2 Sheets—Sheet 1.

H. W. SPANG.

Electro-Magnetic Railway-Signal.

No. 208,995. **Patented Oct. 15, 1878.**

Fig. 1.

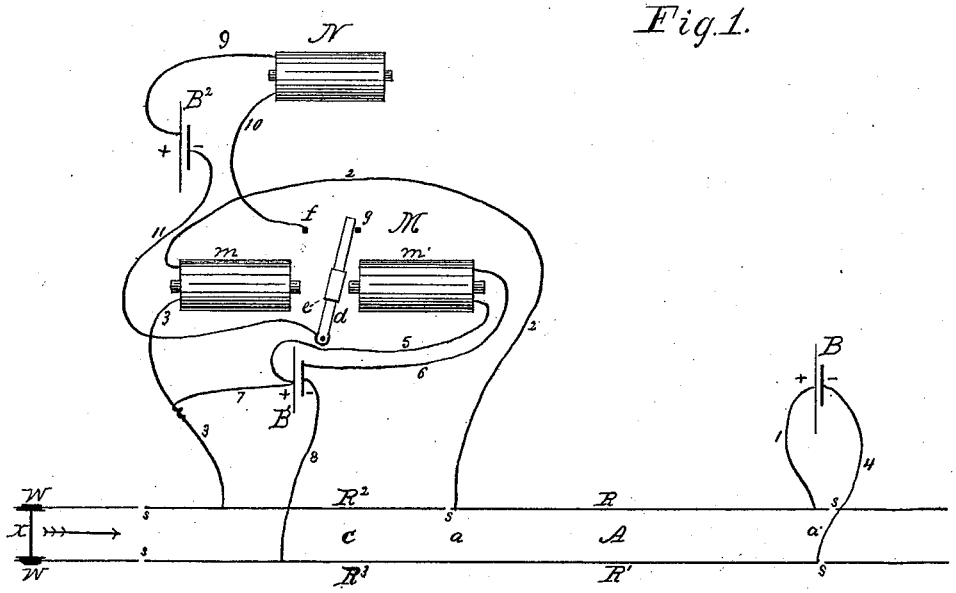
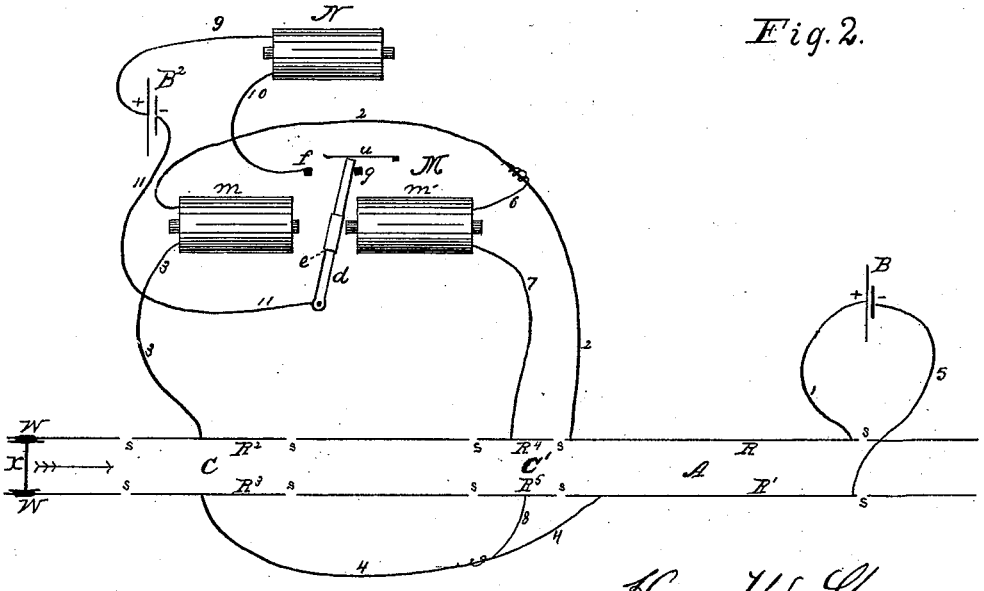


Fig. 2.



WITNESSES

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Wm. R. Chipley.

