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H. W. SPANG.

ELECTRIC CIRCUITS AND APPARATUS FOR RAILWAY SIGNALING.

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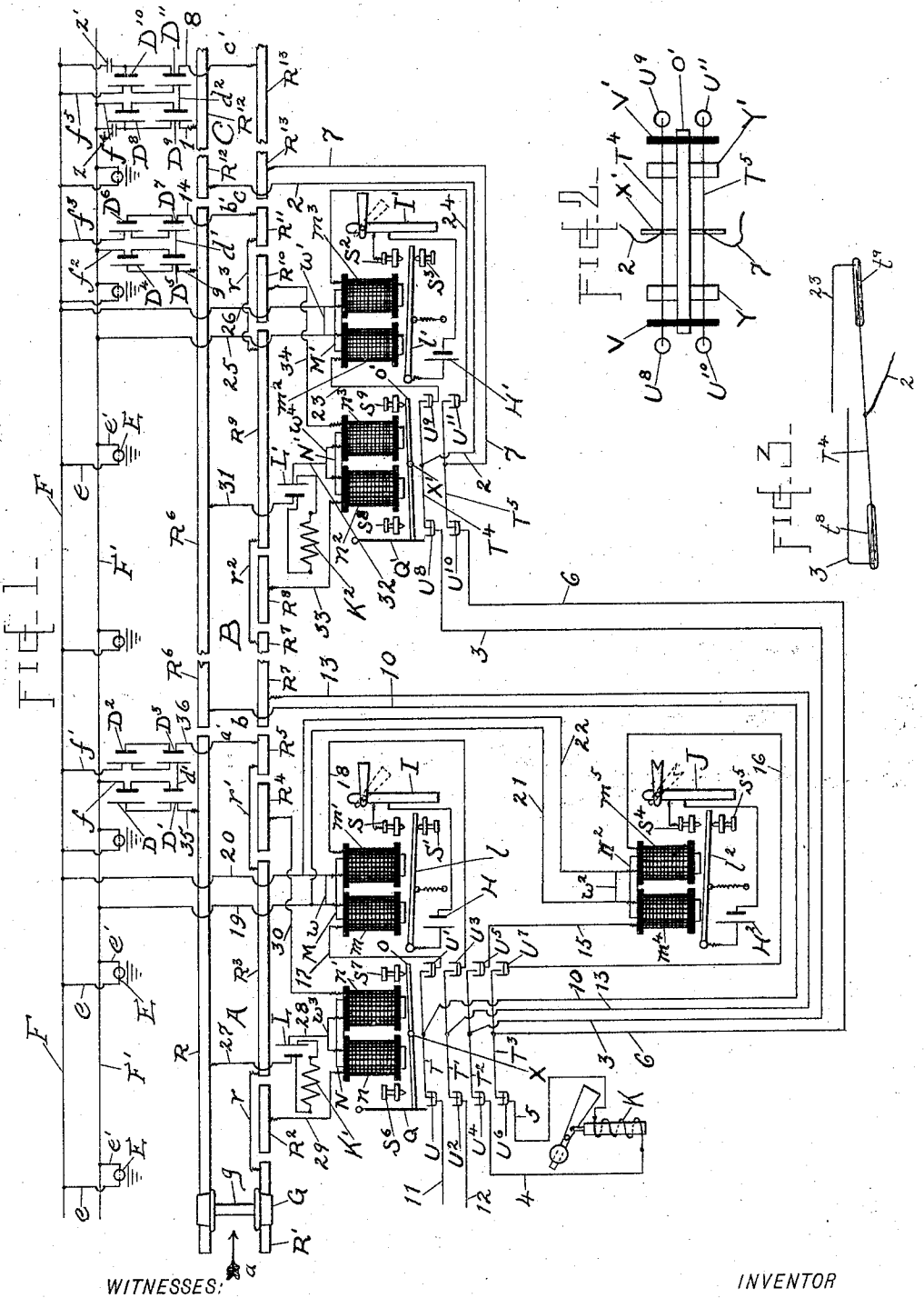

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UNITED STATES PATENT OFFICE.

