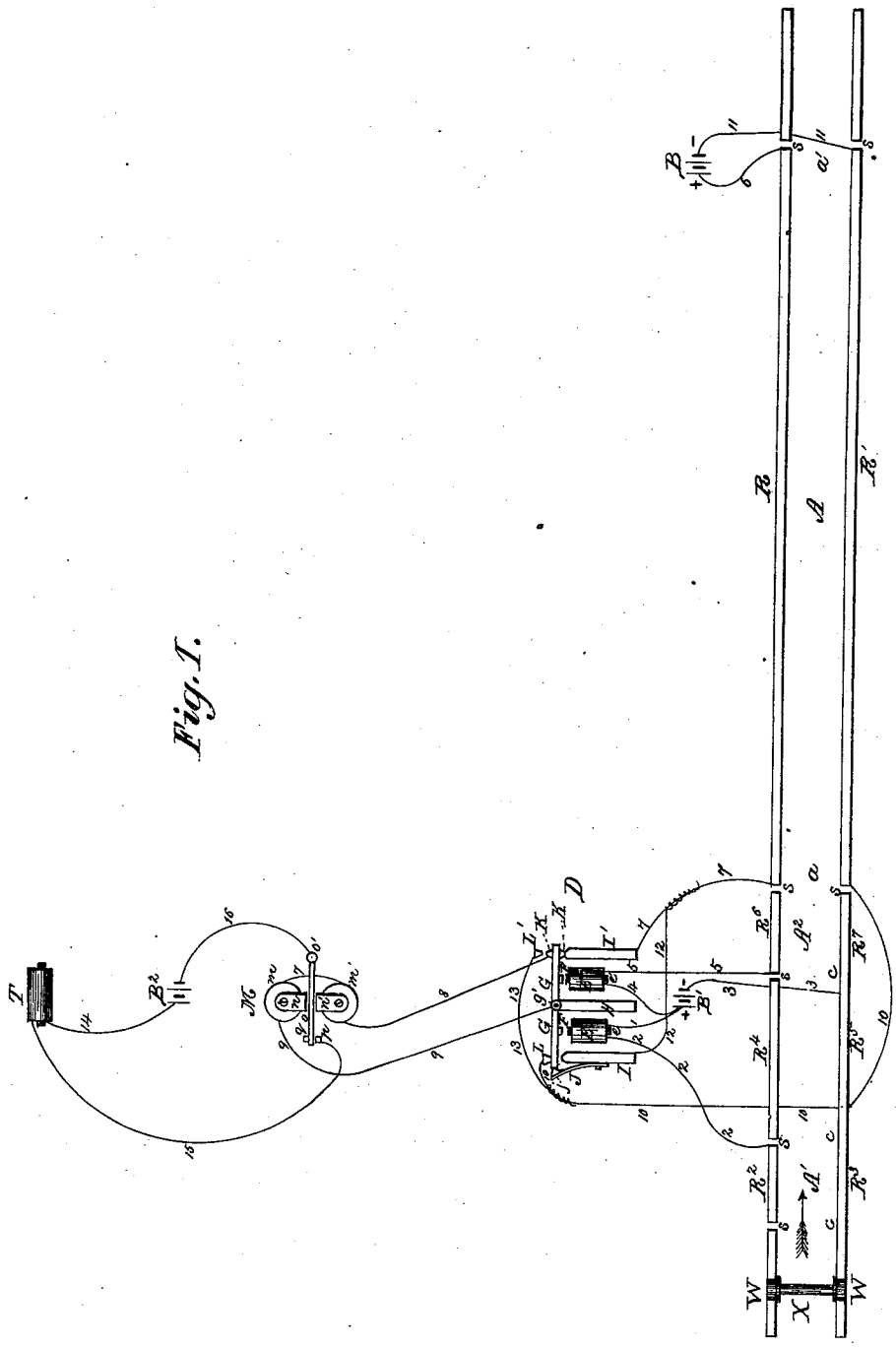
2 Sheets--Sheet 1.

H. W. SPANG.

Electric Railway-Signal.

No. 164,228. Patented June 8, 1875.

Fig. 1.



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2 Sheets--Sheet 2.

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Fig. 2.