Henry W. Spang,

INVENTOR

per Wm Beale Hale

ATTORNEY

2 Sheets—Sheet 2.

H. W. SPANG.

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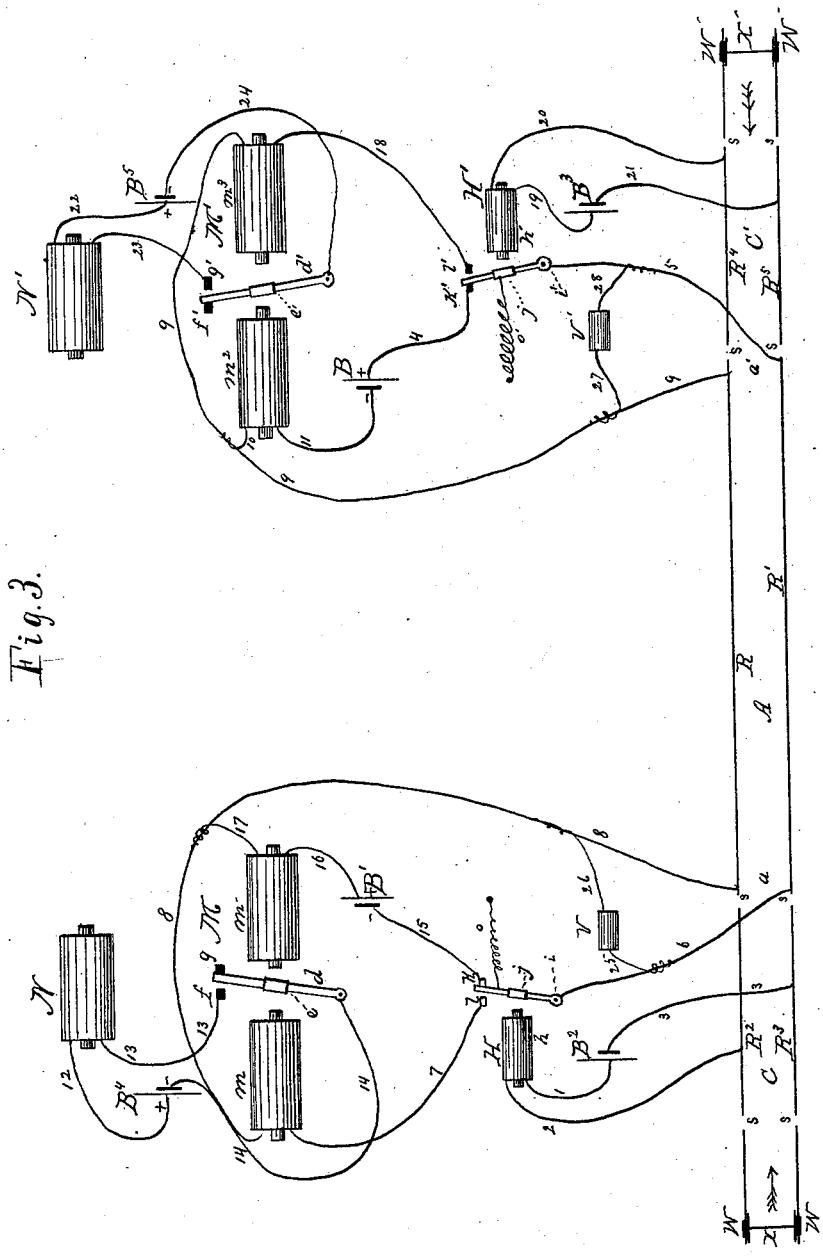

Fig. 3.

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UNITED STATES PATENT OFFICE.

HENRY W. SPANG, OF READING, PENNSYLVANIA.

IMPROVEMENT IN ELECTRO-MAGNETIC RAILWAY-SIGNALS.

Specification forming part of Letters Patent No. **208,995**, dated October 15, 1878; application filed January 29, 1877.

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 Devices for Railway-Signal Apparatus, which are fully set forth in the following specification and accompanying drawings.

My invention is an improvement upon the electric circuits and devices shown and described in Patent No. 164,227, issued to me June 8, 1875, in which the two lines of rails of an insulated section of railroad-track are used as the principal conductors between a galvanic battery connected at one end of the section of track and an ordinary relay, which controls a secondary circuit and a visual or audible signal, or both, and devices for controlling circuit at the opposite end thereof.

It consists in the combination of a relay (one or more) whose armature-lever is moved in opposite direction by electro-magnets in separate or derived circuits, and which controls a secondary 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 relay will be moved in opposite directions by electro-magnetism, and thereby enable signals to be given without requiring any special attention to be given to the lever of the relay when there is a variation in the strength of the rail-battery circuit caused by escape or leakage of electricity from the rails to the earth.