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ELECTRIC CIRCUITS AND APPARATUS FOR RAILWAY SIGNALING.

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Application filed January 19, 1903. Serial No. 139,539. (No model.)

To all whom it may concern:

Be it known that I, HENRY W. SPANG, a citizen of the United States, and a resident of New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Electric Circuits and Apparatus for Railway Signaling, of which the following is a specification.

In the present automatic systems of railway signaling employing a constant track-circuit with galvanic batteries at the farther end of such circuit and a relay at the near end thereof and which controls a signal-circuit extending along a preceding track-section with a home signal at one end and a distant signal at the opposite end thereof and also in cases where a signal-controlling relay or relays are under the control of two adjacent track-circuits, one such circuit controlling the other, the wire coils of the track-circuit relay or relays are damaged during thunderstorms by the induced electricity of the long signal-circuit flowing into its controlling track-circuit via the relay, and vice versa, and also by the induced electricity of one track-circuit flowing into the adjacent track-circuit via the relay, and vice versa, simultaneously with a lightning-discharge taking place between the clouds and earth, especially in line with the railway or an adjacent point.

The object of my invention is to overcome such damage of wire coils of track-relays and also of the signal-magnets and otherwise increase the safety and efficiency of the rails for automatic signaling purposes.

My invention consists, broadly, in a track-circuit having relays located at points distant from each other normally out of circuit and respectively controlling independent short signal-circuits and home and distant signals.

It further consists in the combination, with a track-circuit, of a resistance normally in circuit, signal-controlling relays located at points distant from each other normally out of circuit, and respectively controlling independent short signal-circuits and home and distant signals and circuit-controllers, the latter operating to successively exclude the resistance and include the signal-controlling relays, and vice versa.

It further consists in the combination, with a track-circuit, of a resistance normally in circuit, signal-controlling relays located at points distant from each other normally out of circuit and respectively controlling independent short signal-circuits and home and distant signals, two extended conductors connected at intervals with ground connections, and circuit-controllers, the latter operating successively to exclude the resistance and include the signal-controlling relays, and vice versa, both helices of each relay being in an ordinary metallic circuit when energized and each helix being also in an independent metallic and ground circuit.

It further consists in the combination, with two adjacent track-circuits, of resistances normally in circuit, signal-controlling relays located near each other normally out of circuit and respectively controlling independent short signal-circuits and home and distant signals in such circuits, and a circuit-controller, the latter operating to successively exclude the resistances and include two adjacent relays, respectively controlling a home signal of an adjacent track-circuit and a distant signal of a distant track-circuit.

In the accompanying drawings, Figure 1 is a diagram illustrating one form of my invention as applied to one track of a double-track system in which the trains always move in one direction, as indicated by the arrow, the second or return track not being illustrated herein. Fig. 2 is a plan view of portion of an improved circuit controller or changer. Fig. 3 is a modification thereof.

A, B, and C are sections of a railway each about a mile long, more or less, and a, b, and c are the near ends and a', b', and c' the farther ends thereof, section C being at the end of railway or block system.

Rails R, R′, R^2, R^3, R^4, and R^5 constitute section A, rails R^6, R^7, R^8, R^9, R^{10}, and R^{11} section B, and rails R^{12} and R^{13} section C. The rails of the respective sections are insulated from each other at their abutting ends. Rails R^2

and R^4 of section A and rails R^8 and R^{10} of section B are insulated from the adjacent rails of their respective sections, and each of said rails can be a single rail or two or more bonded rails. In connection with the opposite rails R and R^6 and when bridged by wheels G and axle g of a locomotive or train they constitute circuit-closers. Each line of rails R, R', R^3, and R^5 of section A, rails R^6, R^7, R^9, and R^{11} of section B, and rails R^{12} R^{13} of section C should have metallic continuity throughout its length by means of suitable bonds or connections at the rail-joints thereof. Rails R', R^3, and R^5 of section A are connected together by metallic connectors r and r', and rails R^7, R^9, and R^{11} of section B are connected together by connectors r^2 and r^3.