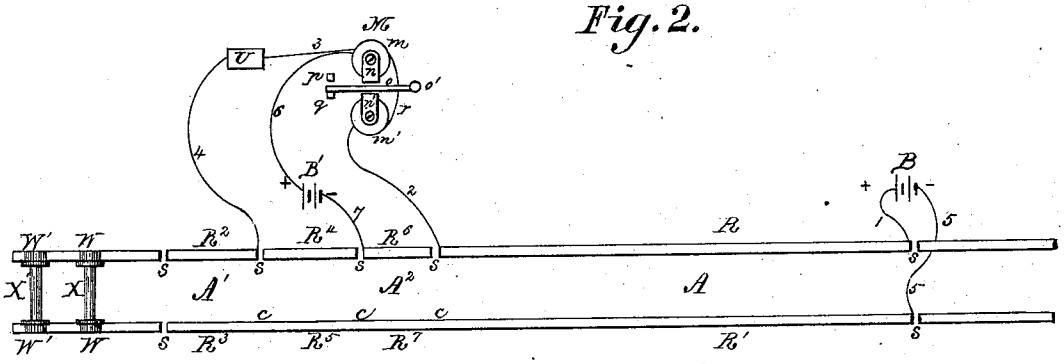
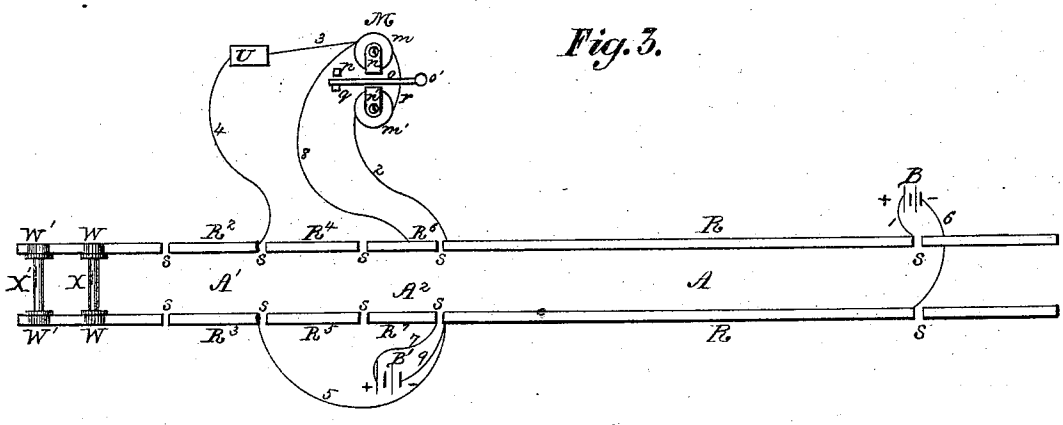


Fig. 3.



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UNITED STATES PATENT OFFICE.

HENRY W. SPANG, OF READING, PENNSYLVANIA.

IMPROVEMENT IN ELECTRIC RAILWAY-SIGNALS.

Specification forming part of Letters Patent No. **164,228**, dated June 8, 1875; application filed October 2, 1874.

To all whom it may concern:

Be it known that I, HENRY W. SPANG, of Reading, in the county of Berks and State of Pennsylvania, have invented certain new and useful Improvements in Electric Circuits and Railway-Signal Apparatus; and I do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings and to the letters of reference marked thereon, which form a part of this specification.

My invention relates to that class of electric circuits in which the two lines of rails of a section of railroad-track are used as the principal conductors between a galvanic battery and an electro or relay magnet, which controls or operates a visual or audible signal, or both.

It consists in the combination of a polarized relay-magnet, which controls or operates a secondary or local circuit and a visual or audible signal, or both, galvanic batteries, one or more, and devices for controlling circuits, with the two lines of rails of an insulated section of railroad-track, so that the lever of said polarized relay-magnet will be operated or actuated by opposite or reverse currents of electricity, and signals will thereby be given without requiring any change of adjustment of said lever to be made when there is a variation in the strength of the battery current or currents, caused by the leakage or escape of electricity from the rails to the earth.

Figures 1, 2, and 3 represent my invention as applied to an insulated section of one line, up or down, of a double-track railroad.

