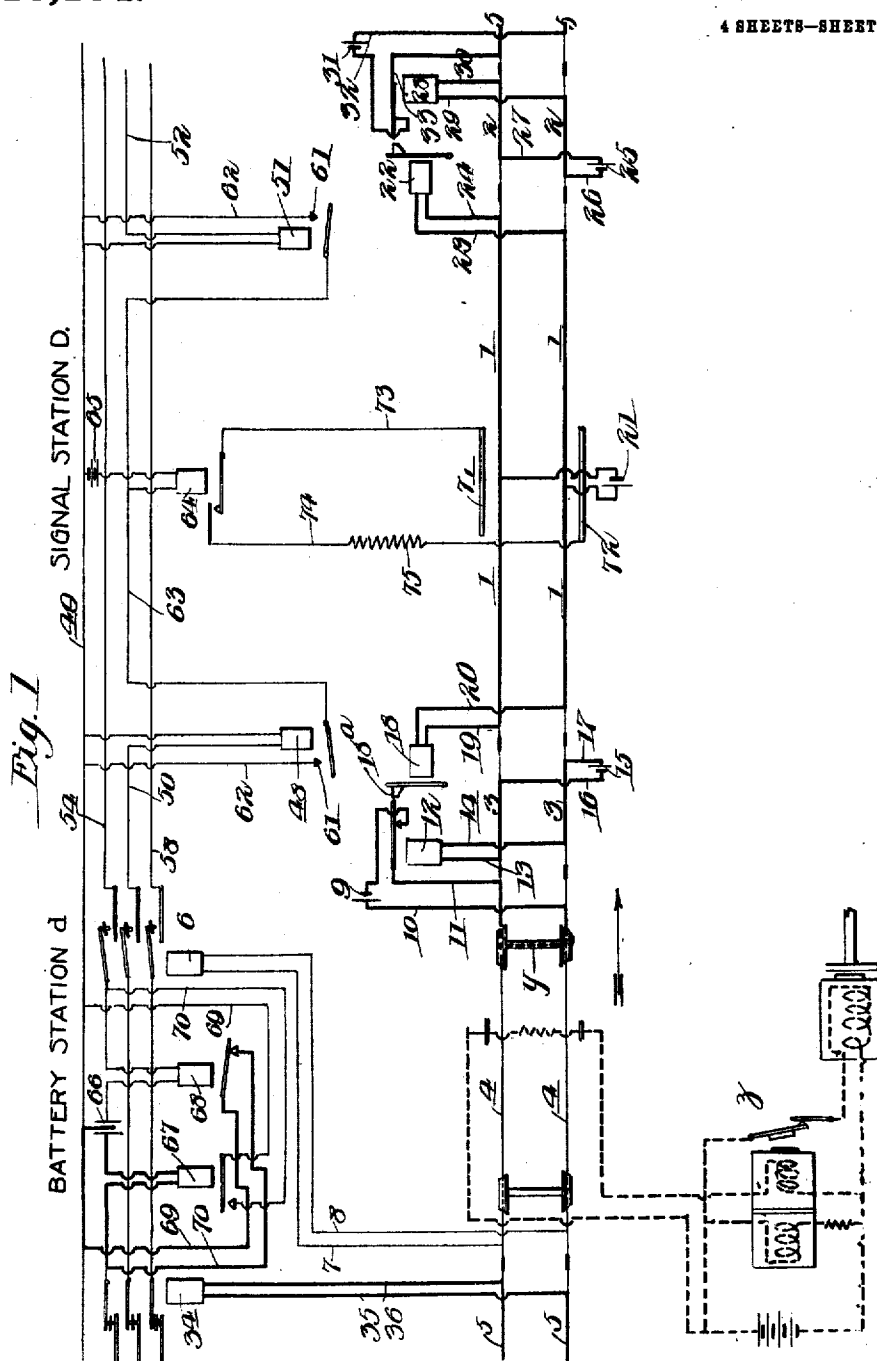


910,184.

Patented Jan. 19, 1909.

4 SHEETS—SHEET 1.



Witnesses. FFF
 U. L. Sherman.
 George L. Chindahl

Inventor:
Charles E. Duffie
By Luther L. Miller
Att'y.

