No. 658,075. **Patented Sept. 18, 1900.**

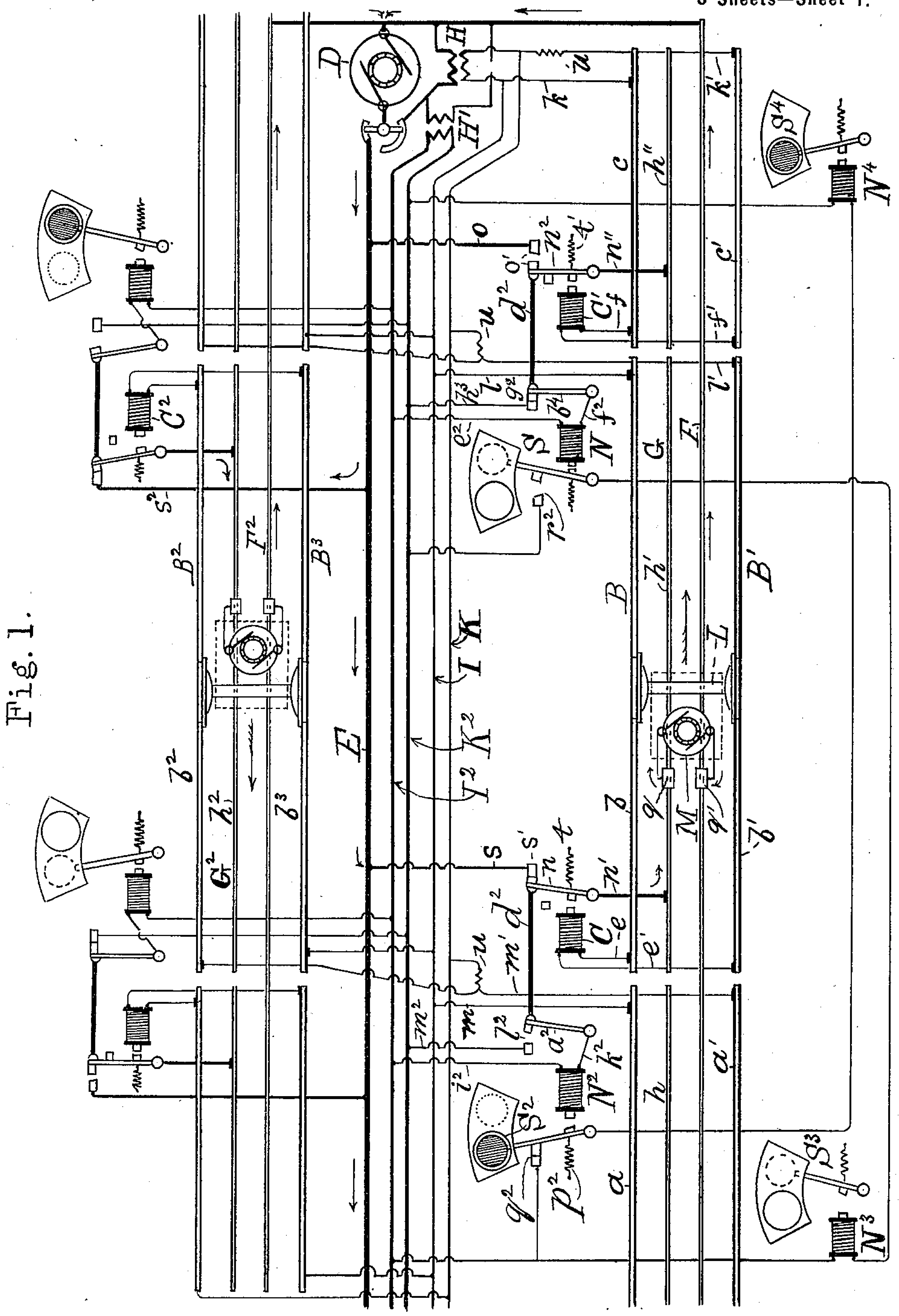
W. ROBINSON.

ELECTRIC RAILWAY SYSTEM.