A, Fig. 1, is an insulated section of railroad-track a mile long, more or less. *a* and *a'* are the respective ends thereof. The rails R R^1 of said section of track should each have metallic continuity throughout its length by having the ends of rails jointed together by the ordinary metallic fish-plates, and be kept well screwed up, so as to maintain a good and constant metallic connection between the ends of rails. A^1 A^2 are short sections of track, and when the rails R^2 R^3 R^6 R^7 thereof, each of which can consist of a single rail, are occupied by the wheels W W and axle X or axles of a locomotive or car, they constitute circuit-closers. Letter *s* indicates that the rails hereinbefore named are separated or insulated from each other, and letter *c* that they are metallically connected together. B B^1 B^2 are galvanic batteries. D is a circuit-changer or reverser, and consists of two pairs of electro-magnets, E E', in separate and independent circuits. *e e'* are the iron cores thereof, the resistance of magnet E being greater than that of magnet E'. F F' are their armatures upon the opposite sides of lever G, which moves on its fulcrum *g'* between two uprights or supports, H.

I I' are metallic posts. J is a spring, which is attached to a post, I, but is insulated therefrom by hard rubber, and has a projection, *j*, which presses against the end of lever G, and holds it in the position placed by magnet E or E' when not charged. K is a metallic conductor, which is set in lever G, but is insulated therefrom by hard rubber, and contacts alternately with post I' and metallic point or conductor L', and the opposite end of lever G contacts alternately with metallic point or conductor L and post I. M is a polarized relay-magnet of Siemens or any other make, and consists of electro-magnets *m m'*, connected together by wire *r*, and to the iron cores thereof iron plates or poles *n n'* are attached, and by which lever *o* is attracted and vibrates on its fulcrum *o'*, contacting alternately with metallic point *p* and hard-rubber or insulated point *q*. The said iron poles *n n'* and lever *o* are polarized by iron cores of magnets *m m'*, and lever *o* being attached to permanent magnets and the polarity of poles *n n'* being alternately changed, alternately contacts with points *p* and *q*, when currents of electricity flow alternately over wire coils of magnets *m m'* in opposite or reverse directions, and when lever *o* contacts with hard-rubber point *q*, caused by a current flowing over magnets *m m'* in one direction, it will not contact with metallic point *p* until another current flows over said magnets *m m'* in an opposite direction, or vice versa. T is

an ordinary electro-magnet, whose armature-lever should be employed in connection with a visual or audible signal, or both, by means of suitable intervening mechanism, so that when not charged by battery B^2 a red or caution or danger semaphoric signal will be shown, or a bell will not be sounded; and when said magnet is charged, the red or caution or danger semaphoric signal will be removed from view, thereby indicating safety, or a white or safety semaphoric signal will be shown, or a bell will be sounded, thereby indicating safety. The section of track A^1 should be about five hundred feet ahead of section A^2, circuit-changer D, and signal-operating magnet T, so that sufficient time will be given for displaying a safety signal to the engineer of a locomotive or train approaching end *a* of section of track A in direction of arrow, when said section of track A is clear, before said locomotive or train reaches said section A^2, circuit-changer D, and signal-operating magnet T.

When the rails R^2 R^3 of section A^1 are occupied by the wheels W W and axle or axles X of said locomotive or train, the circuit of battery B^1 is closed and flows over wire 1, magnet E, wire 2, rail R^2, wheels W W, axle X, rails R^3 R^5, and wire 3, thereby charging iron cores *e* of magnet E, and attracting armature F upon lever G, and thereby causing lever G to break contact with point L, and to contact with post I, and insulated metallic conductor K to break contact with post I′, and to contact with point L′, and thereby causing circuit of battery B to flow over wire 6, line of rail R, wires 7 12, post I, lever G, wire 9, magnet *m*, wire *r*, and magnet *m′* of relay M, wire 8, insulated conductor K, point L′, wires 13 10, line of rails R, and wire 11, thereby changing the polarity of poles *n n′* of relay M, and causing lever *o* to be attracted by pole *n′*, and to contact with metallic point *p*, and close circuit of battery B^2 over wire 14, magnet T, wire 15, metallic point *p*, lever *o*, and wire 16, thereby charging magnet T, and causing a safety signal to be given to the engineer of the approaching locomotive or train, as hereinbefore described, until the first pair of wheels W W and axle X of said locomotive or train reach and occupy rails R^6 R^7 of section of track A^2, when the circuit of battery B^1 will flow over wire 4, magnets E′, wire 5, rail R^6, wheels W W, axle X, rails R^4 R^5, and wire 3, thereby charging iron cores *e′* of electro-magnets E, and attracting armature F′ upon lever G, and causing lever G to break contact with post I, and to contact with metallic point L, and insulated metallic conductor K to break contact with metallic point L′, and to contact with metallic post I′, and cause the circuit of battery B to flow over wire 6, line of rails R, wire 7, post I′, insulated conductor K, wire 8, magnet *m′*, wire *r*, and magnet *m* of relay M, wire 9, lever G, metallic point L, wire 10, line of rails R^1, and wire 11, thereby changing the polarity of poles *n n′* of relay M, and causing lever *o* to be attracted by pole *n*, and to contact with hard-rubber point *q*, thereby breaking circuit of battery B^2, demagnetizing magnet T, and allowing a caution or danger signal to be given, as hereinbefore described, until the said locomotive or train has passed over and off section of track A, when the polarity of poles *n n′* of relay M can again be changed by battery B and circuit-changer D, when the first pair of wheels and axles of a following locomotive or train occupy section of track A^1, and magnet T will be then charged and a safety signal again given, as hereinbefore described.