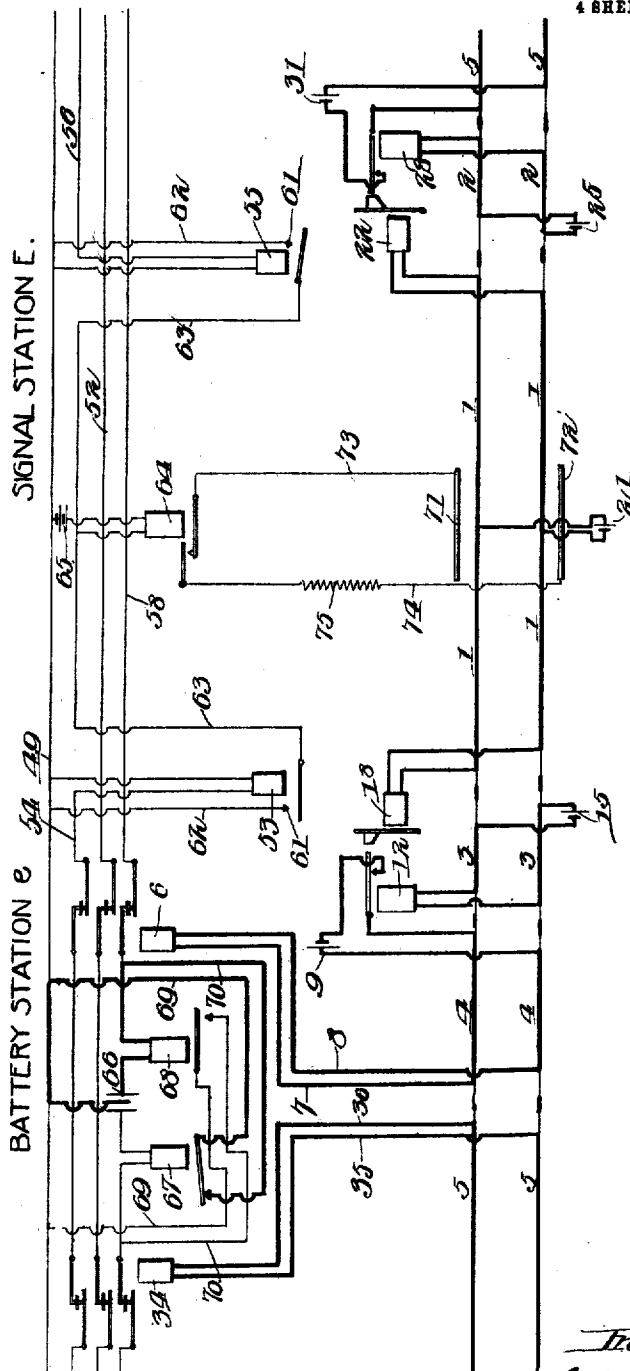
C. E. DUFFIE.
RAILWAY SIGNAL SYSTEM.
APPLICATION FILED AUG. 19, 1907.

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4 SHEETS—SHEET 2.

Fig. 2.



Witnesses.

V. L. Sherman
George L. Chindahl

Inventor.