Insulated rail R^2 of section A and rail R^8 of section B are preferably located about one thousand feet ahead of ends a' and b' of said sections, while rails R^4 and R^{10} should preferably be near said ends, so that when a locomotive reaches R^2 or R^8 and a safety home signal is not then given it can be stopped before reaching rail R^4 or R^{10} and await such safety-signal before passing over or making contact with rail R^4 or R^{10}.

D D' D^2 D^3 D^4 D^5 D^6 D^7 and D^8 D^9 D^{10} D^{11} are gravity batteries or cells or other generators connected, preferably, in multiple series with the rails of sections A, B, and C, and thereby constituting sectional generators.

M, M', and M^2 are relays of suitable type located along the permanent way, M and M^2 being at or ahead of the end b of section B and relay M' being at or ahead of end c of section C. They consist of helices m m' m^2 m^3 and m^4 m^5, connected together in the usual manner or by wires w, w', and w^2. When said helices are energized, they attract armature-levers l, l', and l^2, causing them to make contact with stops s, s^2, and s^4, and when said helices are deënergized said levers by gravity or springs make contact with stops s', s^3, and s^5.

Relay M controls signal-circuit battery H and home signal I and is normally disconnected from track-circuit of section B, and relays M' and M^2 control, respectively, signal-circuit batteries H' and H^2 and home signal I and distant signal J and are normally disconnected from track-circuit of section C. All the signals are normally upon open circuit and at danger indication, and when relay M, M', or M^2 is energized, lever l, l^2, or l^3 makes contact with stop s, s^2, or s^4, and thereby closes circuit of battery H, H', or H^2 and causes the signal to assume the safety indication. (Shown by the dotted lines.)

N N' are magnets for operating circuit changers or controllers and consist of helices n, n', n^2, and n^3, connected by wires w^3 and w^4. The resistance of n and n^2 can be about one ohm and of n' and n^3 about a half-ohm, and they are successively energized by batteries L and L' and cause armature-levers O and O' to move on their fulcrums x and x' and successively contact with stops s^6 s^7 and s^8 s^9.

Q and Q' are flat springs which press against the end of levers O and O' and serve to hold said levers in the position placed by either helix n or n^2 n' or n^3 and when either is no longer energized. Normally levers O and O' contact with stops s^7 and s^9.

The circuit changers or controllers may comprise circuit-changing wires T T' T^2 T^3 and T^4 T^5 with bent ends or immersion-points, which are insulated and separated from each other and from metal levers O and O' by wooden or other non-conducting strips. The said strips V V', as shown in Fig. 2, are fastened to lever O', and the bent wires T^4 T^5 move with lever O' when the armatures Y Y' are successively attracted, and said bent wires contact with mercury in metal cups U^8 U^{10} or U^9 U^{11}. Normally wires or conductors T T' T^2 T^3 and T^4 T^5 contact with the mercury in cups U' U^2 U^4 U^6 and U^8 U^{10} and not with the mercury in the opposite cups U' U^3 U^5 U^7 and U^9 U^{11}.

In order to prevent the oxidation of the mercury and keep its surface bright and clean, tubes t^8 t^9 of glass or other non-conducting material should be employed, as shown in Fig. 3, hermetically fastened at one end with wire T^4, which extends for a suitable distance therein and hermetically fastened at other end with another wire 23, or 3, which also extends therein for a suitable distance, but separated from conductor T^4, the circuit between them being successively closed and opened by mercury, which is moved from one position to another simultaneously with movement of lever O'.

K is a suitable resistance which is normally in circuit, and its function is to keep the track-batteries D^8 D^9 D^{10} D^{11} of section C in proper working order.

Normally the resistance K impedes the flow of induced electricity from one leg of track-circuit of section C into the other leg thereof, and it is evident that whatever such flow takes place between them via resistance K when in circuit no derangement can be caused thereby. Owing to the great distance of resistance K from the rails R^{12} R^{13} of section C, the induced electrification of the portion of circuit at or near resistance K will be so weak that it will be possible to safely employ a relay in place of resistance K, which can serve to control a signal-circuit and visual signal which will serve as an indicator or distant signal for section C upon the normally clear plan in addition to or without the distant signal J and with home signal I' upon the normal danger plan.

