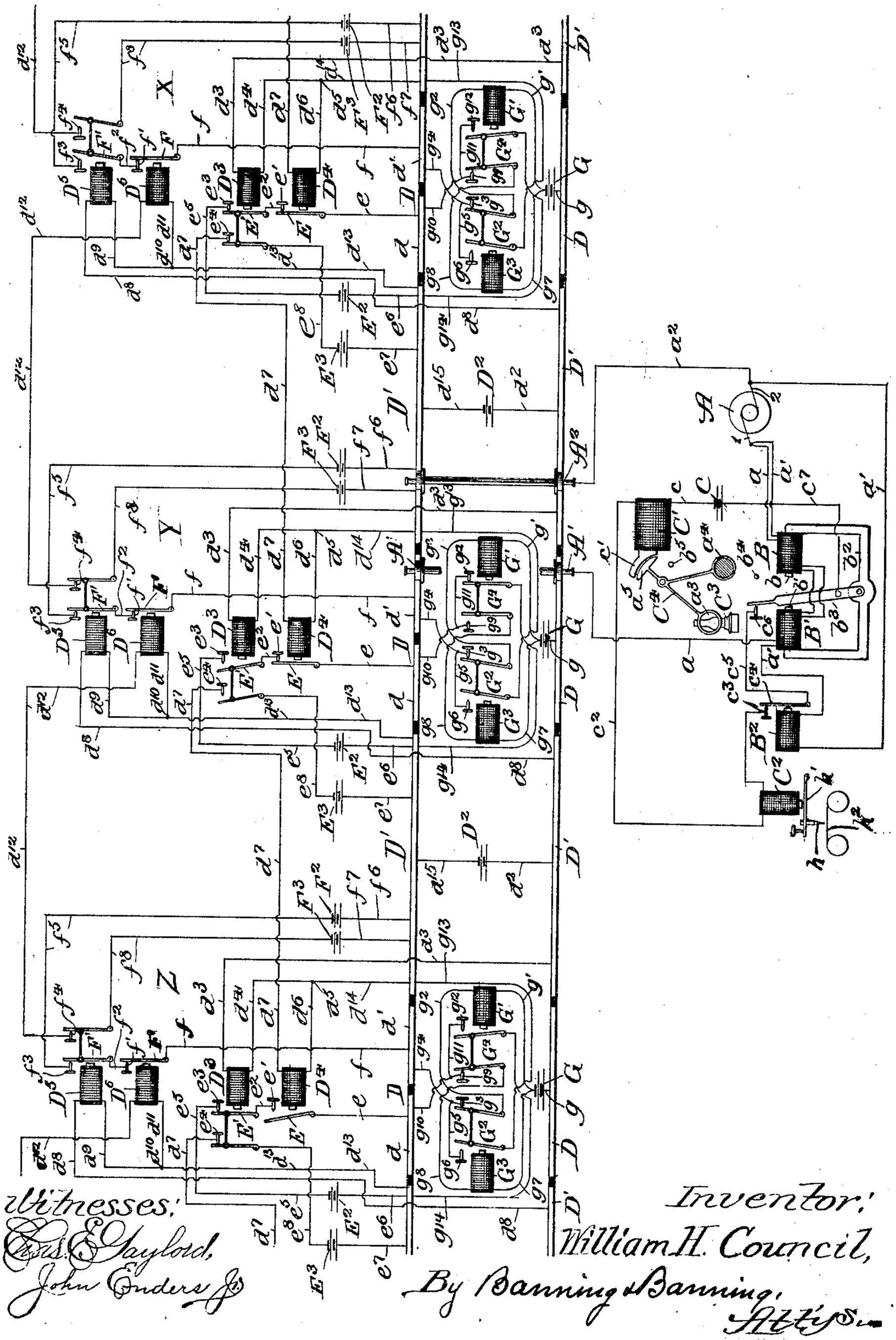
No. 675,086. Patented May 28, 1901.

W. H. COUNCIL.

ELECTRIC RAILWAY SIGNAL.

(Application filed Apr. 19, 1900.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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ELECTRIC RAILWAY-SIGNAL.

SPECIFICATION forming part of Letters Patent No. 675,086, dated May 28, 1901.

Application filed April 19, 1900. Serial No. 13,489. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM H. COUNCIL, a citizen of the United States, residing at Williamsville, Sangamon county, Illinois, have invented certain new and useful Improvements in Electric Railway-Signals, of which the following is a specification.

At the present time two systems of block-signals for railways are known, one employing signals located along or at the side of the track and the other employing signals on the train, usually on the locomotive. The system having the signals by the side of the track has been found objectionable in use from various causes, among which may be mentioned the liability of the signal being obscured by foggy weather or other causes and the non-observance of its condition by the engineer, who in passing the signal may fail to notice what sort of signal is displayed. Some of the objections to block-signals by the side of the track have been overcome by placing the signals on the train, where they will be under the observation of the engineer or other person whose duty it is to note their condition.