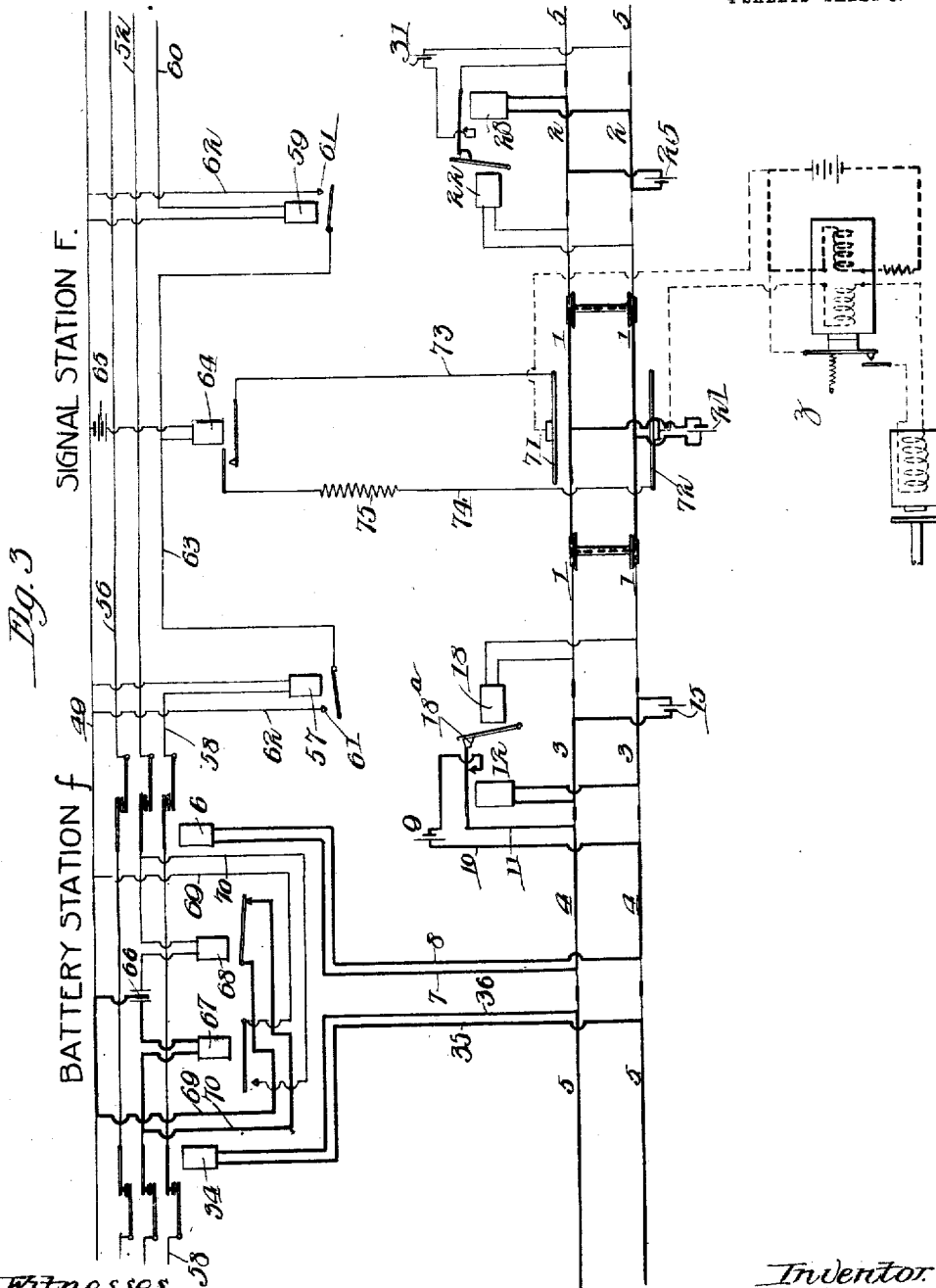
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UNITED STATES PATENT OFFICE.

CHARLES E. DUFFIE, OF OMAHA, NEBRASKA.

RAILWAY SIGNAL SYSTEM.

No. 910,184.

Specification of Letters Patent.

Patented Jan. 19, 1909.

Application filed August 19, 1907. Serial No. 389,187.

To all whom it may concern:

Be it known that I, CHARLES E. DUFFIE, residing at Omaha, in the county of Douglas and State of Nebraska, have invented certain new and useful Improvements in Railway Signal Systems, of which the following is a description, reference being had to the accompanying drawings, forming a part of this specification, in which corresponding letters of reference in the different figures indicate like parts.

One of the objects of the present invention is the provision of an improved automatic electric railway signal system.

Another object of the invention is the production of an electric signal system which shall give a danger signal upon the derangement of any of its parts.

The invention also relates to an electric signal system comprising signal circuits which are not grounded, in order that high voltage currents may be employed.

The invention further relates to a signal system comprising signal circuits entirely independent of each other, any derangement affecting only the circuit in which it occurs.

The invention also relates to an electric signal system, in which there is no electric connection between the signal circuits proper and the track circuits.

The invention also refers to a signal system in which the circuits from which current is most likely to escape are comparatively short.

The invention also refers to other improvements in signal systems and apparatus hereinafter set forth.

In the accompanying drawings, Figures 1, 2 and 3 are diagrams illustrating portions of a signal system embodying my invention. Fig. 4 is a view illustrating the wiring of circuits of the signal system as arranged at switches. Fig. 5 is a diagram of the wiring for a signal system to be used at railway stations.