(Application filed Sept. 22, 1897.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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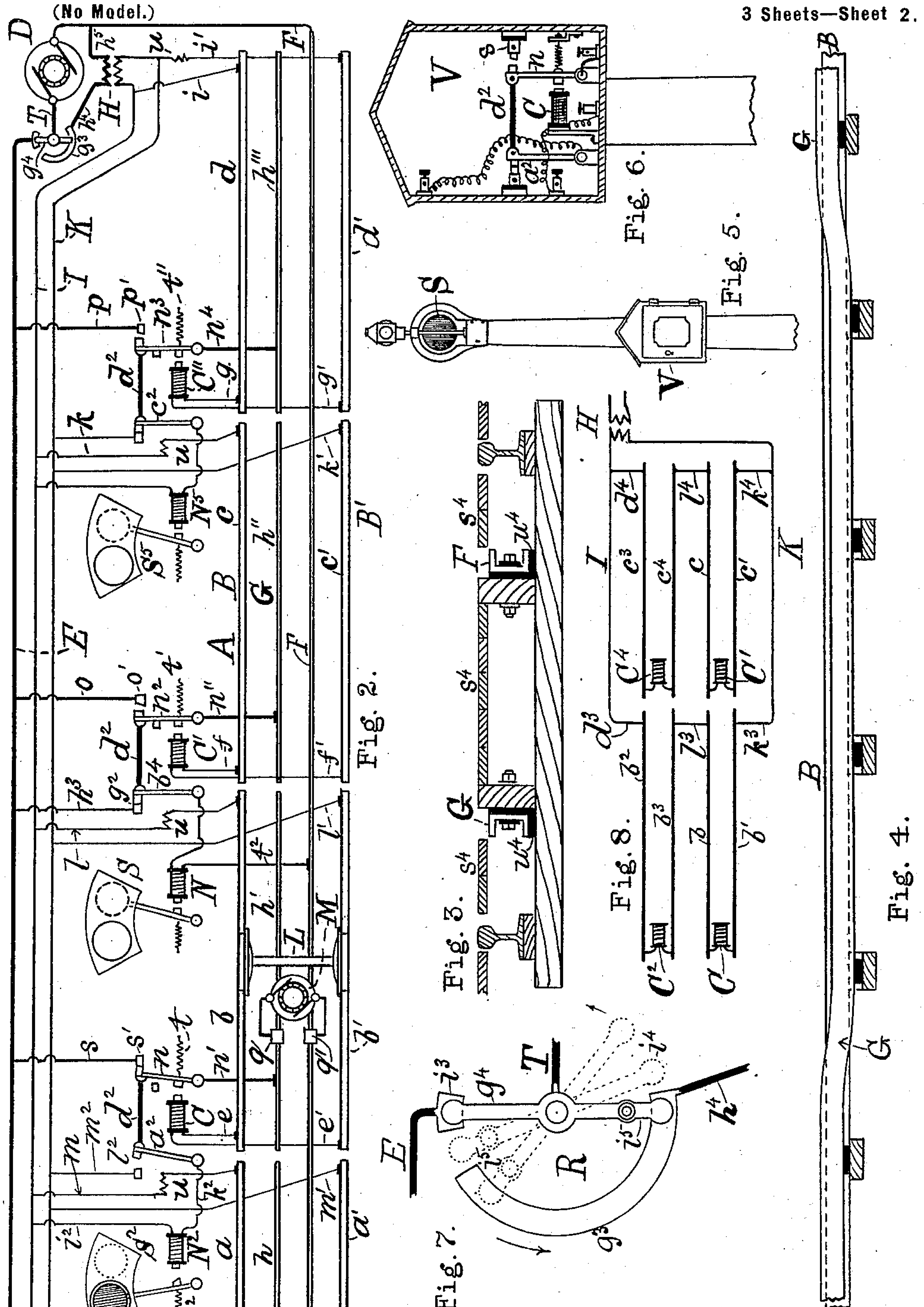