When rails R R^1 of section of track A are occupied and metallically connected by the wheels and axles of a locomotive or train the circuit of battery B is shunted by passing over wire 6, rails R, wheels and axles of said locomotive or train, rails R^1, and wire 11, thereby preventing the polarity of poles *n n′* of relay M being changed by battery B, and a safety signal given, as hereinbefore described.

When a rail in line of rails R or R^1 is removed or broken, or the continuous metallic circuit which connects relay M with battery B be broken in any other manner, the circuit of battery B will flow over wires 6 11, rails R R^1, and into the earth adjacent to said rails, and will not flow over magnets *m m′* of relay M, as hereinbefore described, and consequently a safety signal will not be given.

When sections A^1 A^2 are occupied at the same time by the wheels and axles of a train the circuit of battery B^1 will flow over magnet E′, and not over magnet E, owing to the resistance of magnet E′ being less than that of magnet E, and consequently the polarity of poles *n n′* will be reversed by lever G, conductor K, and battery B, and lever *o* will contact with hard-rubber point *q*, and a caution or danger signal will commence to be given before the locomotive or train enters upon section of track A, and directly after the safety signal was given.

Fig. 2 represents my invention as applied to an insulated section of one line, up or down, of a double-track railroad, in which the lever of polarized relay M is actuated by two batteries, instead of one battery, as shown and described in Fig. 1. W W W′ W′ and X X′ represent the two first pair of wheels of a locomotive or train moving in direction of arrow. U is a rheostat, whose resistance can be the same or greater than the combined resistance of magnets *m m′* of relay M.

When rails R^2 R^3 of section A^1 are occupied by wheels W W and axle X of said locomotive or train the circuit of battery B will flow over wire 1, line of rails R, wire 2, magnet *m′*, wire *r*, and magnet *m* of relay M, wire 3, rheostat U, wire 4, rail R^2, wheels W W, and axles X, rails R^3 R^5 R^7 R^1, and wire 5, thereby changing the polarity of poles *n n′* of relay M, and causing lever *o* to be attracted by pole *n*, and to contact

with metallic point *p*, and cause a safety signal to be given, as hereinbefore described, and lever *o* will continue to contact with metallic point *p* until rails R R^1 are occupied by wheels W W and axle X, and rails R^6 R^7 are occupied by wheels W′ W′ and axle X′, when the circuit of battery B will be shunted, and circuit of battery B^1 will be closed over wire 6, magnet *m*, wire *r*, magnet *m′*, wire 2, rail R, wheel W, axle X, wheel W, rails R^1 R^7, wheel W′, axle X′, wheel W′, rail R^6, and wire 7, thereby changing the polarity of poles *n n′*, and causing lever *o* to be attracted by pole *n′*, and to contact with hard-rubber point *q*, and a caution or danger signal to be given, as hereinbefore described.