F F' are wires or other suitable metal conductors extending along the entire length of railway or along any desired number of track-sections and are connected at suitable inter-

vals with ground connections E, each consisting, preferably, of an iron pipe of suitable length driven into the earth or otherwise well embedded therein, preferably at or near each telegraph-pole. The series of ground connections thus employed, or any desired number thereof, afford much better electrical continuity with the earth than that afforded by either line of rails of section A, B, or C with the wooden ties, ballast, and adjacent surface earth, even during the moist condition thereof. The wires F F′ are connected by wires f f' f^2 f^3 and f^4 f^5 with the batteries of the respective track-circuits and by wires 19 20 21 22 and 25 26 with wires w, w^2, and w', connecting the helices of the respective relays M, M^2, and M′.

The track-circuit of section C, B, or A at or near end c, b', or a' is normally more highly electrified by induction during thunderstorms than at or near end c, b, or a thereof, and especially at or near the resistance K of each circuit, for the reason that normally the grounded conductors F F′ have no connection with the respective track-circuits of section C, B, or A at or ahead of ends c, b, or a thereof, owing to their respective signal-controlling relays being normally disconnected from said circuits by their respective circuit-controllers N′ and N″.

The induced electricity of each track-circuit during a lightning discharge can readily discharge into conductors F F′ and the earth at or near the end c', b', or a'. That of section C flows via the electrodes and liquids of batteries D^8 D^9 D^{10} D^{11} and wires f^4 f^5 into F F′ and ground connections E. It is obvious that suitable lightning-arresters Z Z′ can also be employed between each leg of said track-circuit and wires F F′, or either, preferably at or near end c', and thereby provide additional paths for the discharge of such induced electricity between such track-circuit and the earth simultaneous with lightning-discharges between the clouds and the earth in line with the railway or an adjacent point. The relays M M^2 M′ and circuit changers or controllers N N′ being normally on short and open circuits are then not electrified by induction during thunderstorms, and the insulation of conductors T T′ T^2 T^3 and T^4 T^5 from armature-levers O and O′ also serve to normally reduce the induced electrification of that portion of track-circuit of section C at or near circuit-changers N N′ and prevent such electricity seeking the rails R or R^6 via electromagnets of said circuit-changers and batteries L L′.

The signal-circuits embracing batteries H, H′, and H^2 and signals I, I′, and J are very short, and therefore are not electrified by induction.

It will be observed that normally there is no relay in the track-circuit of section C or any such section and that the induced electricity can flow over its entire length toward end c' of section C and even over the conductors T^2 T^3 and T^4 T^5 and contacts U^4 U^6 and U^8 U^{10} without causing any fusion or damage of such contact-points, due to the non-fusion of mercury. Furthermore, the induced electricity of the rails and wires of track-circuits of sections A, B, and C can readily flow into each other and the earth and toward a lightning-discharge between the clouds and the earth in line with the railway or an adjacent point via the electrodes and liquids of the track-batteries and also by lightning-arresters employed between the legs of such track circuits and conductors F F′, or either.