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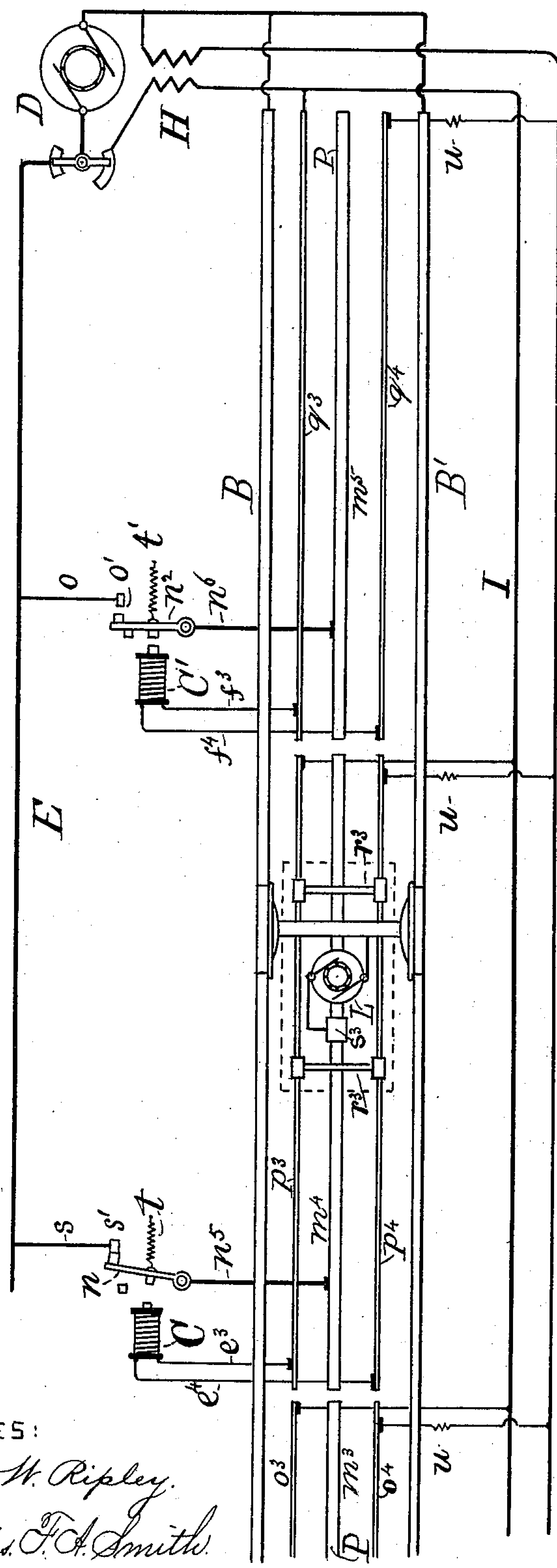

Fig. 9.

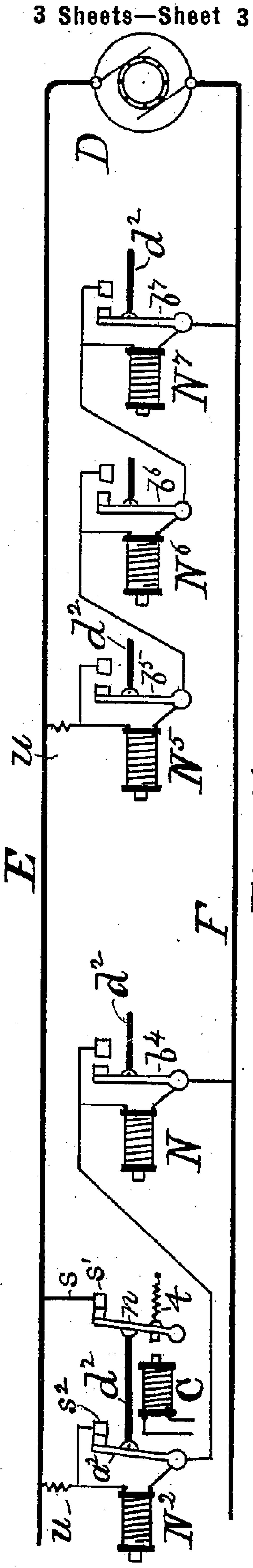

Fig. 10.

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UNITED STATES PATENT OFFICE.

WILLIAM ROBINSON, OF BOSTON, MASSACHUSETTS.

ELECTRIC-RAILWAY SYSTEM.

SPECIFICATION forming part of Letters Patent No. 658,075, dated September 18, 1900.

Application filed September 22, 1897. Serial No. 652,520. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM ROBINSON, a citizen of the United States, residing in Boston, in the county of Suffolk and State of Massachusetts, have invented a new and Improved Electric-Railway System, of which the following is a specification.

My invention has special reference to the conversion of steam into electric railroads.

The nature of my invention will be clearly understood from the description which follows, reference being had to the accompanying drawings, which form a part of this specification, in which—

Figure I is a diagrammatic representation of a double-track electric railroad embodying the main features of my invention. Fig. II is a similar view of a single-track electric railroad, illustrating also an alternative arrangement of certain portions of the circuits. Fig. III represents a cross-section of the track, showing means for securing safety from shocks at stations or other special sections of track. Fig. IV is a longitudinal view of the same with the front rail removed. Fig. V shows a signal-post with its signal and instrument boxes. Fig. VI shows the magnetic switches in position in a box with the door or cover removed, said box being mounted on a post. Fig. VII is an enlarged view illustrating the power-house switch. Fig. VIII shows a plurality of track-circuits coupled in multiple series. Fig. IX shows the application of my invention to a track with the so-called "third-rail" system, and Fig. X shows the signal-magnets arranged in multiple series.