My invention relates to that system of block-signals in which the signals are located on the train, and has for its objects to improve the track at the point where the block is located as regards the construction and insulation of the rails at that point; to improve the construction and operation of signals on the train by employing two electric circuits, one of which is operated from the condition of the track at the point of the block, so that it in turn operates the other or signal-circuit proper; to furnish an electric circuit at the point of the block, operating in conjunction with the signal-circuit on the train to display the proper signal; to furnish a track-circuit operative at both ends of a block track-section and controlling other electric circuits for communicating the condition of the track and operating the signals; to furnish an independent electric circuit for each block operating to restore the track-circuits to normal condition after a train has passed the block in either direction; to furnish an electric circuit coöperating with the main signal-circuit on the train to prevent the display of a danger-signal on the train as it passes a block from its own passage over the block, and to improve generally the system as a whole; and the invention consists in the construction and combinations hereinafter described, and pointed out in the claims.

In the drawing I have illustrated a diagrammatic view of a portion of a railway-track divided into blocks and all the apparatus with which the locomotive or train is intended to be equipped, as well as the other apparatus remaining stationary along the track and intended to be used in conjunction therewith.

In describing my electric railway-signal apparatus, for convenience that portion thereof which is to be located on the train will be referred to as located or arranged on a locomotive, although of course it will be understood that it can be located on any desired part of the train.

A dynamo, storage battery, or other source of electric energy A, adapted to generate a current of electricity, is suitably located and arranged on the locomotive. Connected with a wire or pole 1 of this source of energy are two wires a and a', running to the coils B and B′ on the pole-pieces b and b', respectively, of an electromagnet. This magnet is what is known as a "tripolar consequent-pole permanent maguet," whose free pole-pieces b and b' have the same polarity, while its consequent pole, consisting of the intermediate connecting portion or frame b^2 and the armature b^3, has an opposite polarity. The armature b^3, extending between the two coils, is pivoted on the frame b^2, so that it can be moved toward one coil or the other, as the operation of the apparatus may require. The cores b and b', it will thus be seen, are of one polarity, while the armature b^3 is of another. Each of the coils B and B′ has two windings, the wire a being connected with one winding and the wire a' with the other, and the two windings of each coil are in opposite directions and are arranged upon the cores so that under one set of circuit conditions one core will be a north pole of an electromagnet and the other the south pole, overcoming the permanent magnetism, and under opposite conditions the cores will be oppositely affected, repelling and attracting

the armature b^3 as the change in polarity occurs. From the coil B the wire a is continued or carried to a track-contact on the engine, which may be the front wheels A′ of the locomotive, as illustrated in the drawing. The wire a' is continued or carried from the coil B′ to an electromagnet B^2, and from it the wire a' is continued or carried back to the wire or pole 2 of the source of energy. From the wire or pole 2 a wire a^2 is carried to a track-contact, which may be the rear wheels A^2 of the locomotive, as illustrated in the drawing, it being understood that the track-contacts should be insulated one from the other.

For brevity and convenience I shall hereinafter refer to the circuit of the battery A as the "primary circuit." Inasmuch, however, as this circuit has two sides—the track side, including the track-contacts, and the side which runs to the magnet B^2—I will refer to them as the "track side" of the primary circuit or the "magnet side" of the primary circuit, as occasion may require.

Arranged on the locomotive is a battery C, of any suitable or desired kind, from one pole of which is carried a wire c to an electromagnet C′. The core of this magnet is provided with a protruded or extended point c', preferably arc-shaped, as shown in the drawing. A wire c^2 is carried from the magnet C′ to an electromagnet C^2, and from the magnet C^2 the wire c^2 is continued or carried to a contact-point c^3, where it terminates. An armature c^4 is located in proper proximity to the contact-point c^3 and is so pivoted that it can oscillate to or from the contact-point, as may be required by the operation of the apparatus. From the armature c^4 a wire c^5 is carried to a contact-point c^6, against which the armature b^3 may be drawn in the operation of the apparatus, and from the armature b^3 a wire c^7 is carried to the other pole of the battery C. This completes an electric circuit from the battery C through the magnet C′ and back to the battery by the wires c and c^2, contact c^3, armature c^4, wire c^5, contact c^6, armature b^3, and wire c^7, the wire c^2 passing to and from an electromagnet C^2, for a purpose hereinafter described. For brevity and convenience I shall hereinafter refer to the circuit of the battery C as the "secondary circuit." At the opposite side of the armature b^3 to the contact-point c^6 is a stop or pin b^4 to limit the movement of the armature in that direction or toward the coil B. A lamp C^3 is arranged in proper position on the locomotive, and a bifurcated oscillating lever C^4 is pivoted in proper position in relation to the lamp. One leg of this lever carries a disk a^3 of transparent material, so that when in front of the light the safety-signal will be displayed. The other leg of the lever carries a transparent red disk a^4, so that when in front of the light the danger-signal will be displayed. The upper end of the bifurcated lever is provided with an armature a^5 to be acted upon by the magnetized point c'. A stop b^5 is arranged to limit the movement of the oscillating lever, so that when the electromagnet C′ is demagnetized the armature a^5 will drop by its own weight against the stop and bring the red transparent disk a^4 opposite or in front of the light to display the danger-signal.