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

A, Figs. 1, 2, and 3, is an insulated section of railroad-track a mile long, more or less. *a* *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 the rails jointed together by metallic fish-plates, and be kept well screwed up, so as to maintain a good and constant metallic connection between the ends of the rails. C, Figs. 1 and 2, and C C', Fig. 3, are circuit-closers, and consist of short lines of rails, R^2 R^3 R^4 R^5, when occupied by the wheels W W and axle or axles X of a locomotive or car. Letter S indicates that the rails hereinbefore named are separated or insulated from each other. B B^1 B^2 B^3 B^4 B^5 are galvanic batteries.

M or M^1, Fig. 3, is a relay, whose armature-lever *d* or *d'* is moved between points *f* and *g* or *f'* and *g'* by means of two electro-magnets, *m* m^1 or m^2 m^3, which are in separate circuits and charged alternately. The resistance of electro-magnet m^1 in Figs. 1 and 2 is less than that of *m*; and magnets m^1 m^2, Fig. 3, can be of any suitable resistance.

N or N', Fig. 3, 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 a battery-current 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, or a white or safety semaphoric signal will be shown, or a bell will be sounded, thereby indicating safety.

H or H', Fig. 3, is an ordinary relay, whose armature-lever *i* is moved between metallic points *l* and *k* or *l'* and *k'*, by means of electro-magnet H or H' and adjusting-spring *o* or *o'*.

The circuit-closer C or C', Fig. 3, should be about five hundred feet ahead of relay M or M' and signal-operating magnet N or N' and end of section of track A, so that sufficient time will be given for displaying a safety-signal to the engineer of a locomotive or train approaching end *a* or *a'* of section of track A in direction of arrow, Fig. 3, when section of track A is clear and before said locomotive or train reaches end *a* or *a'* of said section of track.

Referring to Fig. 1, when rails R^2 R^3 are occupied by wheels W W and axle or axles X of a locomotive or train moving in direction of arrow, the circuit of battery B^1, which is normally closed over wire 5, magnet *m'*, and wire 6, and draws lever *d* against point *g*, will be shunted by flowing over wires 7 3, rail R^2, wheels W W, and axle or axles X, rail R^3, and wire S, and at the same time the circuit of

battery B will be closed over wire 1, line of rails R, wire 2, magnet *m*, wire 3, wheels W W, and axle or axles X, rails R^3 R^1, and wire 4, thereby charging magnet *m* and attracting lever *d* against metallic point *f*, thereby closing circuit of battery B^2 over wire 9, signal-operating magnet N, wire 10, metallic point *f*, lever *d*, and wire 11, charging magnet N, and causing a safety-signal to be given to the engineer of the approaching locomotive or train, as hereinbefore explained, which will be kept displayed until the locomotive or train has passed over rails R^2 R^3, when the current of battery B^1 will again flow over wire 5, magnet m^1, and wire 6, charging magnet m^1, and drawing lever *d* against point *g*, thereby breaking circuit of battery B^2, demagnetizing magnet N, and causing a caution or danger signal to be given, as hereinbefore explained, until the said locomotive or train has passed over and off section of track A, and a following locomotive or train reaches rails R^2 R^3, when the circuit of battery B^1 will again be shunted, and magnet *m* of relay M will again be charged by battery B, and a safety-signal given, as hereinbefore described, by the following locomotive or train.

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 1, rails R, wheels and axles of said locomotive or train, rails R^1, and wire 4, thereby preventing magnet *m* of relay M being charged by battery B, and a safety-signal being given, as hereinbefore described.

The batteries B and B^1 are connected, so that the current of battery B is neutralized by B^1 and its current is open, except when rails R^2 R^3 are occupied by wheels W W and axles X of a locomotive or train and section of track A is clear. The poles of battery B or B^1 can, however, be reversed, so that the circuit of battery B will be normally closed over magnet *m* when section of track A is clear. At the same time the current of battery B^1, flowing over magnet m^1, exerts a greater influence upon armature *e* of lever *d* than is exerted upon it by the current of battery B flowing over magnet *m*, and the armature-lever *d* will, therefore, make contact with point *g* until battery B^1 is shunted, when magnet *m* will draw lever *d* against point *f*, provided rails R R^1 of section of track A are not occupied and bridged by the wheels and axles of a locomotive or train.

Instead of shunting current of battery B^1, it can be arranged to be broken by a circuit-breaker operated by a locomotive or train.

