(No Model.) 3 Sheets—Sheet 1

C. A. STONE & E. S. WEBSTER.

ELECTRICALLY OPERATED RAILWAY SWITCH.

No. 511,173. Patented Dec. 19, 1893.

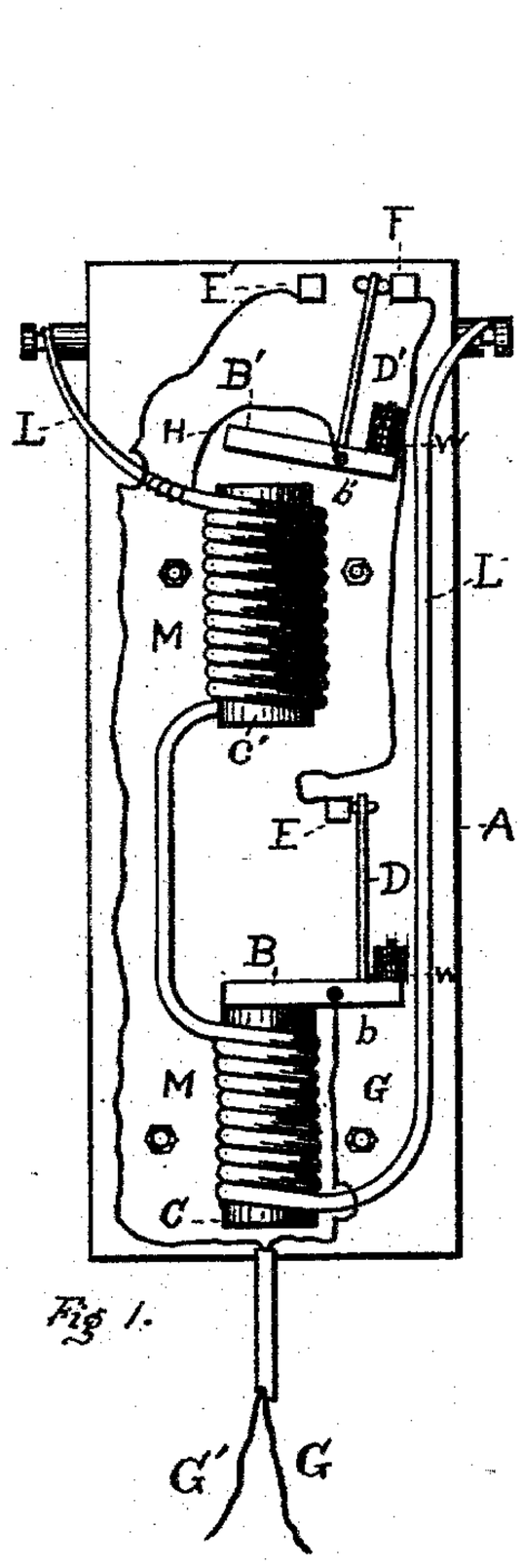

Fig 1.

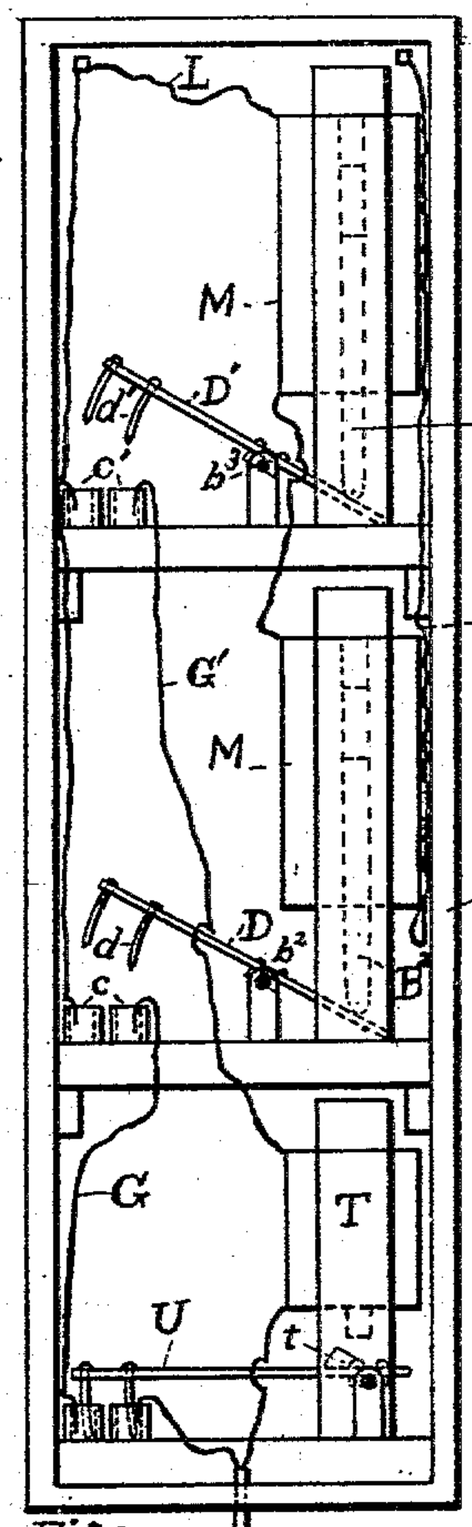

Fig 2.