The operation of the system is as follows: When the wheels G and axle g of a locomotive or train moving in direction of the arrow bridge rails R^2 and R of section A, the current of battery L flows over wire 28, helix n of circuit-changer N, wire 29, rails R^2 R, and wire 27, causing lever O to contact with stop s^6 and simultaneously cause conductors T T′ T^2 T^3 to break contact with mercury in cups U U^2 U^4 U^6 and make contact with mercury in cups U′ U^3 U^5 U^7, thereby excluding resistance K or its equivalent from the track-circuit of section C and including therein relay M^2, which controls distant signal J, and also excluding resistance and including in the track-circuit of section B relay M, which controls home signal I of said section. If section C is clear, the current of batteries D^8 D^9 D^{10} D^{11} will flow over wire 1, rails R^{12} wire 2, conductor T^4, wire 3, conductor T^2, wire 15, relay M^2, wire 16, conductor T^3, wire 6, conductor T^5, wire 7, rails R^{13}, and wire 8, thereby constituting an ordinary metallic circuit, and the helices m^4 m^5 of relay M^2 being then energized will cause armature-lever l^2 to close circuit of battery H^2 and the distant signal J of section C to assume the safety indication. At the same time if section B is clear the helices m m' of relay M will be energized by the current of batteries D^4 D^5 D^6 D^7 flowing over wire 9, rails R^6, wire 10, conductor T, wire 17, relay M, wire 18, conductor T′, wire 13, rails R^7, connector r^2, rails R^9, connector r^3, rails R^{11}, and wire 14 and cause lever l to close circuit of battery H and the home signal I of section B to assume the safety indication. The said distant and home safety-signals will be given until wheels G and axle g bridge rails R^4 and R, when the current of battery L will flow over wire 28, helix n', wire 17, rails R^4 R, and wire 27, and even if a portion of the train is at the same time passing over rails R^2 R, helix n', owing to its resistance being lower than that of helix n, will be energized, causing lever O to contact with stop s^7 and simultaneously causing conductors T T′ T^2 T^3 to break contact with mercury in cups U′ U^3 U^5 U^7 and make contact with mercury in cups U U^2 U^4 U^6 and including resistance K with circuit of section C, similarly changing circuit of section B and

excluding relays M^2 M therefrom, and the distant signal J and home signal I to then assume their normal or danger indication. If rails R^{12} R^{13} of section C or R^6 R^7 R^9 R^{11} of section B are occupied and bridged by the wheels and axle of train and the current of batteries D^8 D^9 D^{10} D^{11} or D^4 D^5 D^6 D^7 thereby shunted, relay M^2 or M cannot be energized and safety-signals will not be given when a locomotive reaches rail R^2 of section A. When the wheels G and axle g of a locomotive bridge rails R^8 R^6 of section B, the current of battery L′ flows over wire 32, helix n^2 of circuit-changer N′, wire 33, rails R^8 R^6, and wire 31, causing lever O′ to contact with stop s^8 and simultaneously cause conductors T^4 T^5 to break contact with mercury in cups U^9 U^{10}, thereby excluding wire 3, conductor T^2, wire 4, resistance K or its equivalent, wire 5, conductor T^3, and wire 6 from track-circuit of section C and including therein relay M′, which controls home signal I′ of said section. If section C is clear, the current of batteries D^8 D^9 D^{10} D^{11} will flow over wire 1, rails R^{12}, wire 2, conductor T^4, wire 23, relay M′, wire 24, conductor T^5, wire 7, rails R^{13}, and wire 8, thereby constituting an ordinary metallic circuit, and the helices m^2 m^3 of relay M′ being then energized will cause lever l' to close circuit of battery H′ and home signal I′ of section C to assume the safety indication and will continue to be given until wheels G and axle g bridge rails R^{10} R^6, when the current of battery L′ will flow over wire 32, helix n^3, wire 34, rails R^{10} R^6, and wire 31, and even if a portion of the train is at the same time passing over rails R^8 R^6 helix n^3, owing to its resistance being lower than that of helix n^2, will be energized, causing lever O′ to contact with s^9 and simultaneously causing conductors T^4 T^5 to break contact with mercury in cups U^9 U^{11} and make contact with mercury in cups U^8 U^{10}, and including resistance K with circuit of section C and excluding relay M′ therefrom and the home signal I′ to then assume its normal danger indication. If rails R^{12} R^{13} of section C are occupied and bridged by the wheels and axles of train and the current of batteries D^8 D^9 D^{10} D^{11} thereby shunted, relay M′ cannot be energized and safety-signal will not be given when a locomotive reaches rail R^8 of section B.