Referring first especially to Fig. II, A is a railroad-track having its rail-lines B B' divided into successive parallel sections *a a'*, *b b'*, *c c'*, *d d'*, said successive sections being separated or insulated from each other. The electromagnet C has its electrodes connected to one end of the rail-sections *b b'* by the conductors *e e'*. In like manner the conductors *f f'* connect the electrodes of the magnet C' to one end of the rail-sections *c c'*, and the conductors *g g'* connect the electrodes of the magnet C'' to one end of the rail-sections *d d'*, all as shown. It will be understood that the magnets C C' C'' are provided, respectively, with armatures arranged to be operated and controlled by said magnets in any usual or suitable manner.

D is an electric generator, E a main-line conductor or feed-wire proceeding therefrom along the railroad and carrying a comparatively-high voltage-current for operating the locomotive or car-motors, and F is the return-conductor, which is preferably supported by the ties between the rails of the track or outside of the same and forms a contact-conductor for one terminal *q'* of the traveling motors.

G is the working conductor, made in successive sections *h h' h'' h'''*, corresponding in length to the rail-sections already described. These working sections are supported by the ties, but preferably insulated therefrom.

H is a step-down transformer receiving primary current from the generator D and producing a secondary current of comparatively-low potential. From this transformer the secondary conductors I K extend out along the line. The said conductors I K are electrically connected by the wires *i i'* to the rail-sections *d d'* at the ends of said sections opposite to those to which the magnet C'' is connected. In like manner said conductors I K are connected by the wires *k k'* to the rail-sections *c c'* and by the wires *l l'* to the rail-sections *b b'*. In each instance the conductors I K are connected, preferably, to the opposite ends of said sections from those to which the magnets are connected. It will be understood that the low-potential current from the transformer H following the circuits described keeps the magnets C C' C'' magnetized as their normal condition, the circuits of said magnets being in multiple with the line-conductors I K. The main feed-wire E is connected by the wire *s* to the anvil *s'*, and when the magnet C is demagnetized the spring *t* draws the armature-lever *n* against the anvil *s'*, thus connecting the main feed-wire E to the working section *h'* through the wire *s*, armature-lever *n*, and the wire *n'*. In like manner the demagnetization of the magnet C' connects the feed-wire E electrically to the section *h''* through the wire *o*, anvil *o'*, armature-lever n^2, and wire *n''*, and the demagnetization of the magnet C'' in like manner connects said main feed-wire E electrically to the working section *h'''* through the wire p, anvil p', armature-lever n^3, and wire n^4. As the magnets C C' C'' are normally magnetized, and thus keep their armatures normally attracted, it is evident that the feed-wire E is normally disconnected from all the working sections h' h'' h''', &c. The contact shoes or brushes q q', forming the terminals of the traveling motor M, travel in contact, respectively, with the sectional working-conductor line G and the return-conductor F.

The operation is as follows: When the electric locomotive or car in its progress reaches the rail-sections b b', for instance, its wheels and axles L make short-circuiting connection between said parallel rail-sections, thus demagnetizing the electromagnet C by short-circuiting. Said magnet, thus demagnetized, releases its armature-lever n, which is instantly drawn back by the spring t, and makes electrical contact with the anvil s', thus bringing the main feed-wire E into electrical connection with the section h' of the working conductor G through the wire s, anvil s', armature-lever n, and wire n', whence the current passes through the motor M, rendering the same operative, and over the return-conductor F to the generator, thus completing the circuit. It will be observed that as long as the wheels and axles of the locomotive or car span the rail-sections b b', whether said car be in motion or stationary, so long will the magnet C remain demagnetized and the working circuit remain completed to the motor-terminal. When, however, the last axle and pair of wheels of the car or train L leaves the sections b b', thus removing the short circuit, the current instantly returns through said sections to the magnet C, remagnetizing the same. The said magnet now instantly reattracts its armature and opens the working circuit at the anvil s', thus cutting off the working current from the section h' and rendering the latter dead. Since car-trucks always have at least two pairs of wheels, it is evident that the advancing car will with at least one pair of wheels invariably bring the succeeding pair of rail-sections into circuit and demagnetize the magnet connected therewith in the manner described before the last wheels leave the preceding section. Thus the main feed-wire is electrically connected to each succeeding section of the working conductor before it is disconnected from the preceding section. The motor-terminal contact device q is so made and arranged that it will make good electrical connection with each succeeding section of the working conductor G before leaving the preceding section of the same, so that the insulated joints between the sections of said working conductor G cannot prove a barrier to the continuous flow of working current to the traveling motor. Thus by the means described an uninterrupted supply of working current is insured to the traveling motor.