In the embodiment herein shown of my invention, the signals are transmitted to the engineer along the right-of-way at stations which I shall denominate signal stations D, E, F, G, H, etc., (stations D, E and F only being shown in the drawings), said signal stations being preferably located approximately one half mile apart. Between the signal stations, preferably midway, are placed the batteries and relays which control the apparatus at the various signal stations.

The points at which said batteries and relays are located I will indicate on the drawings by the letters *d*, *e*, and *f*, etc., and will term battery stations. The term "train" shall be used throughout to designate a steam or electric locomotive, a train or a single car.

The track between each two adjacent battery stations is divided into five insulated sections. The section directly opposite the signal station is preferably about 200 feet long, and is numbered 1 in the drawings. At each end of the section 1 is a shorter section 2, 3. The two track sections completing the distance between the battery stations are numbered 4 5.

Upon each locomotive equipped for service upon a railway provided with this signaling system is placed apparatus adapted to be electrically connected at each of the signal stations along the road with a comparatively short circuit which shall be herein termed the contact circuit. If said contact circuit is closed and otherwise in operative condition, the apparatus carried by the locomotive will not be affected, and no danger signal will be given. If the contact circuit is open or deranged, the apparatus upon the locomotive will be operated to give a danger signal. Said contact circuit is arranged to be opened and closed by apparatus included in a signal circuit extending, in this instance, from said signal station to the third signal station ahead. Said signal circuit, in turn, is arranged to be broken and closed by relays included in a number of circuits of which the track rails and the car wheels and axles form a part. Said track circuits will next be described.

The rails 4 are connected at their left or west ends with a relay 6 by means of wires 7 and 8, the east ends of said rails being connected with a battery 9 by means of wires 10 and 11, the armature of a relay 12 being included in said wire 11. The relay 12 is connected with the rails 3 by means of the wires 13 and 14. Said rails 3 are connected with a battery 15 by means of wires 16 and 17. The rails 1 are connected at their west ends with an electro-magnet 18 by wires 19 and 20. Upon the armature of the magnet 18 is a locking projection 18^a adapted to engage the armature of the relay 12 and prevent said relay-armature from contacting its contact point.

The rails 1 are connected near their middle

portion with a battery 21. At their east ends the rails 1 are connected with an electro-magnet 22 by means of wires 23 and 24. The rails 2 are connected with a battery 25 by means of wires 26 and 27, and with a relay 28 by means of wires 29 and 30. The west ends of rails 5 are connected with a battery 31 by means of wires 32 and 33, the wire 33 including the armature of the relay 28. The east ends of rails 5 are connected with a relay 34 by means of wires 35 and 36.

Fig. 4 illustrates the arrangement of the track circuits at switches, draw-bridges, etc., 37, 38 and 39 being insulated rail sections, 40 a track battery, and 41 a relay for opening the signal circuits to be hereinafter mentioned. A wire 42 connects the rails 38 and 39, a circuit-breaker 43 being inserted in said wire. The movable contact 44 of the circuit-breaker is connected with the switch points so as to be moved to open or shut the track circuit when the switch is set for the siding. An open switch leading from the main line to the siding, therefore, will cause a danger signal to be given to an approaching train as will appear hereinafter. Fig. 4 also illustrates the means for giving a danger signal in case a car be left standing on a siding in such a position that a passing train cannot clear it. The sections 45 and 46 of the siding rails are insulated from the remainder of the siding and connected with the rails 37 and 38 by means of the wires 47. It will be seen that a pair of wheels resting upon the rails 45 and 46 will short-circuit the battery 40 and cause the relay 41 to break the signal circuit. Said signal circuits will now be described. At signal station D a relay 48 is connected with the common return wire 49 and with a signal wire 50 extending to signal station A (not shown), a relay similar to relay 48 being there connected in series with said signal wire 50 and the common return wire 49. At the signal station D another relay 51 is connected in series with the common return wire 49 and a signal wire 52 running eastward to signal station G (not shown), a similar relay being there connected in series with said signal wire and the common return wire. Similarly, at signal station E a relay 53 is connected in series with the common return wire 49 and a signal wire 54 extending to signal station B. At signal station E another relay 55 is connected in series with the common return wire and a signal wire 56 running eastward to signal station H. At signal station F the relay 57 is connected with the return wire 49 and a signal wire 58, extending to signal station C, and a relay 59 is connected with the common return wire and a signal wire 60 extending eastward to signal station I. The contact points 61 of the relays 48, 51, 53, 55, 57 and 59 are connected with the common return wire 49