In addition to the operation of relays M^2, M, and M′ in the complete metallic circuits herein described each helix m^4, m^5, m, m' m^2, and m^3 when energized will, in connection with a line of rails and two batteries, be in an independent metallic circuit and a ground-circuit of the highest efficiency. Helix m will embrace rails R^6, batteries D^4 D^5, and wire F′, helix m' will embrace rails R^7, R^9, and R^{11}, batteries D^6 D^7 and wire F, and helix m^4 or m^2 will embrace rails R^{12}, batteries D^8 D^9, and wire F′, and helix m^5 or m^3 will embrace rails R^{13}, batteries D^{10} D^{11}, and wire F in an independent metallic circuit, and in connection with a series of ground connections E, located within a suitable distance, each helix will also be in a ground-circuit of the highest efficiency. It is evident that with such circuits the resistance and retardation offered to the current of batteries D^4 D^5 D^6 D^7 and D^8 D^9 D^{10} D^{11} will be greatly reduced and the flow thereof over helices m m' m^4 m^5 and m^2 m^3 increased, while the flow thereof via the wooden ties, ballast, and moist earth in a ground-shunt will be reduced to a minimum, thereby enabling the rails of a longer section of track to be used for automatic signaling than has heretofore been possible.

When relay M^2, M, or M′ is energized and in circuit with extended conductors F F′ and and ground connections E during a thunderstorm, it will be subjected to induced electrification of its respective track-circuit during the interval while a locomotive is moving from rail R^2 to R^4 of section A or from rail R^8 to R^{10} of section B; but such electrification will not be as intense as upon that portion of circuit of section B or C as near end b' or c' thereof for the reason that the respective track-batteries and lightning-arresters employed between the legs of said circuits and conductors F F′, or either, offer much better paths for the discharge of such induced electricity to the earth than the paths offered by relays M^2, M, or M′.

Should signal I, J, or I′ indicate "safety" before the locomotive reaches rail R^2 or R^8, the engineer will know that such signal is improper and is due either to armature-lever l, l^2, or l' being held by residual magnetism of iron cores of helices m m' m^4 m^5 or m^2 m^3 or improper working of the circuit-controller N or N′ or by defective signal mechanism, and therefore in the case of improper home signal I or I′ he will proceed cautiously over section B or C.

Instead of employing resistance K, relay M^2, and its distant signal J and their circuit-changer at or ahead of end b of section B they can be employed along section B ahead of relay M′ and circuit-changer N′.

Resistance K can be dispensed with when an electric generator is employed with a number of consecutive track-circuits, and in such case the arresters Z Z′ can be employed with both legs of the track-circuit at the farther end of each block-section and with the earth.

I do not confine myself to any special devices or means for operating circuit-changer or controller-magnets N N′ by a train for successively excluding and including in a track-circuit C resistance K or its equivalent signal-controlling relays M^2, M, and M′.

I do not confine myself to the employment of relay M^2 and M′, respectively, controlling independent short signal-circuits and distant and home signals in normal open circuit with the track-circuit of section C, as shown, as

either relay M^2 or both M^2 and M' can be employed in closed track-circuit and normally inert, due to resistance in series therewith, and energized when resistance is shunted by a locomotive or circuit-controller.

It is obvious that ground connections E could be dispensed with and extended conductors F F′ employed solely as additional return metallic conductors for the coils of the signal-controlling relays.

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

1. In a railway signaling apparatus, the combination of the two lines of rails of an insulated section of railway-track, a generator connected with farther end of said section, two relays, normally out of circuit, located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays and means for causing the successive operation of the latter.

2. In a railway signaling system, the combination of two lines of rails of an insulated section of railway-track, a generator connected with the farther end of said section and relays, normally out of circuit, located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, and means governed by a passing train for controlling the connections of said relays to cause the successive operation of the latter.

3. In a railway signaling system, the combination of two lines of rails of an insulated section of railway-track, a generator connected with the farther end of said section, a resistance, normally in circuit, and relays normally out of circuit, located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of said section and respectively controlled by said relays and circuit-controllers adapted for excluding the resistance and including the relays and vice versa.

4. In a railway signaling system, the combination of two lines of rails of an insulated section of railway-track, a generator connected with the farther end of said section, a resistance, normally in circuit, and relays, normally out of circuit, located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of said section and respectively controlled by said relays and means governed by a passing train for controlling the connections of said resistance and relays to cause the successive operation of the latter.