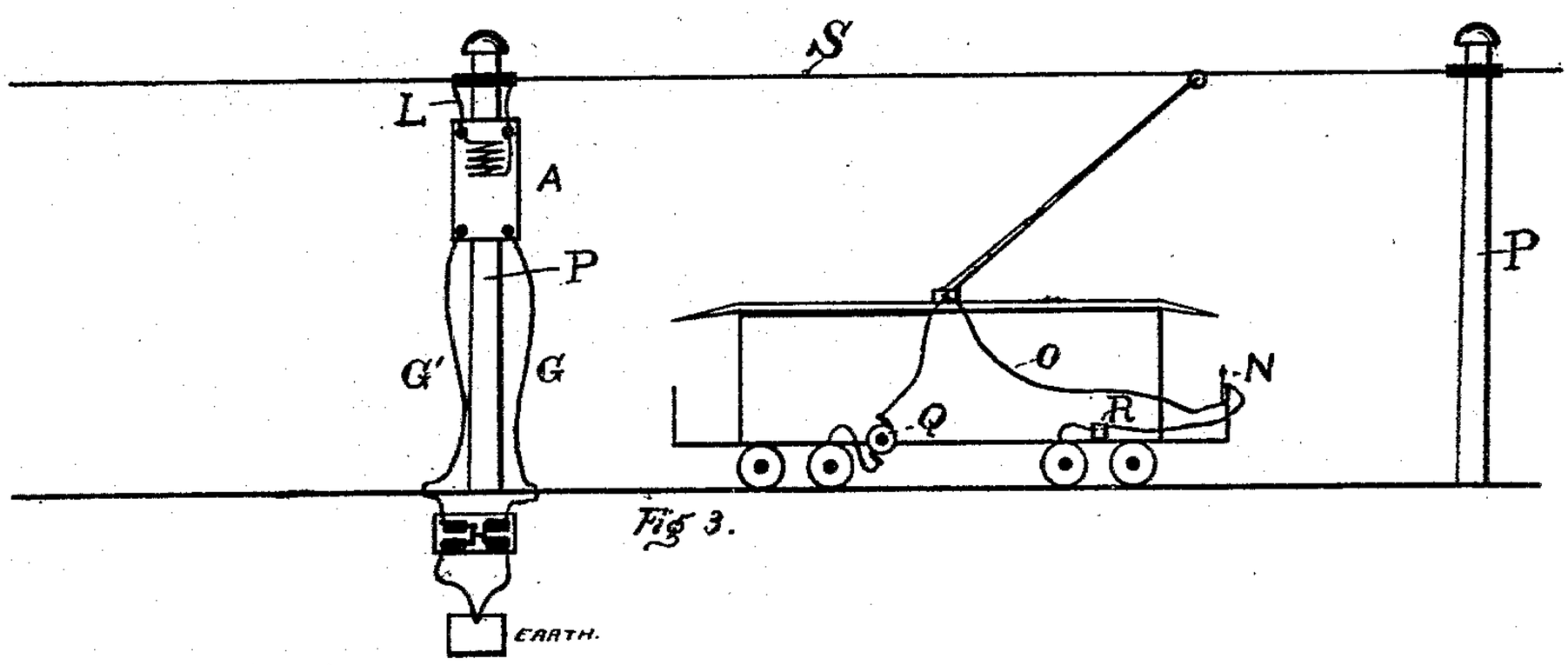

Fig 3.

WITNESSES.

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(No Model.) 3 Sheets—Sheet 2.

C. A. STONE & E. S. WEBSTER.

ELECTRICALLY OPERATED RAILWAY SWITCH.