by means of the wires 62. The armatures of the relays 48 and 51 are electrically connected through the wire 63, as are also the armatures of relays 53 and 55, and 57 and 59. Midway between the said armatures 70 and connected between the wire 63 and the common return wire 49 is a relay 64 and a battery 65. It will be seen that when either of the relays 48 and 51 is energized a circuit will be closed through the relay 64 and the battery 65.

In each of the signal wires 50, 52, 54, 56, 58 and 60 is placed a main battery 66 connected in parallel with the common return wire 49, said batteries being located at the battery stations. At opposite sides of said battery, relays 67 and 68 are included in said signal wire, the contact points of said relays being connected with said signal wire and the common return wire by means of wires 69 and 70. Each of the signal wires 50, 52, 54, 56, 58 and 60 is connected with the armatures of the relays 6 and 34, the springs of said relays tending to move said armatures in the direction to open said wires.

I will next describe the contact circuit at each of the signal stations. At each signal station there is placed along the track at a short distance outside of the traffic rails two contact rails 71 and 72, preferably of inverted V-shape in cross-section. These contact rails are arranged to be contacted by suitable brushes, shoes or similar devices carried by the locomotive, said brushes being connected with cab apparatus (not herein described) for noting the condition of the signal apparatus for the purpose of obtaining a signal. The contact rail 71 is connected with the armature of the relay 64 by means of the wire 73. The contact rail 72 is connected with the contact point of said relay by means of the wire 74. The apparatus carried by the locomotive may be of any suitable character, adapted to be affected by the condition of the contact circuit. Such apparatus is indicated diagrammatically at *z* (Figs. 1 and 3). With certain forms of cab apparatus it may be desirable to include a resistance 75 in the wire 74.

In Figs. 1, 2 and 3 are shown successive portions of a signal system embodying my invention, the live circuits being indicated by heavy lines and the dead circuits by light lines. The track circuits are shown in normal condition in Fig. 2. Rails 4 are included in the circuit comprising the relay 6, battery 9, and the relay point of the relay 12. The relay 12 is in circuit with the rails 3 and the battery 15. The western ends of the rails 1 are connected with the electro-magnet 18, the armature of which carries the locking projection 18^a adapted to engage with the armature of the relay 12 for holding the relay points of said relay open. It will

be seen that so long as the rails 4 are electrically continuous and unoccupied by a pair of wheels the relay 6 will be energized by the current from battery 9 and will attract its three armatures, closing the points of said relay as shown in Fig. 2, and making the signal wires 52, 54 and 58 electrically continuous. But the relay 6 will not be energized unless the relay points of the relay 12 are closed so as to complete the circuit of the battery 9. Said points will be closed so long as the circuit is completed from the battery 15 through the rails 3 unless while the armature of the relay 12 is in its uppermost position, the magnet 18 is deprived of current, in which case the locking projection 18^a upon the armature of said magnet will engage the armature of the relay 12, and hold it open. The purpose of this interlock will be explained hereinafter. Assuming now that a pair of wheels contacts the rails 4, the electrical conditions just described will be altered to those illustrated in Fig. 1. The wheels *y* have short-circuited battery 9 and thus deprived relay 6 of current, breaking the signal wires 50, 54 and 58. Said signal wires also would be opened by the presence of a pair of wheels across the rails 3, said wheels short-circuiting the battery 15, thus depriving the relay 12 of current, and breaking the circuit in which the relay 6 is included. If now, while there is a pair of wheels across the rails 3, a second pair of wheels enters upon the rails 1, (as would occur in the case of a train traveling in the direction of the arrow, Fig. 1), a short circuit will be established through the pair of wheels upon rails 1, depriving the magnet 18 of current, whereupon its armature will be released and the locking projection 18^a will engage the armature of the relay 12 which has previously receded. The circuit through battery 9 and the relay 6 cannot now be again closed, even though the short circuit across the rails 4 be removed, so long as the magnet 18 is deprived of current. As soon as the short circuit is removed from across the rails 1, the magnet 18 again receives current, and attracting its armature, permits the armature of the relay 12 to close the circuit through the relay 6 and close the signal wires 50, 54 and 58 through the armature and relay points of said relay. But it will be seen that the train will not remove said short-circuit before short-circuiting the battery 25 by entering upon the rails 2.