5. In a railway signaling system, the combination with two lines of rails of an insulated section of railway-track, a generator connected with the farther end of said section, a resistance normally in circuit, and relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, and circuit-controllers having movable insulated connectors and bodies of mercury, adapted to exclude the resistance and include the relays and vice versa.

6. In a railway signaling system, the combination with the lines of rails of two adjacent track-sections, each section having a generator connected with the farther end thereof, a resistance, normally in circuit and relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of each track-section and respectively controlled by said relays, and means governed by a passing train for controlling the connections of said resistances and relays to cause the successive operation of two adjacent relays respectively controlling a home signal of an adjacent section, and a distant signal of a distant section.

7. In a railway signaling system, the combination with the lines of rails of two adjacent track-sections, each section having a generator connected with the farther end thereof, a resistance normally in circuit and relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals located ahead of the near end of each track-section and respectively controlled by said relays, and circuit-controllers having movable insulated connectors and bodies of mercury adapted to exclude the resistances and successively include two adjacent relays, respectively controlling a home signal of an adjacent section and a distant signal of a distant section.

8. In a railway signaling system, the combination of the two lines of rails of an insulated section of railway-track, a sectional generator connected with the farther end of said section, a resistance, normally in circuit, relays normally out of circuit, and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, connections taken at points between coils of said relays and sections of said generator with two conductors F, F′, extending along the railroad, and means governed by a passing train for controlling the connections of said resistance and relays to cause the successive operation of the latter.

9. In a railway signaling system, the combination with the two lines of rails of an insulated section of railway-track, a sectional generator connected with the farther end of said section, a resistance normally in circuit,

relays normally out of circuit and located at points, distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, connections taken at points between coils of said relays and sections of said generator with two conductors, F, F', extending along railroad and connected at short intervals with ground connections, E, and means governed by a passing train for controlling the connections of said resistance and relays to cause the successive operation of the latter.

10. In a railway signaling system, the combination of the lines of rails of two adjacent insulated sections of railway-track, each section having a resistance normally in circuit, relays, normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of each section and respectively controlled by said relays, connections taken at points between coils of said relays and sections of said generators with two conductors, F, F', extending along railroad and connected at short intervals with ground connections, E, and means governed by a passing train for controlling the connections of said resistances and relays and cause the operation of two adjacent relays, respectively controlling a home signal of an adjacent section and a distant signal of a distant section.

11. In a railway signaling system, the combination of the two lines of rails of an insulated section of railway-track, a sectional generator connected with the farther end of said section, relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, connections taken at points between coils of said relays and sections of said generator with two conductors F, F', extending along railroad and connected at short intervals with ground connections, E, and means governed by a passing train for controlling the connections of said relays and cause the successive operation of the latter.

12. In a railway signaling system, the combination of the lines of rails of two adjacent insulated sections of railway-track, each section having a sectional generator connected with the farther end thereof and relays, normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of each section and respectively controlled by said relays, connections taken at points between coils of said relays and sections of said generators with two conductors F, F', extending along railroad and connected at short intervals with ground connections, E, and means governed by a passing train for controlling the connections of said relays and cause the operation of two adjacent relays, respectively controlling a home signal of an adjacent section and a distant signal of a distant section.

13. In a railway signaling system, the combination with the two lines of rails of an insulated section of railway-track, having a sectional generator connected with the farther end of said section, a resistance or signal controlling relay, normally in circuit, and located ahead of the near end of the said section, of connections taken at points between sections of said generator with two conductors, F, F', extending along railroad and connected at short intervals with ground connections, E.

14. In a railway signaling system, the combination with the two lines of rails of an insulated section of railroad-track, having a sectional generator connected with the farther end of said section, relays, normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, of connections taken at points between sections of said generator with two conductors, F, F', extending along railroad and connected at short intervals with ground connections, E.