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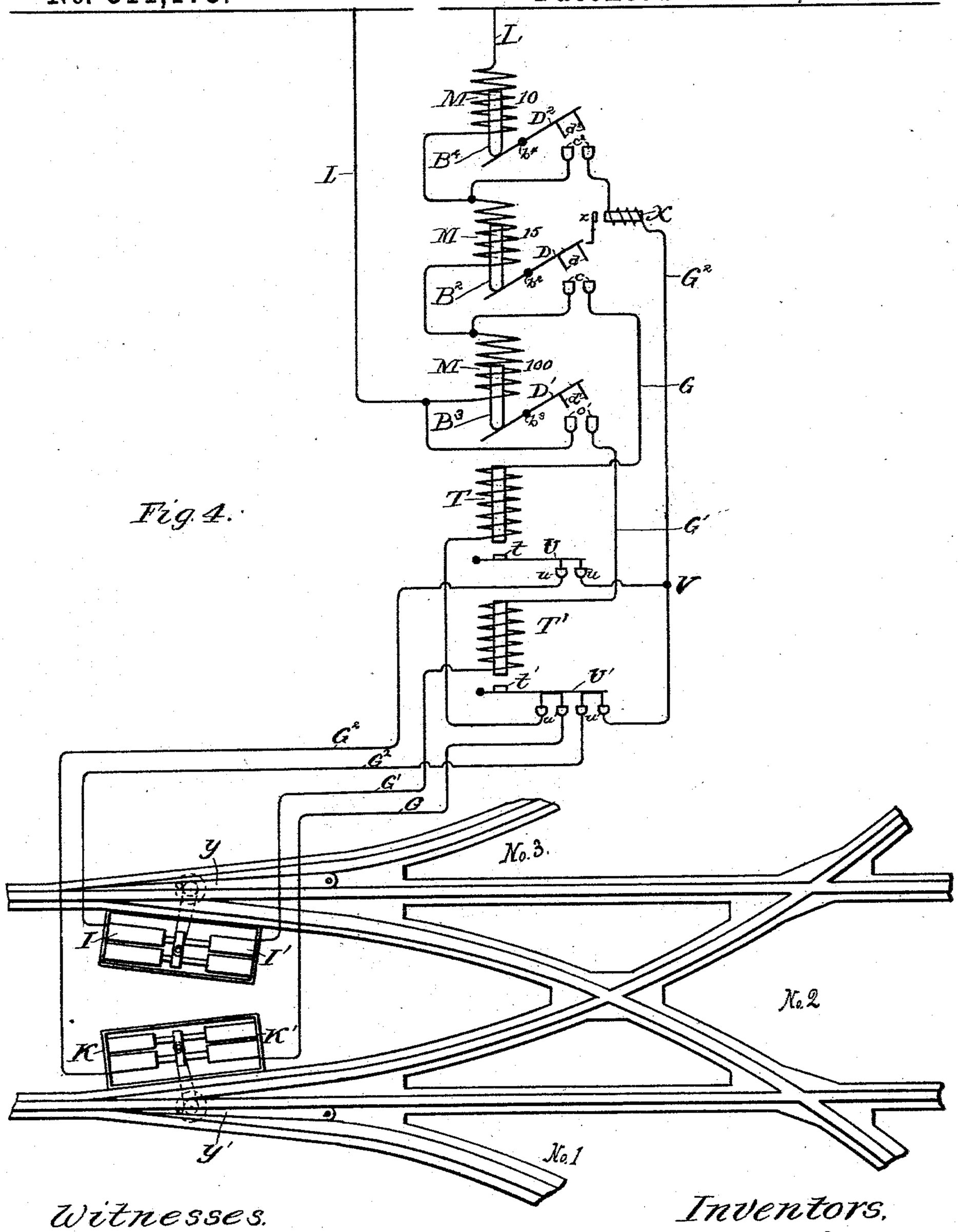

Fig. 4.

Witnesses.

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(No Model.) 3 Sheets—Sheet 3.

C. A. STONE & E. S. WEBSTER.

ELECTRICALLY OPERATED RAILWAY SWITCH.

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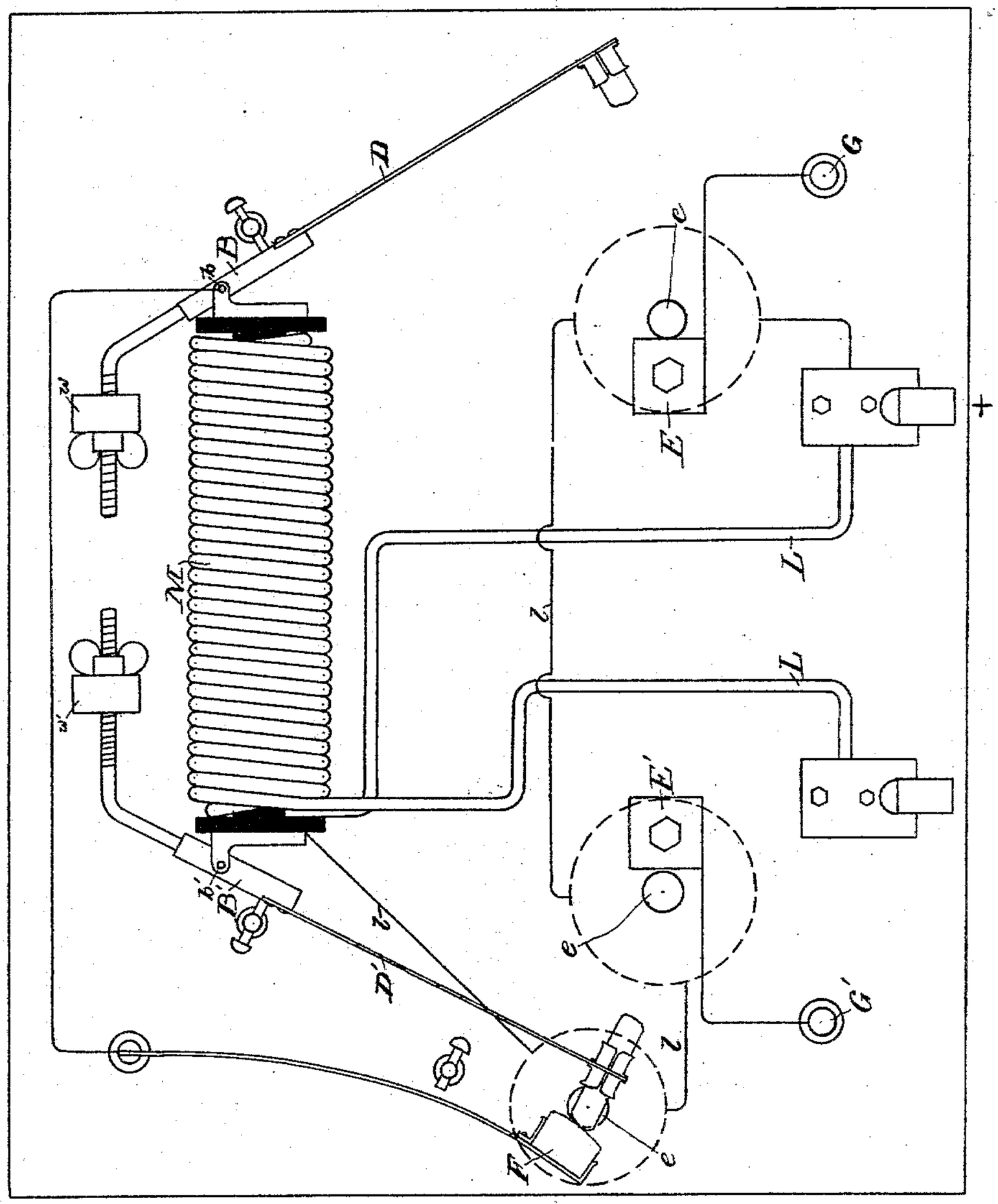