Fig. 3 is a modification of Fig. 2, and when rails R^2 R^3 are occupied by wheels W W and axle X the circuit of battery B will flow over wire 1, line of rails R, wire 2, magnet *m′*, wire *r*, and magnet *m* of relay M, wire 3, rheostat U, wire 4, rail R^2, wheel W, axle X, wheel W, rail R^3, wire 5, line of rails R^1, and wire 6, thereby causing lever *o* to be attracted by pole *n*, and to contact, and to continue to contact, with metallic point *p* until rails R R^1 are occupied by wheels W W and axle X, and rails R^6 R^7 are occupied by wheels W′ W′ and axle X′, when the circuit of battery B will be shunted and circuit of battery B^1 closed over wire 7, rail R^7, wheel W′, axle X′, wheel W′, rail R^6, wire 8, magnet *m*, wire *r*, and magnet *m′* of relay M, wire 2, rail R, wheel W, axle X, wheel W, rail R^1, and wire 9, thereby changing the polarity of poles *n n′*, and causing lever *o* to be attracted by pole *n′*, and to contact with hard-rubber point *q*. Heretofore an ordinary relay-magnet, which controlled a secondary or local circuit or circuits and a visual or audible signal, or both, has been employed in connection with the rails of a long insulated section of railroad-track, and its lever depends for its operation upon the action of an adjustable spring and the closing or interruption of one current. Owing to the frequent and sudden variations in the strength of the battery-current, caused by the large or small amount of leakage or escape of said current from the rails to the earth during the different changes of weather, the lever of said ordinary relay-magnet requires frequent adjustment to suit the varied changes in the strength of said current, and if it is not kept properly adjusted the said lever will either cease to work or cause signals to be given at wrong times. When the earth is dry there is but little escape of battery-current from the rails to the earth, and the current is strong; but when the earth is wet or moist there is a large amount of escape of battery-current to the earth, and the said current becomes weak.

An ordinary relay or electro magnet can only be employed successfully in connection with a short section or sections of track like sections A^1 A^2, where there is but little escape and variation of battery-current. The resistance of an ordinary relay-magnet, when employed in connection with a long section of railroad-track, like section A, must be very low, and said magnet is apt to become charged by the battery-current flowing over one line of rails, when a rail is removed or broken, in damp or wet weather, and thereby cause a safety signal to be given. The resistance of polarized relay M can be high, and therefore the current of battery B will more readily be prevented from charging relay M when rails R R^1 are occupied and metallically connected by the wheels and axles of a locomotive or car, or when a rail in line of rails R or R^1 is removed or broken, than an ordinary relay, whose resistance must be low.

I consider the employment of a polarized relay whose lever is actuated by opposite or reverse currents in combination with the rails of a long insulated section of a railroad-track, when said rails are used as electric conductors, as a very important and necessary feature for the successful working of a rail system of electric railway-signaling; and, while I have shown a few methods of employing a polarized relay in combination with the rails of a long insulated section of a railroad-track, so as to be operated by opposite or reverse currents, nevertheless I do not propose to confine myself to the specific methods hereinbefore shown and described; for, instead of the devices hereinbefore shown and described for controlling circuits, and the arrangements of battery or batteries, wires, &c., various other devices and arrangements of battery, wires, &c., can be employed.

The secondary battery B^2, wires 14 15 16, and magnet T, Fig. 1, could be dispensed with, and the movements of a visual or audible signal, or both, be controlled by lever *o* through suitable intervening mechanism.

For an insulated section of a single-track railroad, it will be necessary to employ a signal-operating maget, polarized relay, galvanic battery, and devices for controlling circuits at each end of the section of track.

Having now fully explained my invention, I claim—

1. A polarized relay-magnet, which controls a visual or audible signal, or both, a galvanic battery or batteries, and devices for controlling circuits, in combination with the rails of an insulated section of railroad-track, A, so as to be operated by opposite or reverse currents, as and for the purpose set forth.

2. Polarized relay M, battery B^2, signal-operating magnet T, circuit-changer D, battery B^1, sections of track A^1 A^2, and battery B, in combination with lines of rails R R^1 of section of track A, as set forth.

3. The combination of circuit-changer D, having two magnets, E E′, of different resistances, battery B^1, and sections of track A^1 A^2, as set forth.

4. The combination of magnet M, battery B^1, wires 2 6 7, and rails R R^1 R^6 R^7, arranged

to be operated by the metallically-connected wheels of a car or train, substantially as set forth.

5. The combination of magnet M, battery B^1, wires 2 7 8 9, and rails R^1 R R^6 R^7, arranged to be operated by the metallically-connected wheels of a car or train, substantially as set forth.

In testimony that I claim the foregoing as my own invention I affix hereto my signature in presence of two witnesses.

HENRY W. SPANG.

Witnesses:
C. T. SELLERS,
C. A. HOMAN.