The battery B^1 in Fig. 1 can be dispensed with, and magnets *m* and m^1 be alternately charged by battery B when section of track A is clear and unoccupied by employing an additional circuit-closer, C^1, and connecting magnets *m* m^1 with circuit-closers C C^1 and rails R R^1, as shown in Fig. 2.

When rails R^2 R^3, in Fig. 2, are occupied by wheels W W and axles X of a locomotive or train moving in direction of arrow, and section of track A is clear, the circuit of battery B will be closed over wire 1, rails R, wire 2, magnet *m*, wire 3, rail R^2, wheels W W, and axles X, rail R^3, wire 4, rails R^1, wire 5, thereby charging magnet *m*, causing lever *d* to contact with metallic point *f*, and closing circuit of battery B^2, charging magnet N, and causing a safety-signal to be given, as hereinbefore described; and when rails R^4 R^5 are occupied by first pair of wheels W W and axles X of said locomotive or train the circuit of battery B will then flow principally over wire 6, magnet m^1, wire 7, rail R^4, wheels W W, axles X, rail R^5, and wire 8, and not over magnet *m*, as hereinbefore described, owing to the resistance of magnet m^1 being less than that of magnet *m*, and consequently lever *d* will then be attracted by magnet m^1 and be drawn against point *g*, breaking circuit of battery B^2, thereby demagnetizing magnet N and causing a caution or danger signal to be given.

In order to keep lever *d* of relay M, Fig. 2, in the position it is placed and left by magnet *m* or m^1, and prevent it from being moved from said position by the jar of trains passing along the opposite track, when the current of battery B does not flow through magnet *m* or m^1, it is advisable to employ a flat spring, *u*, or any other suitable device to press against the top or any other suitable part of lever *d*. The base of relay M can, if desired, be partly inclined, so that lever *d* will fall over and lie against point *g* by gravity when magnet *m* is not charged.

Referring to Fig. 3, when rails R^2 R^3 are occupied by the wheels W W and axles X of a locomotive or train moving in direction of arrow and section of track A and rails R^4 R^5 are clear, the current of battery B^2, flowing over wire 1, magnet *h*, wire 2, rail R^2, wheels W W, and axle X, rail R^3, and wire 3, charging magnet H and drawing armature-lever *i*, which is normally held against metallic point K by spring O against metallic point *l*, thereby breaking circuit of battery B^1 and allowing current of battery B to flow over wire 4, metallic point *h'*, and lever *i'* of relay H', wire 5, rails R^1, wire 6, lever *i*, and metallic point *l* of relay H, wire 7, magnet *m* of relay M, wire 8, rails R, wires 9 10, magnet m^2 of relay M', and wire 11, thereby charging magnet *m*, which, attracting armature *e*, causes lever *d* to contact with metallic point *f*, closing circuit of battery B^4, charging magnet N, and causing a safety-signal to be given, as hereinbefore described. Should rails R R^1 of section of track A be occupied by a locomotive or train, the circuit of battery B would be shunted; or should rails R^4 R^5 be occupied, the circuit of battery B will be opened, and magnet *m* of relay M cannot be charged, and a safety-signal will be prevented being given as hereinbefore described.

When rails R^4 R^5, Fig. 3, are occupied by the wheels W' W' and axles X' of a locomo-

tive or train moving in direction of arrow, and section of track A and rails R^2 R^3 are clear, the current of battery B^3, flowing over wire 19, magnet h' of relay H', wire 20, rail R^4, wheels W' W', axles X', rail R^5, and wire 21 charging magnet h' and drawing armature-lever i', which is normally held against metallic point h' by spring o', against metallic point l', thereby breaking circuit of battery B, and allowing current of battery B^1 to flow over wire 16, magnet m^1 of relay M, wires 17 8, rails R, wire 9, magnet m^3 of relay M', wire 18, point l', and lever i' of relay H', wire 5, rails R^1, wire 6, lever i, and point K of relay H, and wire 15, thereby charging magnet m^3, which, attracting armature e', causes lever d' to contact with point g', closing circuit of battery B^5, charging magnet N', and causing a safety-signal to be given, as hereinbefore described. Should rails R R^1 of section of track A or rails R^2 R^3 be occupied by a locomotive or train, the magnet m^3 cannot be charged by battery B^1, and a safety-signal cannot be given. Magnets m^1 and m^2 are normally charged, and, in order to charge magnet m^1 by battery B^1 and magnet m^2 by battery B when a rail in section of track A is removed or broken during dry weather, it is necessary to connect rheostats U and U' of high resistance with wires 6 and 8 and with wires 5 and 9 by wires 25, 26, 27, and 28, as shown.