The mechanism and appliances above described carried on the locomotive may be regarded as constituting one branch or division of the entire signal system and for convenience will be hereinafter referred to generally as the "traveling member" of the signal system. An arrangement of track-circuits is also necessary in carrying out my electric signaling system located in stationary relation to the railway-track, dividing the track into what are known as "blocks" or "block-sections," and each track-circuit for a block will be hereinafter referred to generally as the "stationary member" of the signaling system. The drawings show three blocks X, Y, and Z, and as a s ationary member or track-circuit is to be provided for each block into which the railway is divided three stationary members or track-circuits are shown, one for each block X, Y, and Z, as represented in the drawing. The block-circuits are alike, and a description of one block and its circuits will of course be the description of each and every one of the separate blocks and circuits located along the line of railway equipped with my signaling system. The corresponding parts of each circuit will therefore be identified by the same reference-letters. At the point where one block ends and another block begins, or the division-line between two blocks, is located on each side of the track an insulation for the rails of the track, which breaks the rail or track circuit and may be either a full-length track-rail or part of a full-length track-rail, forming a rail D, insulated from the ends of the adjoining track-rails D′, as will be understood from the drawing. One of the insulated rails D is left whole or undivided and insulated at its ends, and the other one of the insulated rails D is divided or broken to have two parts or members d and d', insulated from each other and insulated at the ends. The particular rail shown in the drawing as divided need not necessarily be the divided rail, as the opposite rail could be just as well the divided one, if preferred; but it is to be understood that only one of the rails for the insulation of the track or rail circuit is to be divided. Each block is to have a battery D^2, supplying electric energy to the track-rails of its block, for which purpose one pole of the battery is connected by a wire d^2 with the track-rails D′ on one side of the track and the other pole of the battery is connected with the track-rails D′ on the opposite side by a wire d^{15}. A wire d^3 is carried from the track-rails on the side having connection by the wire d^2 with the battery D^2, and this wire d^3 extends to an electromagnet D^3, and from the magnet D^3 a

wire d^4 is carried to a separating or branch point d^5, from which point a wire d^{14} is carried to the track-rails on the side having connection by the wire d^{15} with the battery D^2. A circuit is thus formed at one end of the track-section from the battery back to the battery by the wire d^2, track-rails, wire d^3, electromagnet D^3, wire d^4, wire d^{14}, track-rails, and wire d^{15}. A wire d^8 leads from the track-rails on the side of the track connected by the wire d^2 with the battery D^2 and is carried to an electromagnet D^5, and from the magnet D^5 a wire d^9 is carried to a separating or branch point d^{10}, from which point a wire d^{13} is carried to the track-rails D′ on the side of the track connected by the wire d^{15} with the battery D^2. A circuit is thus formed at the other end of the block from the battery D^2 back to the battery by the wire d^2, track-rails, wire d^8, magnet D^5, wire d^9, wire d^{13}, track-rails, and wire d^{15}. For brevity and convenience I shall hereinafter refer to these circuits as the "main-track circuits." One of the main-track circuits is split or divided at the point d^5 by a wire d^6, carried to an electromagnet D^4, from which a wire d^7 connects with the adjoining block X, and the other main-track circuit is split or divided at the point d^{10} by a wire d^{11}, leading to an electromagnet D^6, and from the magnet D^6 a wire d^{12} is connected with the adjoining block Z. It will thus be seen that each block has at each end a track-circuit and that each track-circuit has a connection with the adjoining or next block.

A wire e is carried from the part or member d of the insulated divided or broken rail D′ to a pivoted armature E, located adjacent to the electromagnet D^4 and adapted to be drawn by the magnet against a contact-point e', from which point a wire e^2 leads to one of the pivoted members of a double armature E′, located adjacent to the electromagnet D^3 and adapted to be drawn by the magnet against contact-points e^3 and e^4. From the contact-point e^3 a wire e^5 is carried to one pole of a battery E^2, and the contact-point e^4 has connected thereto the wire d^7, running to the electromagnet D^4 of the adjoining or next block-circuit or stationary member of the system—that is, the wire d^7 of the block X runs from the double armature E′ to the electromagnet D^4 of the block Y, as an illustration. A wire e^6 leads from the other pole of the battery E^2 to the track-rails D′ on the side of the track having the divided or broken rail D at a point adjacent or next to the part or member d of the insulated rail. This forms an incomplete electric circuit between the battery E^2 and the insulated divided or broken rail and the track-rails when the armature E′ is engaged with the electromagnet D^3, the circuit being incomplete, owing to the insulation of the rail D from the track-rails. The circuit will be completed when a conductor is provided from the insulated rail to the track-rails, and such conductor is found in the passage of the train over the track, as hereinafter described.

For brevity and convenience I shall hereinafter refer to the circuit of the battery E^2 through the armatures E and E′ as the "signal-controlling circuit of battery E^2."

From the track-rails on the side having the divided or broken insulated rail D a wire e^7 leads to one pole of a battery E^3, from which battery a wire e^8 leads to the other pivoted member of the double armature E′. These wires e^7 and e^8 complete a circuit from the battery E^3 back to the battery when the double armature E′ is drawn against the electromagnet D^3 for one of its arms or members to contact the point e^4, connecting the battery E^3 with the contact e^4, so that a circuit will be formed by the wire e^8, double armature E′, contact e^4, wire d^7, magnet D^4, wire d^6, wire d^{14}, track-rails, and wire e^7. For brevity and convenience I shall hereinafter refer to this circuit as the "block-connecting circuit." The block-connecting circuit for the battery E^3 of the block X is thus formed from such battery through the wire d^7, leading to the electromagnet D^4 of the block Y, as an illustration, which circuit is complete when the armature E′ is drawn against the electromagnet D^3 of the block X. It will thus be seen that each block has an electric circuit from the battery E^3 with the adjoining or next block throughout the whole system, which circuit is broken in each case with the demagnetizing of the electromagnet D^3 for the double armature to drop therefrom, as shown in block Y, in which the connecting-circuit of the battery E^3 between the block Y and the adjoining block Z is broken or interrupted.