Fig. 5.

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UNITED STATES PATENT OFFICE.

CHARLES A. STONE, OF NEWTON, AND EDWIN S. WEBSTER, OF BOSTON, MASSACHUSETTS.

ELECTRICALLY-OPERATED RAILWAY-SWITCH.

SPECIFICATION forming part of Letters Patent No. 511,173, dated December 19, 1893.

Application filed August 30, 1892. Serial No. 444,592. (No model.)

To all whom it may concern:

Be it known that we, CHARLES A. STONE, of Newton, in the county of Middlesex, and EDWIN S. WEBSTER, of Boston, in the county of Suffolk, both in the Commonwealth of Massachusetts, have invented certain new and useful Improvements in Electrically-Operated Railway-Switches, of which the following description, in connection with the accompanying drawings, is a specification.

Our present invention relates to improvements in that class of electrically operated railway switches set forth in our Patent No. 484,123, dated October 11, 1892, in which portions of the main electric conductor, which we call switch-sections are insulated from direct electrical connection with the rest of the conductor, but which are indirectly connected therewith; and our invention consists in supplying current to said switch-sections by a loop from the main portion of the conductor, either trolley wire or feed wire, through the coils of one or more electro-magnets which may be made either with fixed cores and movable armatures, or of the solenoid type, and having the armatures or cores of the said coils so adjusted that each will be attracted by the passage, through its coil, of a current of different intensity from either of the others, and further, in connecting the several armatures of the said coils, or circuit-closers controlled by said armatures, or solenoid cores, with shunt lines from the main conductor; and the respective magnets of the railway-switch with a contact-post located in the path of movement of the arm of one of said circuit-closers, so that when either armature or core is attracted by its coil, one of the railway switch-magnets will be automatically switched into the shunt-circuit controlled thereby, as soon as the circuit-closer which it operates bears upon its contact-post. Thus a current of electricity will pass from the main conductor over the shunt-circuit controlled by the armature or core which has been attracted by its coil and through the circuit-closer and its contact-post, to the railway-switch magnet with which it is connected, thereby causing the said switch-magnet to attract its armature or core, and thus move the switch-tongue by means of interconnecting mechanism. When the trolley or electric collector of a passing car enters upon one of the said switch-sections of the main conductor, a current will pass thereto through the coils of the electro-magnets, by which the railway-switch circuit-closers are operated and which are preferably placed in series. The chief reason for placing these armatures or circuit-closers in series in the railway-switch circuit is, in order that they may be so arranged that when an armature requiring one of the larger currents to operate it, is attracted, its movement will automatically break the circuit through one or more railway-switch magnets when it closes the circuit through its own. As above stated, the armatures or cores of these several coils are differently adjusted; for instance, one, so that it will be drawn by its coil when a current of fifteen ampères is passed through that coil; another, so that it will be attracted when a current of say, over one hundred ampères is passed through its coil. Two such coils, each with one armature, or one coil with an armature at each pole of its core, will be sufficient to operate a single switch in both directions; and when the railway-switch is operated by a magnet in one direction only and by a spring in the other direction, for instance, as shown and described in Patent No. 399,732, dated March 19, 1889, but one circuit-closer coil need be used with one armature adjusted to be operated by a current of greater intensity than that ordinarily used for running the car motor; if, however, two railway switches which are in convenient proximity are to be operated from one switch-section, three or more of such circuit-closer coils may be placed in the loop between the main conductor and that switch-section, and the armatures of the third, fourth, &c., coils be adjusted so that they will not operate until the current passing through their coils has reached an intensity of, say, one hundred and twenty-five and one hundred and fifty ampères, and so on, respectively. The first armature of the first circuit-closer coil in the series, may be adjusted so as to be operated by a current of the minimum intensity ordinarily used for supplying the motor, for instance, fifteen or twenty ampères, the second armature, or that connected with the