When trains stop at railroad-stations, unless some precautions be taken passengers crossing the track at the front or rear of the train are liable to step on the two lines of working conductors, and thus receive shocks of more or less severity. To obviate this liability, I depress the working conductors G F for a sufficient distance in the vicinity of stations and elsewhere when necessary, as clearly shown in Figs. III and IV.

As illustrated in Fig. III, planking s^4 is shown between the rails and at a higher level than the upper surface of the conductors F G, thus rendering it impossible for any one to step on both of these conductors at the same time or on either without deliberate effort and purpose to do so. Thus it is evident that stations are thoroughly protected against electrical accidents to passengers. The conductors F G might be run past stations at their normal level provided the planking adjoining said conductors were elevated a sufficient height above the upper surface of the same.

It will be understood that the motor contact-terminals q q' are suitably mounted on springs or otherwise in such a manner as to allow them to follow any depression or irregularity in the conductors F G.

Suitable rheostats or resistances u are introduced, as shown, between the transformer H and the respective sectional rail-circuits, these resistances rendering it impossible for a train on any track-section to short-circuit said transformer or track-current generator, although short-circuiting the switching-magnets C C', &c., as already described.

Many railroads use systems of stationary automatic electric signals operated and controlled by passing trains, as patented by myself in 1872 and at other times. In the electric-railway system herein described, therefore, I not only operate the trains by electricity, but I also provide for operating the aforesaid signal systems in conjunction therewith and without interference therefrom. In carrying out this plan I provide for operating a plurality of stationary block or other signals by a current derived from a single source of electric supply—as, for instance, from a transformer—as shown in the drawings.

In the drawings, S S^2 represent the primary signals directly controlled or operated by the electromagnets N N^2, and S^3 S^4 represent the secondary signals (shown in Fig. I) operated by the magnets N^3 N^4, the circuits of said secondary magnets N^3 N^4, however, being controlled by the primary signals and the position of said secondary signals depending upon the position of said primary signals.

For the purpose of controlling the primary signal-circuits the armature-levers n n^2, &c., already described, are flexibly connected, respectively, to the free or additional circuit-closing levers a^2 b^4, &c., by the insulating-rods d^2 d^2, which latter are pivotally connected to said levers, the position of the armature-levers controlling the position of the levers a^2 b^4.

I prefer to use an independent transformer H′, as illustrated in Fig. I, to furnish current to the magnets directly operating or controlling the signals.

The circuit of the primary signal-magnet N in Fig. I is traced as follows: from the line-wires I^2 K^2, which lead from the transformer H′, through the wire e^2, magnet N, wire f^2, lever b^4, over contact-points g^2 and wire h^3, completing the circuit. In like manner the circuit of the primary signal-magnet N^2 passes from said line-wire I^2 K^2, over the wire i^2, magnet N^2, wire k^2, lever a^2, contact-points l^2, and wire m^2, thus completing the circuit.

It will be observed that when the magnet C has been short-circuited and demagnetized by the train or car L spanning the track-sections b b', as already described, and the spring t has withdrawn the armature-lever n, this action of said spring t has also opened the circuit of the primary-signal magnet N^2 at the contact-points l^2, as shown. The signal-magnet N^2 thus demagnetized releases its armature and the signal S^2 is swung by suitable mechanism, such as a spring p^2 or a weight, into a position of exposure, indicating "danger," as shown. It will be observed also that when the train is running toward the right, as indicated by the arrows, on the track-section b b' of the track B B′ the signal S^2 is exposed at "danger" behind the train either at the beginning of the track-sections b b' occupied by the train or overlapping the preceding section a a' as far back as desired, thus answering as a block-signal against following trains. When the signal S^2 is in a position indicating "danger," it closes the contact-points q^2, thus closing the circuit of the magnet N^4 and bringing the secondary signal S^4 into a position of exposure. This signal may be located at any point desired, either behind or in advance of the train, either within the limits of the section occupied by the train, overlapping the preceding section, or, as shown in the drawings, overlapping the advance section c c'. When the section c c' is occupied by the train and the magnet C′ thus demagnetized, the circuit of the primary signal S is opened and said signal swings to "danger" and instantly closes the contact-points r^2, thus closing the circuit of the magnet N^3 and bringing the secondary signal S^3 into a position of exposure in the manner described in connection with the secondary signal S^4.