A wire f leads from the part or member d' of the divided or broken insulated rail D to a pivoted armature F, located adjacent to the electromagnet D^6 and adapted to be drawn by the magnet against a contact-point f', from which point a wire f^2 leads and is connected with one arm or member of a pivoted double armature F′, located adjacent to the electromagnet D^5 and adapted to be drawn by the magnet for its arms or members to engage with contact-points f^3 and f^4, respectively, and from the contact-point f^3 a wire f^5 leads to one pole of a battery F^2, the other pole of which is connected by a wire f^6 with the rails of the track on the side having the divided or broken insulated rail. The circuit thus formed from the battery F^2 by the wire f, armature F, contact f', wire f^2, armature F′, contact f^3, wire f^5, and wire f^6 is incomplete, owing to the insulation of the divided or broken rail D, and is made complete when a conductor is provided for the rails of the track, as hereinafter described.

For brevity and convenience I shall hereinafter refer to the circuit of the battery F^2 through the armatures F and F′ as the "signal-controlling circuit of the battery F^2."

From the track-rails on the side having the

divided or broken insulated rail a wire f^7 leads to one pole of a btttery F^3, and from the opposite pole of this battery a wire f^8 leads to the arm or member of the double armature F′, which contacts with the point f^4, and from the point f^4 the wire d^{12} leads to the electromagnet D^6 of the adjoining or next block circuit or stationary member of the system—that is, from the contact-point f^4 of the block Y the wire d^{12} leads to the electromagnet D^6 of the block X, as an illustration. A circuit from the battery F^3 back to the battery is formed when the armature F′ is drawn against the electromagnet D^5 by the wire f^8, double armature F′, contact-point f^4, wire d^{12}, electromagnet D^6, wire d^{11}, wire d^{13}, track-rails, and wire f^7, forming an electric circuit between the two adjoining block or track circuits of the system. For brevity and convenience I shall hereinafter refer to this circuit as the "block-restoring circuit." This circuit is complete as long as the armature F′ is drawn to the electromagnet D^5, but is broken when the armature F′ is away from the magnet, as shown in the block X, in which block the circuit of the battery F^3 is broken, while the circuit for the battery F^3 in the block Y is complete, as is also the circuit of the battery F^3 for the block Z.

To complete my electric signaling system, a wire g is carried from the unbroken insulated rail D of each block to one pole of a battery G. From the other pole of the battery G a wire g' is carried to an electromagnet G′, and from the magnet G′ a wire g^2 is carried to one arm or member of a pivoted double armature G^2, located adjacent to an electromagnet G^3, and adapted to be drawn by the magnet in one direction and to be moved by gravity or other suitable means in the opposite direction for one arm to engage a contact-point g^3 when the armature is away from the magnet and for the other arm to engage a contact-point g^6 when the armature is drawn to the magnet, and from the contact-point g^3 a wire g^4 leads to the part or member d' of the divided or broken insulated rail D, and a branch wire g^5 leads from the wire g^4 to the contact-point g^6, engaged by the other arm or member of the double armature G^2. From the battery G a wire g^7 leads to an electromagnet G^3, and from the magnet a wire g^8 is carried to one arm or member of the pivoted double armature G^4, located adjacent to the electromagnet G′, to be drawn in one direction by the magnet and to be moved by gravity or other suitable means in the other direction, for the arms or members to engage contact-points g^9 and g^{12}, and from the contact-point g^9 a wire g^{10} leads to the part or member d of the divided or broken insulated rail D, and from the wire g^{10} a branch wire g^{11} leads to the contact-point g^{12}, against which one arm or member of the pivoted double armature G^4 is adapted to be drawn into engagement. A wire g^{13} connects one member of the pivoted double armature G^2 with the track-rails on the side of the track having the divided or broken insulated rail D, and a wire g^{14} leads from one member of the divided double armature G^4 to the track-rails on the side of the track having the divided or broken insulated rail, but at the other end of the divided or broken insulated rail from the connection of the wire d^{13} to the track-rails.

For brevity and convenience I shall hereinafter refer to the circuits of the battery G as the "train-signal-restoring" circuits.