railway-switch magnet opposed to the first, so as to be operated by a current of somewhat greater intensity than that ordinarily drawn by the motor; for instance, over one hundred ampères, and the third, fourth, &c., each by currents of progressively greater intensity than that of the next preceding, and in order to vary the current which is thus being drawn through the coils of the said circuit-closer magnets, besides the usual rheostat or commutator which is employed upon the car to vary the current supplied to the motor, and which might be used to sufficiently intensify the current drawn through the said coils to operate the armatures or cores of more than one of them, by first partially applying the brakes to the car; we may use an additional independent resistance box, controlled by an independent switch, which, by being placed on properly indicated positions or contacts of the resistance box, will switch into an additional parallel circuit from the main conductor, connected either with the ground or a return conductor, a predetermined definite amount of resistance, and thereby change the intensity of the current drawn through the said circuit-closer coils, to the required specified degree to attract any particular armature and thus close the shunt-circuit through either railway-switch magnet and move the switch controlled thereby to the proper position to turn the car upon the track desired.

When using three or more railway-switch circuit-closing armatures, it will be found convenient to adjust one of the series so that it will be operated by a current even less than that needed to operate the motor, and when using this low current its operation can be insured against interference by the circuit-closer which is operated by the current of next succeeding greater intensity, by a locking device hereinafter described.

Among the advantages of our improved construction and arrangement of apparatus and their connections, over prior systems are, dispensing with any additions or extra attachments either to the trolley or contact brush, or to their support, and in fact under ordinary conditions with the necessity of any additions at all to the car; and also doing away with the connections which carry the main current through the ground, where there is chance for leakage.

When one of the circuit-closer magnets which requires a large current through its coil to operate it, has been attracted by and is once in contact with the core therein, we have found in practice that only a minimum current will be required to hold such armature in that position. Consequently the switch which controls the additional parallel circuit for increasing the flow of current through the said coils, will need to be closed only for a short time, or a period sufficient for the coil to attract any particular armature, so that there need be no waste or long continued use of this electric current of great intensity.

For the purpose of operating one railway switch tongue in both directions, instead of using two circuit-closer coils with an armature for each as above described, a more compact and economical construction is that, also above mentioned, and shown in Fig. 5 of the drawings where we use one coil with a soft iron armature and its attached circuit-closer, placed at each pole of the core of said coil, the respective armatures being differently adjusted as in the case of the use of two coils, with one armature for each; and for the purpose of preventing the continuance of any arc which may be formed between the circuit-closers and their respective contact-posts, whenever they are separated, we may employ the well known means described by Henri Becquerel in the *Journal de Physique*, Vol. IV, page 206, of the year 1875, that is, either by a blast of air directed across the path in which such arc may be formed or by placing a small electro-magnet near each contact of the said circuit-closers, with one pole of the core of such electro-magnet directed toward the path in which such arc will be formed, and with the core in such position that its extended axis will intercept that path. The effect of the blast of air or the small electro-magnet when a current of electricity is passing through its coil, will be to so deflect the arc between the circuit-closer and its contact as to break it almost instantaneously, and thus prevent any injurious results therefrom. These arc-breaking magnets may be in the circuits which are controlled by the circuit-closers, or they may be supplied with current from some other source.

In the drawings forming a part of this specification, Figure 1, is an elevation of two electro-magnets, in a loop from the electrical conductor, having circuit-closers attached to the armatures of said magnets, for closing the railway-switch circuits. Fig. 2, is an elevation of another arrangement for closing the railway-switch circuits, by the operation of the cores of solenoids. Fig. 3, is a diagrammatic view of the connections of the various devices including the car with its trolley upon a switch-section of the trolley wire. Fig. 4, is a diagrammatic view of the arrangement of solenoids for closing the track-switch circuits when more than two such circuits are to be operated from the same switch-section, and with their accompanying cut-outs, and connections with the track-switch magnets, the track-switches and operating magnets being in plan view. Fig. 5, is an elevation of the arrangement of a pair of circuit closers operated by a soft iron armature at each end of the core of a single electro-magnet.