It will be seen by inspection that the secondary signal S^3, controlled by the train occupying the section c c', is carried back beyond the limits of the preceding section b b' and overlaps the preceding section a a'. Thus an advancing train is notified when the second section ahead is blocked, as well as of the "safe" or "blocked" condition of the section directly ahead.

It will be noted that the primary signals are swung to the exposed or danger position by mechanical means and brought into and held in a position indicating "safety" by the action of the charged electromagnet. On the contrary, the secondary signals are brought into the exposed position by the action of the charged electromagnets and into the reversed or concealed position by mechanical means. Thus the exposed position of a secondary or telltale signal indicates beyond peradventure that its primary signal is necessarily exposed.

Inspection will show that all the signal-magnets, both primary and secondary, as illustrated in Fig. I, are connected in multiple to the line-wires I^2 K^2 and derive current from the transformer H′, a common source of electric supply. Inspection will show also that in Fig. I the rail-sections of both tracks B B′ and B^2 B^3 derive current in multiple from the line-wires I K and have a common source of supply—the transformer H. Also the motors on both tracks derive working current from the common feed-wire E. It is not deemed necessary therefore to describe all of these circuits in detail.

In Fig. II the signal-magnets N^2 N^5 are shown as deriving current directly from the line-wires I K, from which the rail-sections derive current, as already described, the transformer H furnishing current in this case to both the rail and the signal-magnets. In this figure also the signal-magnet N is shown as deriving current directly from the feed-wire E, which carries the working current. I prefer, however, usually to furnish current to the signal-magnets from an independent transformer or source of electric supply, as described in connection with Fig. I, for the reason that the current best suited for the rail-circuit magnets is usually not strong enough to give the best results in operating the signal-magnets. In like manner also the working current from the feed-wire E is of too high a potential to operate the signal-magnets most successfully—that is, when the latter are in simple multiple. When a sufficient number of the signal-magnets are placed in series, however, as shown in Fig. X, in which they are illustrated in multiple series, the magnets N^2 N in one series and N^5, N^6, and N^7 in another, they may advantageously receive current from the high-potential feed-wire E, since the normal voltage of the feed-wire E will be divided proportionally to the number of said magnets included in the series. When the signal-magnets are thus included in series, as will be observed on reference to Fig. X, they are demagnetized independently of each other by short-circuiting. Thus when the track-magnet C, for instance, is demagnetized, as already described, and the spring t draws back the armature-lever n and the free lever a^2, connected therewith by the insulating-rod d^2, the said lever a^2 in this instance makes connection with the anvil s^2, thus demagnetizing the signal-magnet N^2 by short-circuiting without interfering with the circuits of the other signal-magnets N, &c., in the same series, all as clearly illustrated in Fig. X. In this case also the resistance u, placed between the feed-wire E and the first signal-magnet N^2, will prevent the short-circuiting of the generator D even if all the signal-magnets happen to be cut out at once by short-circuiting. Furthermore, the resistance u in this situation may be made to control the relative strength of current delivered to said signal-magnets. It will be noted also that by placing a large number of magnets N^5 N^6 N^7, &c., in the series next the generator, a smaller number N^2 N, &c., in the next series beyond, and gradually reducing the number of magnets in each succeeding series receding from the generator allowance is thus made in a simple manner for the natural progressive drop in current, and the strength of the magnets in the different series is thus regulated and rendered approximately equal.

Fig. VIII shows the sections of a double-track road electrically connected in multiple series with each other and to the transformer H. In this case the line-wire I is electrically connected to the rail-sections b^2 c^3 by the branch wires d^3 d^4 and the wire K to the rail-sections b' c' by the branch wires k^3 k^4, as shown. The magnets C C′ C^2 C^4 are electrically connected, respectively, to the rail-sections b b', c c', b^2 b^3, and c^3 c^4, as shown. The rail-sections b b^3 are electrically connected by the wire l^3 and the rail-sections c c^4 by the wire l^4, thus, as will be seen by inspection, connecting the rail-sections in series and in multiple series. R represents the switch at the power-house, composed, as shown here, of the lever g^4, to which the conductor T from one terminal of the generator is electrically connected, the metallic plate or segment g^3, to which the primary h^4 of the transformer H is electrically connected, and the terminal plate i^3, to which the main feed-wire E is electrically connected. When the lever g^4 is disconnected from the plates g^3 i^3, as shown in dotted outline at i^4, there is no current passing over any part of the circuit shown. On turning the lever g^4 in the direction of the arrow, however, the end i^5 of said lever is first brought in contact with the plate g^3, thus completing circuit through the transformer H. This generates current through the secondary or line wires I K and of course through the track-magnets C, &c. These magnets, thus magnetized, attract their armatures, and thus disconnect the main feed-wire E from the working-conductor sections at all points before any current passes through said feed-wire. Further turning of the lever g^4, bringing it into contact with the plate i^3, as shown, brings the main line or feed wire E into direct electrical connection with the generator D ready to deliver current under control of the track-magnets to the traveling motor.