15. In a railway signaling system, the combination with the two lines of rails of an insulated section of railroad-track, having a sectional generator connected with the farther end of said section, a resistance normally in circuit, relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of the said section and respectively controlled by said relays, of connections taken at points between sections of said generator with two conductors F, F', extending along railroad and connected at short intervals with ground connections, E.

16. The combination with the sectional lines of rails of consecutive block-sections, of sectional generators connected with the farther ends of said sections, relays, normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near ends of the said sections and respectively controlled by said relays, of connections respectively taken at points between sections of said generators and wire coils of said relays with two conductors F, F', extending along railroad, and circuit-controllers adapted to successively include and exclude said relays.

17. The combination with the sectional lines of rails of consecutive block-sections, of sectional generators connected with the farther ends of said sections, relays normally out of circuit and located at points distant from each other, independent short signal-circuits for

distant and home signals, located ahead of the near ends of the said sections and respectively controlled by said relays, connections respectively taken at points between sections of said generators and wire coils of said relays with two conductors F, F', extending along railroad and connected at short intervals with ground connections, E, and circuit-controllers adapted to successively include and exclude said relays.

18. The combination with the sectional lines of rails of consecutive block-sections, of sectional generators connected with the farther ends of said sections, resistances normally in circuit, relays normally out of circuit and located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near ends of the said sections and respectively controlled by said relays, connections respectively taken at points between sections of said generators and wire coils of said relays with two conductors F, F', extending along railroad and connected at short intervals with ground connections, E, and circuit-controllers adapted to exclude the resistances and include the relays and vice versa.

19. The combination with the sectional lines of rails, of consecutive block-sections, of sectional generators connected with the farther ends of said sections, resistances or magnets normally in circuit and located at points ahead of the near ends of said sections, and connections taken at points between sections of said generators with two conductors F, F', extending along railroad and connected at short intervals with ground connections E.

20. The combination with the sectional lines of rails of consecutive block-sections, of sectional generators connected with the farther ends of said sections, relays normally out of circuit and located at points distant from each other, independent short signal-circuits located ahead of the near ends of the said sections and respectively controlled by said relays, connections respectively taken at points between sections of said generators and wire coils of said relays with two conductors extending along railroad and connected at short intervals with ground connections, E, and circuit-controllers having movable insulated connectors and bodies of mercury adapted to exclude and include the said relays.

21. An electric circuit having a magnet or relay under control of an electromagnetic circuit-controller, consisting of an armature-lever controlling insulated connectors and mercury in a non-metallic tube, so arranged that the movement of the armature-lever will successively cause the mercury to move from one position to another and successively close and open a circuit.

22. In a railway signaling system, the combination with an electric circuit having a generator at farther end of said circuit, a magnet normally in circuit located at or ahead of the near end of said circuit, of arresters Z, Z', connected with both legs of said circuit adjacent to the generator and with extended conductors F, F', connected at short intervals with ground connections, E.

23. In a railway signaling system, the combination with the rails of an insulated section of railway-track, having a generator at the farther end of said section, and a signal-controlling relay normally in circuit located at or ahead of the near end of said section, of arresters Z, Z', connected with both legs of said circuit at the farther end of track-section and with extended conductors F, F', connected at short intervals with ground connections E.

24. In a railway signaling system, the combination with the rails of an insulated section of railway-track, having a generator at the farther end of said section, a resistance normally in circuit and relays normally out of circuit, located at points distant from each other, independent short signal-circuits for distant and home signals, located ahead of the near end of said section and respectively controlled by said relays and means governed by a passing train for controlling the connections of said resistance and relays to cause the successive operation of said relays, of arresters Z, Z', connected with both legs of said circuit at the farther end of track-section and with extended conductors F, F', connected at short intervals with ground connections E.

25. The combination with an electric circuit having a generator connected with one end thereof and a magnet or relay with the opposite end thereof, of arresters Z, Z', connected with both legs of said circuit near the generator and with extended conductors F, F', connected at short intervals with ground connections, E.

Signed at New York city, in the county of New York and State of New York, this 15th day of January, A. D. 1903.

HENRY W. SPANG.

Witnesses:
J. GALLWITZ,
E. L. LAWLER.