Referring to the drawings, A indicates a box, which may be secured to one of the poles which support the trolley wire, and in which we place the electro-magnets M, by which the circuits of the railway-switch magnets are automatically closed. These electro-magnets M, are in a loop L, which is part of the main

conductor circuit. In Fig. 1 they are shown with fixed cores C, and armatures B, B′, pivoted at *b*, *b′*. To each armature a circuit closing arm D is attached. The lower armature of this figure is represented as the one which is attracted by the minimum current, for instance, fifteen ampères, and its circuit closing arm has but one contact piece E. The upper armature is represented as adjusted or weighted so that it will not be operated until the current passing through the coils of its magnet has reached a much greater intensity, for instance, one hundred ampères. The circuit closing arm of this upper armature has two contact pieces E′ and F; E′ being connected with the shunt line G′, which runs to one of the railway-switch magnets and F being connected with the contact piece E of the circuit-closer attached to the lower armature B. The upper armature B′ or its circuit-closing arm is connected with the main conductor by a shunt line H, and the armature B or its circuit-closing arm is connected by a line G, to the railway-switch magnet opposed to that with which the line G′ is connected. The armatures B, B′ may be adjusted to be operated by a current of a definite intensity by weights *w* placed upon the outer ends thereof.

S represents a switch-section of the main trolley wire, insulated from direct connection with the rest of the wire at the posts P.

The operation of the circuit-closing devices when in the position illustrated in Fig. 1 is as follows: When the trolley of a car enters upon a switch-section, as S, the current of electricity drawn therefrom by the motor passes over the loop L and through the coils of the magnets M. The lower armature B is adjusted so that it will be drawn to its magnet whenever a current of fifteen ampères or more passes through its coils. Under all ordinary conditions therefore the armature B will be drawn into contact with the core of its magnet, as illustrated, as soon as the trolley runs upon the switch-section; by this operation the arm D will be caused to bear upon the contact piece E, thus closing one of the railway-switch magnet circuits through the line H, arm D′, contact F, its connection with contact E, arm D, line G, through the railway-switch magnet to earth, or a return conductor, to the source of power. The current thus passed through the coils of the railway-switch magnet will cause it to attract its armature, or core if a solenoid, and thereby move the railway-switch tongue in the prearranged direction. When it is desired to move the said switch-tongue in the opposite direction, the car brake may be partially applied or until the power required to turn the motor Q, shall have raised the intensity of the current drawn through the coils of the magnets M, sufficiently to draw the armature B′ to its core, or as above suggested, to one hundred ampères. By this operation the arm D′ will be moved from the contact piece F to the contact piece E′, thus breaking the circuit through the line G and closing it through the line G′, and the railway-switch-magnet in circuit therewith, and thereby move the railway-switch tongue in a direction opposite to that caused by the opposed railway-switch magnet, in line G.

Instead of applying the brakes to the car for the purpose of increasing the current drawn through the coils of the circuit closing magnets, an independent rheostat or resistance box R (Fig. 3) may be used, which by means of a hand switch N, can be switched into an independent circuit O, in parallel with the motor circuit, as heretofore described.

In Fig. 2 is illustrated a construction of circuit-closing magnets of the solenoid type. In this construction the plungers B^2, B^3, operate the circuit closing arms D, D′, which instead of being attached to a pivoted armature are pivoted directly to suitable bearings at b^2, b^3, and in each instance the circuit is closed by fingers *d*, *d′*, upon the end of each arm, which fingers dip into mercury in cups *c*, *c′*, or other well known contact devices may be used in place of mercury cups *c*.

When employing the construction shown in Fig. 2, in order to break the circuit through one railway-switch magnet as soon as it is closed through the other, a supplemental electro-magnet T is connected with one of the mercury cups *c′*, in the circuit G′, so that as soon as the arm D′ drops and closes the circuit G′ through the cups *c′*, the electro-magnet T will be energized and immediately attract the armature *t*, which is attached to circuit-closing arm U, and thus raise said arm and open the railway-switch circuit G.

The operation of the railway-switch circuit-closers illustrated in Fig 2, is as follows: Assuming that the plunger B^2 will be drawn into its coil when a current greater than fifteen ampères is passed through that coil, and that the plunger B^3, will not be raised by its coil until the current passing through it is much greater than fifteen ampères, for instance, one hundred ampères, when there is no trolley upon the switch-section of the trolley wire the several parts will occupy the positions shown, with the plungers resting upon one end of the circuit-closing arms D, D′; but as soon as the trolley of a car runs upon a switch-section of the wire, if a current between fifteen and a hundred ampères is drawn by the motor, the plunger B^2 will be raised, the arm D will drop and by the immersion of the fingers *d* in the mercury of the cups *c*, close the circuit G, through one of the railway-switch magnets. When a current of one hundred ampères is drawn through the coils of the magnets M, the plunger B^3 will be raised, the arm D′ will drop and immerse its fingers *d′* in the mercury of cups *c′*, thus closing the other railway-switch circuit G′. As stated above, when the circuit G′ is closed the mag-

net T will be energized and draw up the arm U, thus withdrawing its fingers from the mercury cups and open the circuit G.

