traffic-controlling circuit to move in one direction and thereby perform a given traffic-controlling operation and vary the influence of the electrotranslative magnet upon such translating device, and such device being also responsive to an inverse conductance variation in the traffic-controlling circuit to move in reverse direction, means for effecting a compensative conductance variation to counteract the variation of influence of the translative magnet due to movement of the translating device, and means for producing the inverse conductance variation to effect the reverse movement of the translating device.

38. Railway traffic-controlling apparatus comprising an electric traffic-controlling circuit of variable conductance, an electrotranslative traffic-controlling magnet controllable by the traffic-controlling circuit, one or more movable translating devices controllable by the magnet and responsive to a given conductance variation in its traffic-controlling circuit to move in one direction and thereby perform a given traffic-controlling operation and increase the influence of the electrotranslative magnet upon such translating device, and such device being also responsive to an inverse conductance variation in the traffic-controlling circuit to move in reverse direction, means for effecting a compensative conductance variation to counteract the increase of influence of the translative magnet due to movement of the translating device, and means for producing the inverse conductance variation to effect the reverse movement of the translating device.

39. Railway traffic-controlling apparatus comprising an electric traffic-controlling circuit of variable conductance, an electrotranslative traffic-controlling magnet controllable by the traffic-controlling circuit, one or more movable translating devices controllable by the magnet and responsive to a given conductance variation in its traffic-controlling circuit to move in one direction and thereby perform a given traffic-controlling operation and decrease the influence of the electrotranslative magnet upon such translating device, and such device being also responsive to an inverse conductance variation in the traffic-controlling circuit to move in reverse direction, means for effecting a compensative conductance variation to counteract the decrease of influence of the translative magnet due to movement of the translating device, and means for producing the inverse conductance variation to effect the reverse movement of the translating device.

40. Railway traffic-controlling apparatus comprising an electric traffic-controlling circuit of variable conductance, an electrotranslative traffic-controlling magnet controllable by the traffic-controlling circuit, one or more movable translating devices controllable by the magnet and responsive to a given conductance increase in its traffic-controlling circuit to move in one direction and thereby perform a given traffic-controlling operation and vary the influence of the electrotranslative magnet upon such translating device, and such device being also responsive to a decrease in conductance of the traffic-controlling circuit to move in reverse direction, means for effecting an additional compensative decrease in conductance of the traffic-controlling circuit to counteract the variation of influence of the translative magnet due to movement of the translating device, and means for producing the decrease in conductance of the traffic-controlling circuit to effect the reverse movement of the translating device.

41. A railway traffic-controlling system comprising a traffic-controlling electric circuit of variable conductance, traffic-controlling electrotranslative apparatus controlla-

ble by such traffic-controlling circuit and by variations of conductance therein and including one or more translating devices responsive to a given conductance variation to perform one traffic-controlling operation and also including one or more other translating devices responsive to a second conductance variation to perform another traffic-controlling operation, the first-mentioned translating device or devices being subject to a variation in the actuative influence of the translating apparatus due to response of such first-mentioned devices to the first-mentioned conductance variation, and the one or more last-mentioned translating devices being arranged to effect, by their response to the second conductance variation, a compensative variation in the conductance of the traffic-controlling circuit to counteract the variation in influence upon the first-mentioned translating device or devices due to their response to the first-mentioned conductance variation.

42. A railway traffic-controlling system comprising a traffic-controlling electric circuit of variable conductance, and traffic-controlling electrotranslative apparatus controllable by the traffic-controlling circuit and by variations of conductance therein and including one or more translating devices movable by a given increase in conductance of the traffic-controlling circuit to perform a given traffic-controlling operation and also one or more other translating devices movable by a greater increase in conductance of the traffic-controlling circuit to perform a second traffic-controlling operation, the first-mentioned translating device or devices being subject to a variation in actuative influence of the traffic-controlling circuit due to their movement in response to the first-mentioned conductance increase, and the last-mentioned translating device or devices being adapted, by their movement in response to the second conductance increase, to introduce a compensative resistance into the traffic-controlling circuit to counteract the said variation in actuative influence effective upon the first-mentioned translating device or devices.