Fig. IX shows the application of my invention when the so-called "third-rail" system is used. In this case the ordinary rail-lines B B′ of the track are continuous and form a return for the working current. The third or center rail line P is divided into sections m^3 m^4 m^5, &c., electrically insulated or disconnected from each other. Additional parallel sectional conductors o^3 o^4 p^3 p^4 q^3 q^4 are provided, preferably supported by the ties, but insulated therefrom. The switch-magnets C C′, &c., are electrically connected, as shown, to one end of the respective sets of sectional conductors p^3 p^4 q^3 q^4, while the line-wires I K are connected in multiple to the opposite ends of said sectional conductors p^3 p^4 q^3 q^4, thus completing the circuits through the switch-magnets C C′. The locomotive L is provided in this case with the short-circuiting devices r^3, which make short-circuiting connection between the sectional conductors p^3 p^4, thus demagnetizing the magnet C. When the armature-lever n is thus released, it establishes electrical connection between the feed-wire E and the section m^4 of the sectional third-rail conductor P, thence by the brush or collector s^3 through the motor to the axles and wheels of the locomotive or car, and thence completing the circuit through the ordinary rails of the track. Otherwise the operation is as more fully described in connection with other figures of the drawings.

Inspection of Fig. IX will show that the extreme ends of the current-collector s^3 of the working circuit come well within the lines of the extreme ends of the short-circuiting device r^3 r^3, from which it is evident that as the car progresses the said collector s^3 will wholly leave the section m^4 of the working conductor and enter upon the adjacent section before the short-circuiting device r^3 r^3 leaves the sections p^3 p^4—that is, the magnet C continues under short circuit until after the working current has ceased to flow through the wire s and armature-lever n. Consequently at the time the magnet C becomes remagnetized through the complete passing of the short-circuiting device r^3 r^3 from the sections p^3 p^4 and attracts its armature-lever n there can be no arcing or burning of the contact-points at s' in separating the same, since there is no current passing between said points at the time the separation takes place.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination, substantially as described, of a plurality of continuously-closed multiple circuits formed in part of parallel sections of railroad-track, a switch-magnet included in each of said circuits, a source of electric supply furnishing current to said magnets through said sections of railroad-track, said magnets being connected in multiple to the conductors from said source of electric supply and operating independently of each other, a traveling motor, a feed-wire, furnishing working current to said motor through a sectional working conductor normally disconnected from said feed-wire, the circuit of said motor being controlled at suc-

cessive stages by said switch-magnets in succession, and means consisting of the wheels and axles of a car for actuating or controlling said magnets by short-circuiting, said working-conductor sections being independent of said switch-magnet circuits.

2. The combination, substantially as described, of a plurality of electromagnets included in a circuit formed in part of two parallel lines of sectional conductors consisting of the rails of a railroad-track, an electric transformer furnishing current in multiple to said respective magnets through said parallel sections of railroad-track, and the wheels and axles of a locomotive or car forming connection between said parallel sections of track, and thereby controlling the operation of said respective magnets independently of each other.

3. In an electric-railway system, the combination substantially as described, of a feed-wire, a working conductor formed in successive sections normally disconnected from said feed-wire, a traveling motor, switch-magnets arranged to establish and control electrical connection between said working sections and said feed-wire, additional sectional contact-conductors formed independently of said working conductors and forming a part of the circuits of said switch-magnets, and two independent traveling contact or circuit making devices, one making electrical connection between said motor and the sectional working conductor and the other establishing electrical connection between parallel sections of the said independent contact-conductors connected to said magnets, and thereby controlling the operation of said magnets, the last-named contact or circuit making device extending at both ends beyond the lines of the current-collector of the working conductor.

4. In an electric-railway system, the combination of a feed-wire, a working conductor formed in successive sections normally disconnected from said feed-wire, a traveling motor, an independent current-collector electrically connected to said motor and making traveling contact with said sectional working conductor, electromagnets arranged to establish and control electrical connection between said working sections and said feed-wire, additional sectional contact-conductors forming part of continuously-closed independent circuits through said magnets and means for demagnetizing said respective magnets by establishing and continuing short-circuiting connection between said last-named sectional contact-conductors while the train or car is running over said respective sections, said short-circuiting device overlapping and extending at each end beyond the lines of said current-collector of the working conductor, said current-collector and short-circuiting device being electrically independent of each other, substantially as and for the purpose described.