In Fig. 4, is shown the manner in which two track-switches may be operated from the same switch-section of the main conductor, and the arrangement of the circuit closing coils is the reverse of that shown in Fig. 2, that is, in Fig. 4 the coil which has a core that is raised by the minimum current is placed at the top, and the two below are operated by currents of successively greater intensity, and we will assume that the upper core B^4 will be drawn up when a current of ten ampères passes through its coil; by this means the circuit closing fingers d^2 will drop into the cups c^2, and close the circuit G^2, which is split at V, one branch running to the track-switch magnet I, through the circuit-closer U', and the other branch to the track-switch magnet K, through the circuit-closer U. Thus the cores of the two magnets I and K will be drawn in, and through their respective connections with the switch tongues y, y', those tongues will be moved outward to the positions in which they appear in the drawings. This will direct the car upon the middle or straight track, No. 2. In order to close circuit G^2 alone, the electric current must be almost entirely shut off as the car trolley enters upon a switch-section, or after it has entered, the current must be wholly shut off and then turned on gradually until it has reached an intensity of ten ampères which will close circuit G^2; and to prevent interference by the closing of circuit G when a sufficient current is turned on to move the car, for instance, fifteen ampères, a small electro-magnet X is placed in the circuit G^2, with its armature upon one end of a tilting arm z. This arm z, is so located that when the magnet X attracts its armature the other end of the arm z will engage with the circuit closing arm D, and prevent it from falling when the core B^2, is raised. As soon as the locking arm z, has engaged the circuit-closer D, any current less than one hundred ampères may be drawn by the motor without causing any change in the position of the railway switches. As illustrated, the circuit-closer D will be operated when a car enters upon a switch-section with the motor drawing a current sufficient to propel the car, or any current between fifteen and one hundred ampères, and as the core B^2, will also be operated by any current greater than ten ampères we construct the coil of the magnet X, so that it will operate more slowly than the coil of the core B^2, in order that when it is desired to close the circuit G, and a sufficient current is drawn through the coils M for that purpose, the core B^2 will be raised and the arm D will fall, before the magnet X has moved the locking arm z. As in Fig. 2, so in Fig. 4, as soon as the fingers d drop into the mercury of cups c, the circuit G will be closed, the magnet T energized, which will attract armature t, and raise the lever U, thus opening the branch of the circuit G^2 which passes through the cups u, u. The circuit G being closed will energize the track-switch magnets K', causing them to draw their cores in and thus operate the mechanism which connects said cores with the switch tongue y', thereby moving it inward or against the rail opposite to the one where it is shown in the drawings. The branch of G^2 through the circuit-closer U' being closed the track-switch magnets I will attract their cores and the switch tongue y, will remain in or be moved to the position illustrated and the car will be directed upon track No. 1.

In order to place the switch tongues in a position to direct the car upon track No. 3 the brakes should be partially applied, or the additional resistance mentioned switched into circuit, so as to draw a current of one hundred or more ampères through the coils M. By this means the core B^3 will be raised and the circuit G' will be closed by the falling of circuit-closer D'; this will energize magnet T' which is in circuit G; the armature t' will be attracted and thus raise the arm U' thereby opening circuit G, and the branch of G^2 through U'. The closing of circuit G' will cause the track-switch magnets I', to draw in their cores and move the switch tongue y over to the rail opposite to that where it is represented to be resting. The branch of circuit G^2 through the circuit-closer U still being closed the track-switch magnets K, will move the switch tongue y' into the position illustrated and the car will be directed on to track No. 3, by the switch tongue y. It will be seen, therefore, that when circuit G^2 alone is closed, it cuts out or rather prevents the closing of circuit G; that when circuit G is closed it cuts out one branch of circuit G^2 at U; that when circuit G' is closed it cuts out circuit G and one branch of circuit G^2, at U', and there will be no interference in the operation of the several circuits, for the only occasion when the two switch tongues y, y', are simultaneously moved in opposite directions is when circuit G^2, alone is closed. It will be found convenient and economical to use the low currents of circuits G^2 and G with the locking device z, even when two circuits only are employed to operate a single track-switch.

In Fig. 5 where two circuit closing arms are arranged, one at each end of a single magnet core; L, L, is the loop from the main conductor through the coil M. The supports $b\ b'$ of the circuit closing arms D D', are insulated from the magnet M, and current is carried to each arm D, D', through the shunt line l, l, from the main conductor. By reason of the position of the weight w, upon the upper end of the arm D, a small current, for instance, fifteen ampères, through the coil M, will cause it to attract the soft iron armature B, while a much greater current will be needed to cause it to attract the armature B', the weight w' of which being adjusted, for

example, to withstand the force of any current less than one hundred ampères. When any current between fifteen and one hundred ampères passes through the coil M, the armature B will be attracted and the end of the arm D will bear upon the contact E, thus closing the circuit G to one track-switch magnet; the current passing from the main conductor through line *l*, support *b'*, arm D', contact F, support *b*, arm D, contact E to line G. When a current greater than one hundred ampères passes through the coil M, the armature B' will be attracted, the end of the arm D' will leave contact F and bear upon contact E', thereby closing the other track-switch magnet G'. When the arm D' leaves the contact F it opens the circuit G, thus preventing any interference in the action of the two track switch magnets. In this Fig. 5, *e*, *e*, *e*, represent the location of the magnets, or outlets of air tubes, which may be employed to prevent the continuance of any arc which may form when the arms D, D', separate from the contacts E, E', or F, and when magnets are used for the purpose, they may be supplied with current by placing the coils of the magnets *e*, *e*, *e*, in series in the line *l*, *l*, connected with the coil M.