43. A railway traffic-controlling system comprising a traffic-controlling electric circuit including a portion of variable conductance, and traffic-controlling electrotranslative apparatus controllable by the traffic-controlling circuit and by conductance variations therein and including an electrotranslative magnet in series with the variable portion of the traffic-controlling circuit and two electrotranslative magnets in parallel with such variable portion and including one or more translating devices controllable jointly by the series magnet and one of the parallel magnets and one or more other translating devices controllable jointly by the series magnet and the other parallel magnet, the first-mentioned translating device or devices being magnetically movable by a given conductance variation in the traffic-controlling circuit to perform a given traffic-controlling operation and being subject to a variation in magnetic influence due to such movement, and the second-mentioned translating device or devices being adapted to effect, by their movement in response to the second conductance variation, a compensative variation in the conductance of the traffic-controlling circuit to counteract the said variation in magnetic influence effective upon the first-mentioned translating device or devices.

44. A railway traffic-controlling system comprising a traffic-controlling electric circuit extending along the railway-line and including the traffic-rails thereof, and a source of traffic-controlling current connected to the rails at the advance end of the circuit and including also one or more rear branches leading from rail to rail at the rear end of the traffic-controlling rail-circuit but such circuit having all its rear branches normally open, traffic-controlling electric translating apparatus comprehending one or more electrotranslative conductors included in the aforesaid one or more normally open rear branches of the rail-circuit, and means governable by the approach of a railway train or vehicle toward the traffic-controlling electric translating apparatus for closing the one or more rear branches of the rail-circuit so as to effectively include therein the electrotranslative conductors of the traffic-controlling translating apparatus.

45. Normal blocking railway signaling apparatus including electric translating apparatus comprising an electromagnet, one or more movable translating devices coöperative with the magnet and subject to influence of its energization in either direction of polarity, and a polarized armature also coöperative with the magnet but responsive to energization of the magnet in one direction only.

46. Normal blocking railway signaling apparatus comprising an electrotranslating-magnet, one or more movable translating devices controllable by magnetization of the magnet in either direction of polarity, and a polarized translating-armature responsive to change in the polarity of the magnet.

47. Railway signaling electric translating apparatus comprising a translating-magnet including two magnetic circuits, one or more movable translating devices subject to attractive force of the magnetic flux of both magnetic circuits, and one or more translating devices operatable by the magnetic flux of one of the magnetic circuits.

48. Railway signaling electric translating apparatus comprising a translating-magnet including two magnetic circuits, one or more

movable translating devices subject to attractive force of the magnetic flux of both magnetic circuits, and one or more translating devices operatable by the magnetic flux of one of the magnetic circuits and not subjective to influence of the magnetic flux of the other magnetic circuit.

49. Railway signaling electric translating apparatus comprising two translating-magnets, one or more movable translating devices subjective to influence of magnetic attraction of both magnets, and a polarized armature responsive to magnetization of one of the magnets.

50. Railway signaling electric translating apparatus comprising two translating-magnets, one or more movable translating devices subjective to influence of magnetic attraction of both magnets, and a polarized armature responsive to magnetization of one of the magnets but free from influence of magnetism of the other magnet.

51. Railway signaling electric translating apparatus comprising two translating-magnets, one or more translating devices controllable by both magnets, and one or more translating devices controllable by one of the magnets separately and free from influence of the other magnet.

52. Railway signaling electric translating apparatus comprising two translating-magnets, one or more translating devices controllable by both magnets jointly and one or more translating devices controllable by one of the magnets separately and free from influence of the other magnet.

53. Railway signaling electric translating apparatus comprising three translating magnets, a movable translating device controllable by two of the magnets jointly, and one or more other movable translating devices controllable jointly by one of the two magnets controlling the first-mentioned translating device and by the third magnet.

54. Railway signaling electric translating apparatus comprising three translating-magnets, a movable translating device controllable by two of the magnets, and one or more other movable translating devices controllable by one of the two magnets controlling the first-mentioned translating device and by the third magnet.

55. Railway signaling electric translating apparatus comprising two translating-magnets, a translating device movable by magnetic attraction of both magnets, one or more other translating devices movable by magnetic attraction of one of the aforesaid magnets, a retractive magnet for retracting the first said translating device, and still another retractive magnet for retracting the said one or more other translating devices.

56. A railway signaling system comprising a signal-controlling electric circuit, a source of signal-controlling current therefor, signal-controlling electric translating apparatus including a translative conductor and responsive to directional variations of current therein, means for connecting the translative conductor in the signal-controlling circuit so as to vary the conductance of such signal-controlling circuit, and railway signaling apparatus controllable by the signal-controlling circuit and responsive to such variation in its conductance to reverse its signal-controlling current and thereby actuate the signal-controlling electric translating apparatus.