Precisely similar electrical conditions obtain to the right of any signal station upon the approach of a train, but affecting, however, the relays 28 and 34 and the magnet 22.

Having now described the operation of the instruments in the track circuits, the operation of the signal circuits will next be explained. Referring to battery station *e*

(Fig. 2): The battery 66 at this point is connected in the signal wire 58 extending to signal station F and is connected in parallel between said signal wire and the common return wire 49. A part of the current from said battery flows through the relay 67 to the relay points of the relay 34 at battery station *e* and the relay points of the relays 6 and 34 at battery station *d* to the relay corresponding to relay 51 at the signal station C, thence to the common return wire and back to the battery 66 at battery station *e*. The remainder of the current from said battery flows east through the relay 68, the relay points of the relay 6 at battery station *e*, the relay points of relays 34 and 6 at battery station *f* through the relay 57 at signal station F, thence to common return wire 49 and back to battery 66 at battery station *e*. It will be seen that so long as current is flowing in each direction from said battery 66, the relay before referred to at the signal station C and the relay 57 at signal station F will both be energized and will attract their armatures, making an electrical connection between said armatures and the wires 62. If, however, the signal wire 58 be open at any point between battery station *e* and the signal station C, the relay before referred to at said signal station and the relay 67 at battery station *e* will both be deprived of current. When the armature of the former relay drops, the circuit between said armature and its wire 62 will be opened. The dropping of the armature of the relay 67 at battery station *e* will have the following effect. A circuit will be closed from the battery 66 through wires 49 and 69, the armature of the relay 67, wires 70 and 58, and relay 68. This will short-circuit the current from battery station *e*, and it can no longer flow to the relay 57 at signal station F. The latter relay, thus deprived of current, will allow its armature to fall, and the circuit will be broken between said armature and the wire 62 leading to the common return wire 49. A break in the signal wire 58 at a point east of the battery station *e* will, of course, have the same effect on the relays at signal stations F and C, except that in this event the short-circuit would be formed by the relay 68 and would occur between the battery station *e* and the signal station C. It will be observed, however, that when the current from the battery 66 at battery station *e* is short circuited as first described, said current continues to flow through the coils of the relay 68 at said battery station, because said short-circuit is formed outside of the connections of said relay. As soon, however, as the circuit is restored between the battery 66 at battery station *e* and the signal station C, the relay 67 will again be energized, and, attracting its armature, will remove the

short-circuit between the battery 66 at battery station *e* and the signal station F, and current will again be permitted to flow east to the relay 57 at said signal station F. It

5 will now be seen that a pair of wheels across the rails at any point between signal stations F and C will deprive of current both the relay 57 and the relay corresponding to 59 at signal station C, the first by an open
10 circuit and the other by a short circuit, or the reverse, according to where the train stands on the track between said signal stations. The breaking of a track circuit at any point between the said two signal stations will have the same effect, and this will
15 happen not in one only, but in the three signal circuits, because each relay 6 and 34 governs three separate signal circuits. The resistance 75 is included in the contact circuit so that an accidentally or maliciously
20 formed short-circuit cutting out said resistance shall be detected by the cab apparatus. To render such detection certain the resistance 75 should be inserted as near as possible
25 to the relay points of the relay 64.

The magnets 18 and 22 are employed to prevent a misleading clear signal being given to a locomotive drawing no load. The rear wheels of such an engine, westbound, would
30 have left the rails 2 before the contact brushes touched the contact rails 71 and 72. This would allow the track circuits 2 and 5 to close, closing the signal circuit extending rearwardly of the engine, energizing relay
35 48, 51, 53, 55, 57 or 59 in said circuit, closing a circuit through battery 65 and relay 64, and closing the contact circuit. A clear signal would then be given, said signal coming from the portion of the train-control
40 block behind the engine, even if there were a train in the portion of said block ahead of the engine. It is therefore necessary, for the protection of light engines, to keep the relay at the given signal station, in the rearwardly extending circuit, deprived of current until the contact brushes have passed
45 off the contact rails.