Each block has a track-circuit at each end from the battery D^2, one of the circuits running to an electromagnet at its end of the block and the other circuit running to an electromagnet at its end of the block. Both of these track-circuits will be short-circuited with the passage of a train onto the block, as by such passage the current from the battery D^2 at one end of the block will flow through the wire d^2, track-rails, car wheels and axle, track-rails and wire d^{15}, short-circuiting the battery and deënergizing the electromagnet D^3 for the double armature E′ to drop away from the magnet. At the same time the track-circuit at the other end of the block will be short-circuited by the current passing from the battery through the wire d^2, track-rails, wheels and axle, track-rails, and wire d^{15}, short-circuiting the battery and deënergizing the electromagnet D^5 for the double armature F′ to fall away from the magnet. The deenergizing of the electromagnet D^3 breaks the circuit from it to the electromagnet D^4 of the adjoining block for the single armature E to fall away from the electromagnet D^4. It will thus be seen that the passage of a train onto the rails between any two blocks breaks the track-circuit onto which the train passes at both ends thereof, and this breaking of the two track-circuits deënergizes the electromagnet in the circuit of the block onto which the train has passed and at the same time deenergizes the electromagnets for the circuits on the two adjoining blocks, as clearly shown in the drawings, in which the electromagnets designated are shown deënergized—that is, the electromagnet D^3 for the block Y and the electromagnet D^4 for the block Z and the electromagnet D^5 for the block X. It will thus be seen that each block at the point of signaling has on one side a signal-controlling circuit from the battery E^2 and on the other side a signal-controlling circuit from the battery F^2, and that each block at the point of signaling has a block-connecting circuit and a block-restoring circuit, which several circuits are dependent for operation upon the condition of the "track-circuits."

In operation with the train on a block the track of which is clear, the current of the primary circuit of the train-signal will pass from one pole and return to the opposite pole in the usual manner of electric currents, and such passage of the current will not change the polarity of the pole-pieces or cores

of the tripolar consequent-pole permanent magnet, which will maintain the vibrating armature in the position shown in the drawings and no change will occur in the signal displayed. The complete circuit formed by the track side of the primary circuit of the train-signal and the signal-controlling circuit of the battery F^2 through the track-rails, the wheels and axles, and the insulated rail-section will not affect the train-signal if the signal-controlling circuit of the battery F^2 is not broken and the safety-signal is already being displayed; but with the breaking of this circuit through the demagnetizing of the armature F' the current of the primary circuit on the train cannot return to the source of energy through the wire a^2, so that the current only passes from the source of energy A back to such source of energy through the one wire a, changing the polarity of the pole-pieces or cores of the tripolar consequent-pole permanent magnet, by which the movable armature will be repelled from its position adjacent to the coil B' and drawn over toward the coil B. This breaks the "secondary circuit" of the train-signal, deënergizing the magnet C' for the bifurcated lever C^4 to drop and display the danger-signal. It will be understood that when a train is moving from the block X in the direction of the block Y the signal-controlling circuit is that of the battery F^2, while with a train moving from the block Z to the block Y the signal-controlling circuit of the battery E^2 is the operative one.

To illustrate the operation of the system, we will assume that a locomotive has left the block X and is traveling in the direction of the block Y with the signaling apparatus and appliances in the position and condition shown in the drawings and the safety-signal displayed on the locomotive, which would be the case with the section Y clear of obstructions. As the wheels A' of the locomotive, forming the forward track-contact, enter the block of the section Y, if the track of the section Z is clear a circuit will be established between the stationary member and the traveling member of the signaling system by means of the signal-controlling circuit of the battery F^2 and the primary circuit of the train-signal, as already described, without causing a change of the signals on the locomotive. This non-effect on the signals results from the fact that at this time the primary circuit of the train-signal is in series with the source of energy of the signal-controlling circuit of the battery F^2 and the preponderance of current is flowing through the wire a^2, causing the polarity of the cores b and b' to be such that the armature b^3 will adhere more firmly to the contact c^6, so that the armature b^3 will remain unmoved between the cores and in the position shown in the drawings. If, however, an obstruction, as a train, be on or entering the section Z, so that the engineer needs to be warned, the breaking of the track-circuit of the battery D^2 for the section Z by such train will demagnetize the magnet D^5 of the block Y, breaking the signal-controlling circuit of the battery F^2, which breaks or interrupts the flow of current through the track side of the primary circuit of the train-signal, leaving the current of the primary circuit to flow only through the wire a' for such current to act and cause a change in the polarity of the pole-pieces of the tripolar consequent-pole permanent magnet, repelling the armature b^3 from the position shown in the drawings and breaking the secondary circuit of the train-signal, which allows the bifurcated lever to drop and display the danger-signal. A train running with a danger-signal will receive a safety-signal when it reaches a signal-giving point that is clear by the preponderance of current flowing over the wire a^2, caused by the battery F^2 and the primary source of energy being in series, thus causing the polarity of the cores to be such as to bring the armature b^3 back to the contact c^6. The position of the locomotive on the section Y, as illustrated in the drawings, causes warning to be conveyed to an approaching locomotive entering the section Z by breaking or interrupting the block-connecting circuit between the two sections, so that a train entering the block of the section Z from the opposite direction to the train entering the section Y would receive a danger-signal through the interruption of the signal-controlling circuit of the battery E^2, which operates in series with the primary circuit of the train-signal on the approaching train in the same manner as does the signal-controlling circuit of the battery F^2, which has been already described.