57. A railway signaling system comprising a signal-controlling circuit, a source of signal-controlling current therefor, and signal-controlling electric translating apparatus controllable by signal-controlling current from the signal-controlling circuit and including two translating-conductors for receiving such signal-controlling current and the translating apparatus being responsive to current in one of its translating-conductors and responsive to directional variations of current in the other of its translating-conductors.

58. A railway signaling system comprising a signal-controlling circuit, a source of signal-controlling current therefor, and signal-controlling electric translating apparatus controllable by the signal-controlling circuit and including two translating-conductors and being governable by current in both of its translating-conductors jointly and also responsive to directional variation of current in one of its translating-conductors.

59. A railway signaling system including a signal-controlling circuit, a source of reversible signal-controlling current for the signal-controlling circuit, and signal-controlling electric translating apparatus comprising two electrotranslative conductors and governable to maintain one signal-controlling condition by signal-controlling current in both such translative conductors jointly and also responsive to establish another signal-controlling condition to directional variation of signal-controlling current in one of such translative conductors.

60. A railway signaling system comprising a signal-controlling circuit, a source of signal-controlling current therefor, and signal-controlling electric translating apparatus controllable by the signal-controlling circuit and including two translating-conductors and being responsive to signal-controlling current in one of its translating-conductors to perform one signal-controlling operation and responsive to signal-controlling current in its second translating-conductor to maintain the signal-controlling condition effected by the first signal-controlling operation and being responsive also to reversal of signal-controlling current in its second translating-conductor to effect a second signal-controlling operation.

61. Railway signaling electric translating

apparatus comprising two translating-conductors and one or more translating devices movable to given signal-controlling positions by signal-controlling current in one of the translating-conductors and in such positions subject to retentive influence of signal-controlling current in the other translating-conductor.

62. Railway signaling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given signal-controlling positions by signal-controlling current in one of the translating-conductors and in such positions subject to retentive influence of signal-controlling current in the other translating-conductor, and another translating device movable to perform a signal-controlling operation by signal-controlling current in the second translating-conductor.

63. Railway signaling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given signal-controlling positions by signal-controlling current in one of the translating-conductors and in such positions subject to retentive effort of signal-controlling current in the other translating-conductor, and another movable translating device responsive to directional variation of signal-controlling current in the second translating-conductor and to perform a signal-controlling operation.

64. Railway signaling electric translating apparatus comprising two translating-conductors and one or more translating devices movable to given signal-controlling position by signal-controlling current in one of the translating-conductors and in such position subject to retentive influence of signal-controlling current in the other translating-conductor, and another movable translating device responsive to signal-controlling current in the second translating-conductor in one direction only and to perform a signal-controlling operation.

65. A railway signaling system comprising a signal-controlling electric circuit, a source of signal-controlling current therefor, railway signaling apparatus located at a signaling-point in proximity to a railway-line and including an electrotranslative signal-controlling conductor in control of such signaling apparatus and responsive to directional variation of signal-controlling current, means for including the electrotranslative controlling-conductor in the signal-controlling circuit so as to vary the conductance thereof, a second railway signaling apparatus located at a second signaling-point in proximity to the railway-line and controllable by the signal-controlling circuit and responsive to its variation in conductance to effect a signaling operation and also to reverse the signal-controlling current in such signal-controlling circuit and thereby actuate the first-mentioned signaling apparatus through responsiveness of its electrotranslative conductor to indicate the performance of such signaling operation at the second signaling-point.

66. A home and distant railway signaling system comprising a signal-controlling electric circuit, a source of signal-controlling current therefor, home and distant signaling apparatus located at a signaling-point in proximity to the railway-line and including a home-signal-controlling electrotranslative conductor communicating with the signal-controlling circuit and responsive to signal-controlling current therein to govern the home-signal indication of the home and distant signaling apparatus and such signaling apparatus comprising also a distant-signal-controlling electrotranslative conductor in control of the distant-signal indication of the signaling apparatus and responsive to directional variation of signal-controlling current, means for introducing the distant-signal controlling electrotranslative conductor in the signal-controlling circuit so as to vary the conductance of such circuit, a second signaling apparatus located at a second signaling-point in proximity to the railway-line and controllable by the signal-controlling circuit and responsive to variation in its conductance to effect a signaling operation of such second signaling apparatus and to reverse the signal-controlling current in the signal-controlling circuit when such signaling operation is performed and thereby to effect a distant-signal indication of the home and distant signaling apparatus located at the first signaling-point through responsiveness of the distant-signal-controlling electrotranslative conductor of such home and distant apparatus so as to indicate at such first signaling-point the completion of the signaling operation performed by the second signaling apparatus at the second signaling-point.