To prevent the giving of a false danger signal by the train itself at every signal station, the distance of the rails 2 and 3 from the contact rails 71 and 72, in the present
50 embodiment of the invention, should be longer than the distance from the front truck of the longest engine which passes
55 over the road to the rear wheels of the tender, the preferred length being not less than 90 feet.

In order that there may be no points at which two trains could meet without getting
60 signals, I arrange the signal circuits so that they overlap each other, as shown, one of the two signal circuits that end at each signal station extending to the third signal station ahead, and the other circuit running
65 to the third station behind. The reason for

two overlaps instead of but one is to provide against the remote possibility of two approaching trains striking and leaving the contact rails at stations D and G, for example, before the one train reached the rails 70 2 (station D) or the other, the rails 3 (station G). Neither train having reached said track rails before the other left the contact rails, neither would operate the track-circuit apparatus to open the signal wire 52 75 in time to signal the other. The trains would then proceed to stations E and F where they would be stopped, as the signal relays governing these two stations would be deenergized before either train arrived. 80

It will be seen that a train receives signals only from the signal circuits extending forwardly from any particular signal station, but that it transmits signals to stations ahead of and behind it. Any train, therefore, as it
85 moves over the track is practically the center of a movable train-control or signal block three miles long, which shifts forward, as the train progresses, every half mile.

It is evident that a single section of the 90 signal system herein shown may be employed for protecting the right-of-way for any suitable distance at each side of a railway station, or the right-of-way between two adjacent stations. In Fig. 5 I have illustrated 95 diagrammatically an isolated system employed to protect the track for, say, three thousand feet at each side of a railway station. The signal circuit comprises the common return wire 76, the signal wire 77, the 100 central battery 78 connected in parallel between said common return and said signal wire, and the relays 79 and 80, said relays being located at the signal stations 81 and 82, respectively. It is desirable that the circuit extend about two thousand feet outside
105 of the yard limits (not indicated) in order that trains may work freely within the yard, and yet warning be given of their presence or of open switches at a sufficient distance
110 to allow an approaching train to stop. In an isolated signal system, such as shown in Fig. 5, the track circuits and the wiring for the relays at the signal stations are the same as in the system illustrated in Figs. 1, 2 and 115 3, and the mode of operation is the same in both.

For convenience I have herein used the term "battery" to indicate any suitable source of electrical energy, and the term 120 "relay" to designate various equivalent forms of apparatus.

It will be apparent to those skilled in the art that the circuits and apparatus herein shown may be altered and rearranged in 125 various ways without departing from the spirit and scope of my invention. No undue limitation, therefore, should be understood from the foregoing detailed description.

The contact circuit and the locomotive ap- 130

paratus herein disclosed are claimed in my copending application Serial No. 370,590, filed April 27, 1907.

I claim as my invention:

1. In an electric signal system, in combination, a plurality of normally-closed, overlapping, independent signal circuits; a normally-closed track circuit; and means in said track circuit for opening and closing all of said signal circuits.
2. In an electric signal system, in combination, a signal circuit; a track circuit controlling said signal circuit; a track circuit controlling said first mentioned track circuit; and means for rendering ineffective the action of the apparatus in said second mentioned track circuit.
3. In an electric signal system, in combination, a signal circuit; a track circuit controlling said signal circuit; a track circuit controlling said first mentioned track circuit; and a track circuit for rendering ineffective the action of the apparatus in said second mentioned track circuit.
4. In an electric signal system, in combination, a signal circuit; a track circuit controlling said signal circuit; an electromagnet for locking in inoperative position the apparatus in said track circuit; and a track circuit in which said electromagnet is included.
5. In an electric signal system, in combination, a signal circuit; a track circuit controlling said signal circuit; a track circuit controlling said first mentioned track circuit; an electromagnet for locking in inoperative position the apparatus in said second mentioned track circuit; and a track circuit in which said electromagnet is included.
6. In an electric signal system, in combination, signal means comprising a forwardly-extending signal circuit and a rearwardly-extending signal circuit; means operable by a train for opening said rearwardly-extending signal circuit; and means for transmitting a signal to said train from said forwardly-extending signal circuit.
7. In an electric signal system, in combination, a forwardly-extending signal circuit; a rearwardly-extending signal circuit; a contact circuit; means for controlling said contact circuit; and means in each of said signal circuits controlling said last mentioned means.
8. In an electric signal system, in combination, a forwardly-extending signal circuit comprising a relay; a rearwardly-extending signal circuit comprising a relay; a contact circuit and means controlled by said relays for controlling said contact circuit.
9. In an electric signal system, in combination, a forwardly-extending signal circuit; a rearwardly-extending signal circuit; a contact circuit; a circuit comprising a relay controlling said contact circuit; and a relay in each of said signal circuits controlling said last mentioned circuit.
10. In an electric signal system, in combination, signal means comprising a forwardly-extending signal circuit and a rearwardly-extending signal circuit; means operable by a train for opening said rearwardly-extending signal circuit; and means carried by said train for noting the condition of said forwardly-extending signal circuit.
11. In an electric signal system, in combination, a signal circuit comprising a battery connected in parallel in said circuit; means for opening said circuit at one side of said battery; and means operated upon such opening of the circuit for deenergizing the remainder of the circuit.
12. In an electric signal system, in combination, a signal circuit comprising a battery connected in parallel in said circuit; means for opening said circuit at one side of the battery; and means operated upon such opening of the circuit for short-circuiting the current from the remainder of said circuit.
13. In an electric signal system, in combination, a signal circuit comprising a battery connected in parallel in said circuit; means for opening said circuit at one side of said battery; and a relay in said side of the circuit arranged to short-circuit the current from the other side of said circuit.
14. In an electric signal system, units consisting of two oppositely-extending signal circuits; two track circuits each controlling one of said signal circuits; a contact circuit; and means controlled by said signal circuits for controlling said contact circuit.
15. In an electric signal system, in combination, signal means; two track circuits controlling said signal means; two track circuits each controlling one of said first mentioned track circuits; and a track circuit including means for rendering ineffective the action of the apparatus in the two last mentioned track circuits.
16. In an electric signal system, units comprising a track circuit; a contact circuit comprising contact rails located centrally of said track circuit; signal means; and a track circuit at each end of said first mentioned track circuit and controlling said signal means, said first mentioned track circuit including means for rendering ineffective the action of the apparatus in said last mentioned track circuits.
17. In an electric signal system, in combination, signal means comprising a forwardly-extending signal circuit and a rearwardly-extending signal circuit; means for transmitting a signal to a train from said circuits; and means operable by a train for preventing one of said circuits from transmitting a signal to a train.
18. In an electric signal system, in combination, signal means comprising a forwardly-extending signal circuit and a rearwardly-extending signal circuit; means operable by a train for opening said rearwardly-extending signal circuit; and means carried by said train for noting the condition of said forwardly-extending signal circuit.

5 bination, means for transmitting a signal
 to a train; means located in front of said
 signal-transmitting means, for controlling
 said signal-transmitting means; means lo-
 10 cated in the rear of said signal-transmitting
 means, for controlling said signal-trans-
 mitting means; a forwardly-extending sig-
 nal circuit in which the first mentioned con-
 trolling means is included; and a rear-
 wardly-extending signal circuit in which the
 second mentioned controlling means is in-
 cluded.

19. In an electric signal system, in com-

bination, a circuit comprising a relay and a
 source of electrical energy, both connected 15
 in parallel in said circuit; a signal circuit
 arranged to affect said circuit at one side of
 said relay; another signal circuit arranged
 to affect said circuit at the opposite side of
 said relay; and signal means controlled by 20
 said relay.

CHARLES E. DUFFIE.

Witnesses:

H. S. DANIEL,

MABEL C. HIGGINS.

Correction in Letters Patent No. 910,184.

It is hereby certified that in Letters Patent No. 910,184, granted January 19, 1909,
 upon the application of Charles E. Duffie, of Omaha, Nebraska, for an improvement
 in "Railway Signal Systems," an error appears in the printed specification requiring
 correction, as follows: In line 21, page 2, the word "shut" should read *shunt*; and
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 same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of February, A. D. 1909.

[SEAL.]

C. C. BILLINGS,

Acting Commissioner of Patents.

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