5. The combination, substantially as described, of a plurality of switch or track magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets being operated or controlled without opening the circuits of the same, a source of electric supply furnishing current to said magnets through said rail-sections, a plurality of additional or independent magnets receiving current from a common source of electric supply, the circuits of said respective independent magnets being actuated and controlled by said respective track-magnets, and means for operating said track-magnets by short-circuiting.

6. The combination, substantially as described, of a plurality of switch-magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets receiving operative current through said sections of track and being operated or controlled without opening the circuits of said magnets, a series of secondary circuits including translating devices and connected in compound circuit to a source of electric supply, the respective switch or track magnets actuating and controlling the respective secondary circuits independently of each other, and means for operating said switch-magnets by short-circuiting.

7. The combination, substantially as described, of a plurality of switch-magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets receiving operative current through said sections of track and being operated or controlled without opening the circuit of said magnets, a series of secondary magnets included in circuits connected in multiple to a source of electric supply, said secondary magnets and their circuits being operated and controlled independently of each other by the respective switch or track magnets, and the wheels and axles of a car demagnetizing said switch or track magnets by short-circuiting.

8. The combination, substantially as described, of a plurality of switch-magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets receiving operative current through said sections of railroad-track and being operated or controlled without opening the circuits of said magnets, a feed-wire, a working conductor formed in successive sections normally disconnected from said feed-wire, a traveling motor deriving current from said feed-wire through said sections of working conductor, the actuation of each of said respective switch-magnets operating to connect one of said sections of working conductor to said feed-wire and to disconnect the same therefrom, a series of additional circuits containing additional magnets or translating devices, said respective switch-magnets also operating and controlling said respective additional circuits, and means for demagnetizing said switch-magnets by short-circuiting.

9. In an electric-railway system, the combination, substantially as described, of a plurality of switch-magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets receiving operative current through said sections of track and being operated or controlled without opening the circuits of said magnets, a main feed-wire, a working conductor formed in successive sections normally disconnected from said feed-wire, a return-conductor, a traveling motor deriving current from said feed-wire through said sections of working conductor, a series of secondary magnets included in circuits connected in multiple to a source of electric supply, said secondary magnets and their circuits being operated and controlled, independently of each other, by the respective switch-magnets, the demagnetization of either of said switch-magnets also operating to connect the said main feed-wire to one of the sections of working conductor, and means for demagnetizing said switch-magnets by short-circuiting.

10. In an electric-railway system, the combination, substantially as described, of a plurality of switch-magnets included in continuously-closed circuits formed in part of parallel sections of railroad-track, said magnets receiving operative current through said sections of track and being operated or controlled without opening the circuits of said magnets, a main feed-wire, a working conductor formed in successive sections normally disconnected from said feed-wire, a return-conductor, a traveling motor deriving current from said feed-wire through said sections of working conductor, a plurality of signals operated or controlled by means of electromagnets connected in multiple to a source of electric supply, said signal-magnets being operated and controlled, independently of each other, by the respective switch-magnets, the operation of either of said switch-magnets also serving to connect the said main feed-wire to one of the sections of working conductor and to disconnect the same therefrom, and the wheels and axles of a car operating to demagnetize said switch-magnets by short-circuiting.

11. In an electric-railway system, the combination, substantially as described, of a generator, a transformer and a switch, said generator furnishing current, through a suitable feed-wire, for the operation of the motors, and also current to the primary of said transformer, the secondary of said transformer furnishing current to magnets connected to sections of railroad-track, said switch being so arranged that in closing the same current from said generator will be thrown on the primary of said transformer before being delivered to said feed-wire.

12. In an electric-railway system, the combination substantially as described, of a generator, a transformer and a switch, said generator furnishing current to a main conductor and also to the primary of said transformer, said switch being so constructed and arranged that in closing the same current from said generator will be thrown on the primary of said transformer before being delivered to said main conductor.

13. In an electric-railway system, the combination substantially as described, of a generator, a transformer and a switch, said generator furnishing current, through a suitable feed-wire, for the operation of the motors and also current to the primary of said transformer, the secondary of said transformer, furnishing current to magnets arranged to control the admission of current from said feed-wire to the working conductor, said switch being so arranged that in closing the same current from said generator will be thrown on the primary of said transformer before being delivered to said feed-wire.

WILLIAM ROBINSON.

Witnesses:
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HAROLD W. SIMONDS.