67. A railway signaling system including a signal-controlling circuit, a source of signal-controlling current therefor, a home and distant railway signaling apparatus located at a given signaling-point in proximity to the railway-line and comprising a home-signal-controlling electrotranslative conductor communicating with the signal-controlling circuit and in control of the home-signal indication of the signaling apparatus and such home and distant signaling apparatus comprising also a distant-signal-controlling electrotranslative conductor in coöperation with the home-signal electrotranslative conductor to control the home-signal indication of the apparatus and also responsive to directional variation of signal-controlling current to govern the distant-signal indication of the apparatus, means for introducing the distant-signal-controlling electrotranslative conductor in the signal-controlling circuit so as

to vary the conductance thereof, a second signaling apparatus located at a second signaling-point in proximity to the railway-line and controllable by the signal-controlling circuit and responsive to the variation of its conductance to perform a signaling operation and also to reverse the signal-controlling current in the signal-controlling circuit so as to actuate the home and distant signaling apparatus through directional responsiveness of its distant-signal-controlling electrotranslative conductor to give at the first-mentioned signaling-point a distant-signal indication indicative of the performance of the said signaling operation of the signaling apparatus at the second signaling-point.

68. A railway signaling system including a signal-controlling electric circuit, a source of signal-controlling current therefor, a signal controlling apparatus located at a given signal-controlling point in proximity to the railway-line and controllable by the signal-controlling circuit and responsive to a variation in the conductance thereof, a second signal-controlling apparatus located at a second signal-controlling point in proximity to the railway-line and also controllable by the signal-controlling circuit and responsive to signal-controlling current therein, and means both for varying the conductance of the signal-controlling circuit to actuate the first-mentioned signal-controlling apparatus and for compensating the effect upon the second signal-controlling apparatus of current perturbation caused by such variation in conductance.

69. A railway traffic-controlling system comprising a railway traffic-controlling apparatus located in proximity to a railway-line and including an electromagnet, a movable translating device in controlling relation to the traffic-controlling apparatus and in turn controllable by the electromagnet and movable by diminution of its magnetizing force to a value below normal so as to decrease the influence of a given magnetizing force in such electromagnet on such translating device, and the traffic-controlling apparatus also including means for increasing the magnetizing force of its electromagnet above the normal value to compensate the decrease in influence due to the aforementioned movement of the translating device, and, in combination with the foregoing traffic-controlling apparatus, a source of magnetizing electric current for its electromagnet, and a traffic-controlling electric circuit in controlling shunt relation to such electromagnet and extending along the railway-line in rear of the traffic-controlling apparatus.

70. A railway traffic-controlling system comprising a normal blocking traffic-controlling apparatus located at a given traffic-controlling point on a railway-line and including an electrotranslative traffic-controlling electromagnet, a movable translating device in controlling relation to the normal blocking traffic-controlling apparatus and in turn controllable by the traffic-controlling magnet and movable by decrease in its magnetizing force below normal to permit an unblocking operation of the normal blocking traffic-controlling apparatus and also to diminish the influence of a given magnetizing force in the magnet over the translating device, and such normal danger traffic-controlling apparatus also including means for increasing the magnetizing force in the traffic-controlling electromagnet above normal value to restore its translating device to normal traffic-blocking position, and, in combination with the foregoing normal blocking traffic-controlling apparatus, a source of electric current for its traffic-controlling electromagnet, and a traffic-controlling circuit in controlling relation to the traffic-controlling magnet.

71. A railway signaling system comprising a normal danger-signaling apparatus located at a given signaling-point on a railway-line and including a signal-controlling electrotranslative electromagnet, a movable translating device controllable by the signal-controlling magnet and in turn controlling the normal danger-signaling apparatus and movable relative to the electromagnet and by decrease of magnetizing force therein to permit clearing of the normal danger-signaling apparatus and also to diminish the influence of such electromagnet on such translating device, and the foregoing normal danger-signaling apparatus including also automatic means for effecting an increase of magnetizing force above normal value in the signal-controlling electromagnet to restore its translating device to normal position maintaining the normal danger condition of the signaling apparatus, and, in combination with the foregoing normal danger-signaling apparatus, a source of electric current communicating with its controlling-electromagnet, and a signal-controlling circuit in controlling shunt relation to the signal-controlling electromagnet and extending along the railway-line in rear of such normal danger-signaling apparatus.