It will thus be seen that a train entering the section Y from the section X will receive a safety or danger signal, according to the condition of the signal-controlling circuit of the battery F^2, and that a train entering the section Y from the section Z will receive a safety or danger signal, according to the condition of the signal-controlling circuit of the battery E^2. The locomotive entering the block of the section Y, as illustrated in the drawings, has, as already explained, received the safety-signal if the section Z is clear, as it contacted the circuit of the first member d' of the block, showing that the track ahead is clear, and at the same time the short-circuiting and deënergizing of the magnet D^3 has opened the circuit to display the danger-signal on a train approaching such block from the opposite direction, and such opening also opens the circuit of the second member d of the same block on which the locomotive enters as it leaves the first member, so that a danger-signal would be received as well as given by this locomotive, notwithstanding the signal received on entering the first member showed that the track ahead was clear. To avoid this difficulty, the signal-restoring circuit of the battery G on that side having the con-

necting-wire g' is completed or closed, causing the energizing of the magnet G', which causes the pivoted double armature G^4 to be drawn against the contact-point g^{12}, short-circuiting or cutting out the signal-controlling circuit of the battery E^2 through the member d of the divided or broken rail, the wire g^{10}, the wire g^{11}, the contact-point g^{12}, the pivoted double armature G^4, and the wire g^{14} to the rail of the approached block, which prevents the open circuit from operating the electric signals on the locomotive as it leaves a block. It will thus be seen that by the use of my system signals can be conveyed from one locomotive to another, both in the case of approaching and following trains, it being understood that the first contact when a locomotive approaches a block is the one that furnishes the signal, irrespective of the direction of the travel of the train.

The division of the current from the source of energy A, passing through the wire a, when the train has passed a block or signal station and entered a section of the track, with the track clear, has a free and uninterrupted return to the source of energy through the wheels or other track-contacts and the track-rails. This will be the course of the current when the train is between two block or signal stations and on a clear track and no action of the signals will occur as the current passes from and returns to the source of energy under natural conditions. The passage of the train onto the entered first section or division of the undivided insulated rail and the divided insulated rail or rail-section at the block or signal station breaks the circuit of the current through the wire a, wheels or other track-contacts and the rails, by reason of the insulation of the track-contacts and the undivided insulated rail and the divided insulated rail or rail-section, which prevents the return of the current through the track-rails, and to secure this return and to connect or complete the circuit from the source of energy A through the wire a some means must be provided to bridge the insulation between the track-contacts and the insulated rail and the divided insulated rail or rail-section at the block or signal station, as otherwise, with an interrupted current through the wire a, the equality of current passing through the free pole-pieces of the tripolar consequent-pole permanent magnet would be broken and the movable armature on the consequent pole of the magnet would be shifted or changed over, breaking the circuit of the operating or secondary signal circuit and displaying a danger-signal, when as a matter of fact the track ahead of the block or signal station which had been entered by the train would be clear. This giving of a wrong signal is prevented through the medium of the incomplete electric circuit connecting the track-rails with an insulated division of the divided rail or rail-section, so that with conditions indicating the block ahead as clear and with the circuit of the incomplete circuit not interrupted the current from the source of energy A will pass through the front or forward track-contact and thence through the circuit of either the battery E^2 or F^2, according as to which side of the block or signal station was entered, to the track-rails outside of the insulation, the rear track-contacts, and the wire a^2 back to the source of energy without any interruption of the current and without changing the action of the free poles of the tripolar consequent-pole permanent magnet and producing no change in the nature of the signal displayed; but with the incomplete circuit of the approached and entered insulated rail or rail-section interrupted or broken by the deenergizing of the magnet of the track-circuit which maintains the armature of the incomplete circuit in place the return of the current from the source of energy A on the train through the wire a will be interrupted, leaving the current to return only through the wire a', producing a shifting of the armature between the free pole-pieces, breaking the circuit of the signal-controlling or secondary circuit and displaying the danger-signal, as already described. It will thus be seen that a train entering the side of a block or signal station having the insulated rail-section d' employs the incomplete circuit from the battery F^2 to furnish a connection for returning the current of the wire a back to the source of energy A, and a train entering the block or signal station on the side having the insulated rail-section d employs the incomplete circuit from the battery E^2 to furnish a connection for returning the current of the wire a back to the source of energy, so that in whichever direction a train enters the block or signal station an electric circuit incomplete in itself, but forming a bridging or connecting circuit, is provided for returning the current to the source of energy A without affecting the condition of the signal, when the incomplete circuit is not interrupted or broken by the deënergizing of the magnet which controls the armature of such incomplete circuit.

In case the source of energy A on the locomotive should fail for any reason it is important that other means should be provided to demagnetize the magnet C' and cause the display of the danger-signal. To do this, I have provided an electromagnet B^2, which is constantly energized so long as the normal or intended operation of the source of energy is uninterrupted. As soon as a failure in such source of energy occurs the magnet B^2 becomes demagnetized and the armature c^4 drops away from the contact-point c^3, breaking the circuit formed with the magnet C' through the wire c^2. This releases the armature a^5 of the bifurcated lever C^4, so that it falls by gravity to the point b^5 and displays the danger-signal.

I also show in conjunction with the electric signal apparatus on the locomotive a mag-

net C^2, controlling a pencil-point h on an armature h', held against the core of the magnet C^2 when the same is magnetized. As soon as the circuit is broken and the danger-signal displayed, so that the magnet C^2 also becomes demagnetized, the armature h' drops away from the core of the magnet and brings the point of the pencil h against a speed-record sheet h^2, on which it will travel as long as the magnet C^2 is demagnetized. The record-sheet h^2 is operated in any usual and well-known manner for traveling speed-recording sheets through the medium of a speed-recording mechanism connected with and operated from a moving part of the train in any usual and well-known manner and need not therefore be specifically described as to the mechanism and its mode of operation. In this way a record is formed showing the speed of the train immediately after each display of the danger-signal and the distance that such train runs before the speed is reduced to the rate required on the display of a danger-signal. This forms a check or means of determining whether the engineer or person in charge has obeyed the signal conforming to the rules imposed for such cases.