When using the construction and arrangement shown in Figs. 2 and 4 there will be no occasion to use either an air-blast or magnet to rupture an arc between the fingers and their contacts, when the former are withdrawn in the act of opening either circuit, for the reason that when the plungers B^2, B^3, drop upon the outer ends of their respective circuit-closing arms, their fingers are withdrawn from the mercury so suddenly that no perceptible arc is formed.

We claim—

1. In an electric-railway system a pair of railway-switch magnets each in an independent circuit from the main conductor, which circuits are respectively closed by a switching device which is automatically operated by a current different in intensity from that of the others, but all drawn through the trolley of a passing car, substantially as described.

2. In combination with the operating electro-magnet of a railway-switch, a circuit connecting said switch-magnet with a main current conductor through a circuit-closer operated by the armature of an electro-magnet; and a branch circuit through said electro-magnet connecting two sections of the main conductor which are otherwise insulated from one another, substantially as described.

3. In an electric railway, the combination with the main electric conductor, of an insulated section connected therewith by a branch conductor provided with one or more electro-magnets in circuit, and a shunt-line which has a circuit-closer, controlled by the armature of one of the said electro-magnets and the magnet of an electric railway-switch in circuit, which shunt-line is closed by the attraction of one of the electro-magnet armatures and opened when said armature is released, substantially as described.

4. In an electric railway system, having a main conductor provided with insulated switch-sections which are supplied with current through the coils of a plurality of electro-magnets; armatures therefor which are respectively operated by a current of different intensity, and circuits from the main conductor, each of which has in series, a circuit-closer operated by one of said armatures, and a railway switch operating magnet, for the purpose substantially as described.

5. In an electric railway system the combination with the main electric conductor, of an insulated section connected therewith through a pair of electro-magnets each adapted to be operated by a current of different intensity from the other, and shunt circuits from the main conductor each of which has a circuit-closer controlled by one of the armatures of the said electro-magnets and the coils of one of a pair of operating magnets of the railway switch, in series, whereby the said railway-switch magnets will be energized and the switch be moved in one direction or the other by the attraction of the armature of one or the other of said electro-magnets substantially as described.

6. In an electric railway system, a main current conductor which has switch-sections insulated from direct electrical connection therewith, conductors to supply current to said sections through two or more electro-magnet coils, with the armatures of the magnets in the connection for each section, severally adjusted to be operated by a current of different intensity from that of the others, and one or more independent lines which respectively have one of said electro-magnet armatures and a railway-switch operating magnet in circuit, for the purpose substantially as described.

7. In an electric railway system, a main current conductor provided with switch-sections insulated from direct electrical connections therewith, conductors to supply current to each of said sections, with the coils of two or more electro-magnets in circuit; armatures for said electro-magnets respectively adjusted to be operated by a current of different intensity from the others; two or more railway-switch magnets; an independent line for each railway-switch magnet; a circuit-closer for each of said lines, which closer is operated by an armature of one of said electro-magnets, and one or more of which circuit-closers are adapted to open the circuits of one or more of the others by the operation of closing its own, substantially as described.

8. In an electric railway system, which has sections of the main electric conductor insulated from direct connection therewith, a supplemental conductor to supply current to each of said insulated sections through two or more magnet coils, with each of the armatures of the said magnets, at each section, adapted to

be operated by a current of different intensity from that of the others; an independent shunt circuit from the contact post of a circuit-closer controlled by each of said armatures, and through one of a pair of railway-switch operating magnets; and an additional resistance upon the car adapted to be switched into circuit with the insulated switch-sections, whereby the current drawn through said magnet-coils may be varied when the trolley is upon an insulated section, for the purpose substantially as described.

9. In combination with a pair of oppositely pulling magnets of a railway-switch, an independent circuit for each magnet, which connects it with a main electric conductor through a switch or circuit-closer operated by the armature of an electro-magnet, each of which armatures is differently adjusted for each circuit, and their electro magnet coils are in a conductor circuit; an insulated section of said main conductor supplied with current through said electro-magnet coils and a rheostat upon the car to vary the current drawn through the said coils when the trolley is upon the insulated section, for the purpose substantially as described.

10. In an electric railway system, a main current conductor which has sections insulated from direct electrical connection therewith, a connecting loop between the main conductor and each of said sections with a plurality of electro-magnets in circuit; differentially adjusted armatures for said magnets; two or more shunt lines from said connecting loops, each having in circuit a circuit-closer which is operated by one of said armatures, and a magnet of a railway-switch, and a rheostat upon the car adapted to be switched into an electric circuit, in parallel with the motor circuit, for the purpose of operating the railway switch, substantially as described.

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