72. A railway traffic-controlling system comprising a railway traffic-controlling apparatus located at a given traffic-controlling point on a railway-line and including a traffic-controlling electromagnet, a translating device controllable by the magnet and arranged in controlling relation to the traffic-controlling apparatus and movable by a given variation of magnetizing force in the magnet so as to vary the influence of a given magnetizing force thereof on the translating device and require an inverse variation of magnetizing force greater than the given variation in order to restore the translating de-

vice, and the foregoing traffic-controlling apparatus also including means for effecting a compensative variation in magnetizing force inverse to the given variation to compensate the aforementioned variation in magnetic influence of the magnet, and, in combination with the foregoing traffic-controlling apparatus, a source of electric current for magnetizing its traffic-controlling magnet, and a traffic-controlling circuit extending along the railway-line in rear of such traffic-controlling apparatus and arranged to effect the first-mentioned given variation of magnetizing force and to effect an inverse variation in magnetizing force of the traffic-controlling electromagnet aggregating, with the aforementioned compensative inverse variation, an inverse variation greater than the said given variation and sufficient to restore the translating device.

73. A railway traffic-controlling system comprising a railway traffic-controlling apparatus located at a given traffic-controlling point on a railway-line and including a traffic-controlling electromagnet, a translating device controllable by the magnet and arranged in controlling relation to the traffic-controlling apparatus and movable by a given variation of magnetizing force in the magnet so as to vary the influence of a given magnetizing force thereof on the translating device and require an inverse variation of magnetizing force greater than the given variation in order to restore the translating device, and the foregoing traffic-controlling apparatus also including an electrical contact making and braking device and a conductor controllable thereby to effect a compensative variation in magnetizing force inverse to the given variation to compensate the aforementioned variation in magnetic influence of the magnet, and, in combination with the foregoing traffic-controlling apparatus, a source of electric current for magnetizing its traffic-controlling magnet, and a traffic-controlling circuit extending along the railway-line in rear of such traffic-controlling apparatus and arranged to effect the first-mentioned given variation of magnetizing force and to effect an inverse variation in magnetizing force of the traffic-controlling electromagnet aggregating, with the aforementioned compensative inverse variation, an inverse variation greater than the said given variation and sufficient to restore the translating device.

74. A railway signaling system comprising a normal danger railway signaling apparatus located at a given signaling-point on a railway-line and including a signal-controlling electromagnet, a translating device controllable by the magnet and arranged in controlling relation to the signaling apparatus and movable by a given variation of magnetizing force in the magnet so as to vary the influence of a given magnetizing force thereof on the translating device and require an inverse variation of magnetizing force greater than the given variation in order to restore the translating device, and the foregoing signaling apparatus also including an electrical contact making and breaking device and a conductor controllable thereby to effect a compensative variation of the magnetizing force inverse to the given variation to compensate the aforementioned variation in magnetic influence of the magnet, and, in combination with the foregoing signaling apparatus, a source of electric current for magnetizing the signal-controlling magnet, and a signal-controlling circuit extending along the railway-line in rear of such signaling apparatus and including the traffic-rails of the railway-line and arranged to effect the first-mentioned given variation of magnetizing force and to effect an inverse variation in magnetizing force of the signal-controlling electromagnet aggregating, with the aforementioned compensative inverse variation, an inverse variation greater than the said given variation and sufficient to restore the translating device.

75. A railway traffic-controlling system comprising a traffic-controlling rail-circuit including the traffic-rails of a block or section of the railway-track, a source of traffic-controlling electric current arranged to supply the rail-circuit, and an electrotranslative apparatus including two magnet-coils connected with the rail-circuit and including also a contact making and breaking device controllable by both coils and arranged to control the connection of one of the coils with the rail-circuit.

76. A railway traffic-controlling system comprising a traffic-controlling electric circuit and two electrotranslative magnet-coils connected with the traffic-controlling circuit and in parallel with each other, and a contact device controllable by both the magnet-coils and arranged to make and break the path of the traffic-controlling electric circuit through one of the coils.

In testimony whereof I have affixed my signature in presence of two witnesse

HENRY BEZER.

Witnesses:

HENRY D. WILLIAMS,

HERBERT H. GIBBS