While I have described the rail of the track as the common return for the circuits operating the electric mechanism of the stationary members, it is obvious that wires could be employed for the same purpose.

While I have described the arrangement and operation of my electric railway signaling system with considerable minuteness and detail, I desire it to be understood that I do not intend to limit myself to details or particular features than as the same may be specified and called for in my claims.

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

1. In a railway block-signaling system, an insulated rail or rail-section in the track-rails at each block-signal station on each side of the track, with the insulated rail or rail-section on one side undivided and the insulated rail or rail-section on the other side divided into two parts or members insulated from each other, an incomplete electric circuit for each part or member of the insulated divided rail or rail-section and the track-rails on its side of the track, an electric circuit for the track-rails at each end of the block, a complete electric circuit for each block independent of the track-rail circuits at the ends of the block, and means carried on a train for completing the incomplete circuit of the divided insulated rail or rail-section with the passage of a train onto and over the insulated divided rail or rail-section of the block, substantially as described.

2. In a railway block-signaling system, an insulated rail or rail-section in the track-rails at each block on each side of the track, with the insulated rail or rail-section on one side undivided and the insulated rail or rail-section on the other side divided into two parts or members insulated from each other, an electric circuit for the track-rails at each end of each block, each circuit embracing an electromagnet, an incomplete electric circuit for each member of the insulated divided rail or rail-section and the track-rails on its side of the track, embracing, in each circuit, an armature controlled by the electromagnet of a track-rail circuit, and broken for each immediate preceding and succeeding block by the deënergizing of the magnets in the track-rail circuits of an entered block with the entrance of a train into such block, and a complete electric circuit for each block independent of the track-rail circuits at the ends of the block, embracing an armature controlled by the electromagnet of an end circuit of the track-rails and broken for each immediate succeeded or passed block-section by the deenergizing of the magnet in the track-rail circuit of the entered block with the entrance of the train into such block, substantially as described.

3. In a railway block-signaling system, an insulated rail or rail-section in the track-rails on each side of the track at the block-signal station, one insulated rail or rail-section undivided and the other insulated rail or rail-section divided into two parts or members insulated from each other, an electric circuit for the track-rails at each end of each block, each circuit embracing an electromagnet, an incomplete electric circuit for each member of the insulated divided rail or rail-section and the track-rails on its side of the track, embracing, in each circuit, a source of energy, and an armature controlled by the electromagnet of a track-rail circuit, and broken for each immediate preceding and succeeding block by the deënergizing of the magnets in the track-rail circuits of an entered block by the entrance of a train into such block, and a complete electric circuit for each block, independent of the track-rail circuits at the ends of the block, from the track-rails on one side to the track-rails on the same side, and embracing a source of energy and an armature controlled by the electromagnet of a track-rail circuit, and broken for each succeeded or passed block by the deënergizing of the magnet in the track-rail circuit of the entered block by the entrance of the train into such block, whereby the magnets of both track-rail circuits are deënergized and an alarm given both to a train approaching the entered block from either direction, substantially as described.

4. In a railway block-signaling system, an insulated rail or rail-section in the track-rails on each side of the track at the block-signal station, one insulated rail or rail-section undivided and the other insulated rail or rail-section divided into two parts or members insulated from each other, an electric circuit for the track-rails at each end of each block each circuit embracing an electromagnet and both short-circuited by a train entering the

block, an incomplete electric circuit for each member of the insulated divided rail or rail-section and the track-rails on its side of the track, embracing, in each circuit, a source of energy and an armature controlled by the electromagnet of a track-rail circuit, and broken for each immediate preceding and succeeding block by the deënergizing of the magnets in the track-rail circuits of the entered block by the entrance of the train into such block, a complete electric circuit for each block, independent of the track-rail circuits, from the track-rails on one side to the track-rails on the same side, and embracing a source of energy and an armature controlled by the electromagnet of a track-rail circuit, and broken for each succeeded or passed block by the deënergizing of the magnet in the track-rail circuit of the entered block by the entrance of the train into such block, track-contacts on the train engaging the rails and completing the circuit of the insulated divided rail or rail-section, and an electric circuit on the train embracing a source of energy, a tripolar consequent-pole permanent magnet, an armature movable between the free pole-pieces or cores of the magnet, and a circuit-wire from the source of energy through the coils of the tripolar consequent-pole permanent magnet to the track-contacts, substantially as described.

5. In a railway block-signaling system, a signal-circuit on a train comprising a primary circuit and a secondary circuit, the primary circuit embracing a source of energy, a tripolar consequent-pole permanent magnet, and circuit-wires for the primary circuit from the source of energy through the coils of the tripolar consequent-pole permanent magnet to the track-contacts to complete the primary circuit through the rails, and the secondary circuit operative from the primary circuit and embracing a source of energy, an electromagnet, a pivoted armature movable between the pole-pieces or cores of the tripolar consequent-pole permanent magnet, and circuit-wires for the secondary circuit from the source of energy through the electromagnet of such circuit and the armature movable between the pole-pieces or cores of the tripolar consequent-pole permanent magnet, for the pivoted armature of the secondary circuit to operate the signals on the train with the making and breaking of the primary circuit, substantially as described.