In Patent No. 164,227 an ordinary relay is employed, which controls a secondary circuit or circuits, and a visual or audible signal, or both, in combination with the two lines of rails of a long insulated section of railroad-track, having a galvanic battery connected therewith at the opposite end of the section of track, whose lever depends for its movement in one direction upon an electro-magnet, and in the opposite direction upon an adjusting-spring. When there is a great change in the strength of the battery-current, caused by leakage or escape of the current of said battery from the rails to the earth during the different changes of weather, the spring attached to the lever of said ordinary relay requires readjustment to suit the change in the strength of said current, and if it is not kept properly adjusted the said lever will fail to work properly.

By employing the relay M or M', whose lever is moved in opposite directions by alternately charging magnets m and m^1, or m^2 and m^3, in separate or derived circuits, in combination with section of track A, having battery B or B^1 connected therewith at the opposite end thereof, the said lever will work properly during the different changes of weather, and without requiring any readjustment or attention; and while I have shown two methods of employing relay M, in combination with section A of one line of a double-track railroad and battery B, and one method of employing relays M and M' with section A of a double-track railroad and batteries B and B^1, nevertheless I do not propose to confine myself to the specific methods shown and described, for, instead of the methods and devices shown and described for controlling the circuits of which magnets m and m^1, or m^2 and m^3, form a part, various other devices and arrangement of wires, &c., can be employed.

The magnet m of relay M, Fig. 1, can be connected direct with rails R R^1 of section of track A and battery B, with a circuit-closer or devices for closing circuit similar to those shown in Figs. 9, 10, 11, and 12 of Patent No. 164,227, so that the circuit of battery B will be left open at end a', except when the said circuit is closed by an approaching locomotive or train, and thereby prevent the current of battery B becoming weak during wet or damp weather.

A rheostat of low resistance can be placed in the circuits shown in Figs. 1 and 2, between rail R and battery B, which will prevent the rapid weakening of battery B during wet and damp weather.

The secondary battery B^2 and signal-operating magnet N, Figs. 1 and 2, or secondary batteries B^4 B^5 and signal-operating magnets N and N', Fig. 3, could be dispensed with, and the movements of a visual or audible signal, or both, be controlled by lever d or d' of magnet M or M' through suitable intervening mechanism.

Having now explained my invention, I claim—

1. The combination of relay M, having electro-magnets m and m^1 in separate circuits, and the armature-lever d of which is moved in opposite directions by electro-magnetism, and controls a secondary circuit and a visual or audible signal, or both, and devices for controlling said circuits at one end of an insulated section of railway-track, A, with the rails of said section of track and battery B, which is connected with said rails at the opposite end of said section of track, as and for the purpose set forth.

2. Relay M, battery B^2, wires 9 10 11, signal-operating magnet N, wires 5 6, battery B^1, wires 2 3 7 8, circuit-closer C, in combination with rails R R^1, of insulated section of track A, wires 1 4, and battery B, as set forth.

3. The combination of rails R R^1 of insulated section of railroad-track A, having a galvanic battery, B, and relay M', with magnets m^2 and m^3 in separate circuits, and whose armature-lever d' controls a visual or audible signal, or both, connected therewith at one end, a', of said section of track and galvanic battery B^1, and relay M, with magnets m and m^1, in separate circuits, and whose armature-lever d controls a visual or audible signal, or both, connected therewith at the opposite end, a, of said insulated section of track, in combination with a circuit closer and breaker, or devices for closing and breaking circuit at each end a and a' of said insulated section of track, substantially as described, and for the purpose set forth.

4. Rails R R^1 of insulated section of track A, galvanic battery B^1, relay M, wires 6 7 8

15 16 17, battery B^4, wires 12 13 14, signal-operating magnet N, battery B, relay M′, wires 4 5 9 10 11 18, battery B^5, wires 22 23 24, signal-operating magnet N′, with relay H, battery B^2, wires 1 2 3, circuit-closer C, and relay H′, battery B^3, wires 19 20 21, circuit-closer C′, substantially as described.

5. Rheostat U, in combination with battery B^1 and magnet m^1, substantially as described, and for the purpose set forth.

HENRY W. SPANG.

Witnesses:

ISAAC Y. SPANG,

DANIEL SPANG.