6. In a railway block-signaling system, an insulated divided rail or rail-section having two parts or members insulated from each other and located on one side of the track and having a companion insulated undivided rail or rail-section on the opposite side of the track, an incomplete electric circuit for each member of the insulated divided rail or rail-section and the track-rails on its side of the track, embracing, in each circuit, a source of energy and an armature controlled by an electromagnet, and each broken for the immediate preceding and succeeding block by the deënergizing of the controlling-magnets in the circuits of an entered block by the entrance of a train onto the track-rails of such block, and a primary and a secondary electric circuit on the train, the primary circuit embracing a source of energy, a tripolar consequent-pole permanent magnet, and circuit-wires for the primary circuit from the source of energy through the coils of the tripolar consequent-pole permanent magnet to the track-contacts to complete the primary circuit through the rails when the incomplete track-circuit of the insulated divided rail is not interrupted by the deënergizing of its armature-controlling electromagnet, substantially as described.

7. A railway block-signaling system, comprising an electric circuit at each end of the block, each circuit embracing a source of energy common to both circuits, the track-rails, an electromagnet and an armature for each electromagnet, an incomplete electric circuit for each member of the insulated divided rail or rail-section and the track-rails on its side of the track, embracing, in each circuit, a source of energy, and an electromagnet and armature of a track-rail circuit, and broken for each immediate preceding and succeeding block by the deënergizing of the magnets in the track-rail circuits of an entered block by the entrance of a train onto the rails of such entered block, a signal-transmitting mechanism carried on the train, embracing a source of energy, a tripolar consequent-pole permanent maguet, and circuit-wires from the source of energy through the coils of the tripolar consequent-pole permanent magnet to the track-contacts to complete the circuit through the track-rails and the insulated track-section when the electric circuit of that section is not interrupted by the deënergizing of its armature-controlling electromagnet, substantially as described.

8. A railway block-signaling system, comprising an electric circuit at each end of the block, the circuits embracing a source of energy common to both circuits, the track-rails, an electromagnet, and an armature for each electromagnet, an incomplete circuit for each block embracing an insulated rail-section, a source of electric energy, and an electromagnet and armature of a track-rail circuit, and circuit-wires from the insulated rail-section to the track-rails, danger and safety signals on a moving train, an arm or lever operating the signals, an operating or secondary electric circuit for the danger and safety signals, embracing a source of energy, an electromagnet controlling the operating arm or lever of the signals, circuit-wires, and a movable armature, and a controlling or primary electric circuit for the signal-operating or secondary circuit embracing a source of energy, a tripolar consequent-pole permanent magnet between the pole-pieces or cores of which the movable armature of the secondary electric circuit is located and operated, and circuit-

wires from the source of energy through the coils of the tripolar consequent-pole permanent magnet to the track-contacts to complete the circuit through the rails and the insulated track-section when the electric circuit of that section is not interrupted by the deënergizing of its armature-controlling electromagnet, substantially as described.

9. In a railway signaling mechanism, signaling devices located on a moving train comprising a safety-signal and a danger-signal, primary and secondary electric circuits for controlling and operating the signals, and a relay-magnet in the primary electric circuit, controlling an armature in the secondary electric circuit for operating the signals, deënergized by the unintentional interruption of the primary circuit and thereby breaking the secondary electric circuit to display the danger-signal, substantially as described.

10. In a railway signaling mechanism, signaling devices located on a moving train comprising a safety-signal and a danger-signal, an arm or lever operating the signals, an operating or secondary electric circuit for the signals embracing a source of energy, an electromagnet controlling the operating arm or lever of the signals, circuit-wires, and a movable armature, a controlling or primary circuit for the signal-operating or secondary circuit, embracing a source of energy, a tripolar consequent-pole permanent magnet between the pole-pieces or cores of which the movable armature of the signal-operating or secondary circuit is located and operated, circuit-wires, a relay-magnet in the controlling or primary electric circuit, and an armature in the signal-operating or secondary electric circuit controlled by the relay-magnet for displaying the danger-signal when the controlling or primary electric circuit is unintentionally interrupted or broken, substantially as described.

11. In a railway signaling mechanism, signaling devices comprising a safety-signal and a danger-signal located on a moving train, a primary electric circuit and a secondary electric circuit controlling and operating the signals, a relay-magnet in the primary circuit, and an armature for the relay-magnet in the secondary circuit for displaying the danger-signal with the unintentional interruption or breaking of the primary circuit, substantially as described.

12. In a railway signaling mechanism, signaling devices located on a moving train comprising a safety-signal and a danger-signal, a primary electric circuit and a secondary electric circuit controlling and operating the signals, a relay-magnet located in the secondary electric circuit, an armature for the relay-magnet carrying a recording-point, and a record-ribbon operated on by the recording-point with the deënergizing of the relay-magnet for recording the speed while the danger-signal is displayed, substantially as described.

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Witnesses:
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