(No Model.) 2 Sheets—Sheet 1.

M. J. WIGHTMAN.

ELECTRIC RAILWAY.

No. 430,329. Patented June 17, 1890.

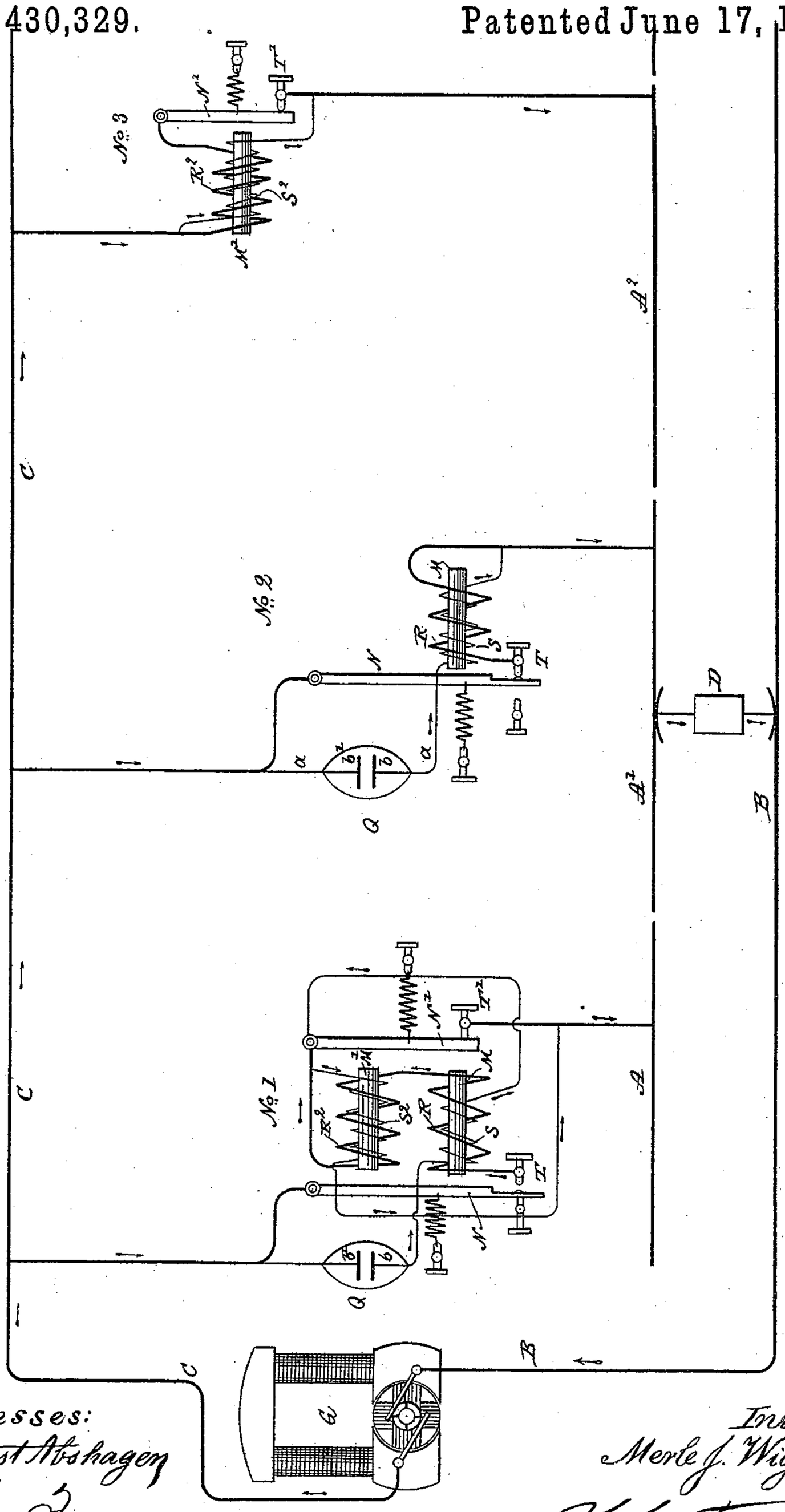

Fig. 1.

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By his Attorney:
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(No Model.) 2 Sheets—Sheet 2.

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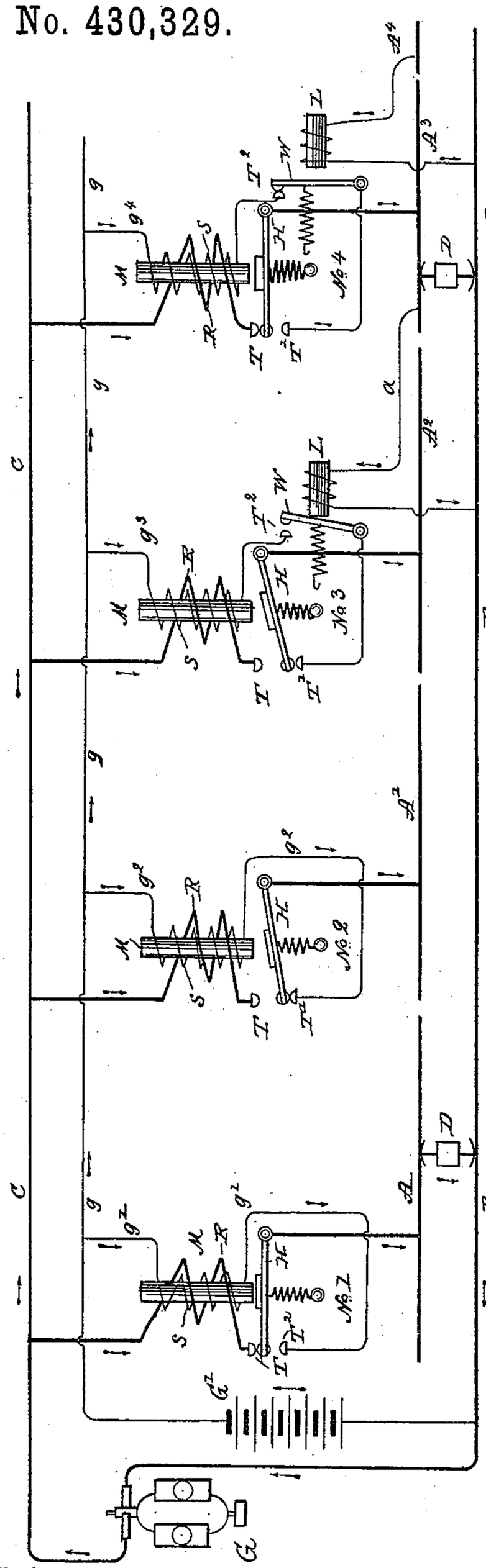

Fig. 2.

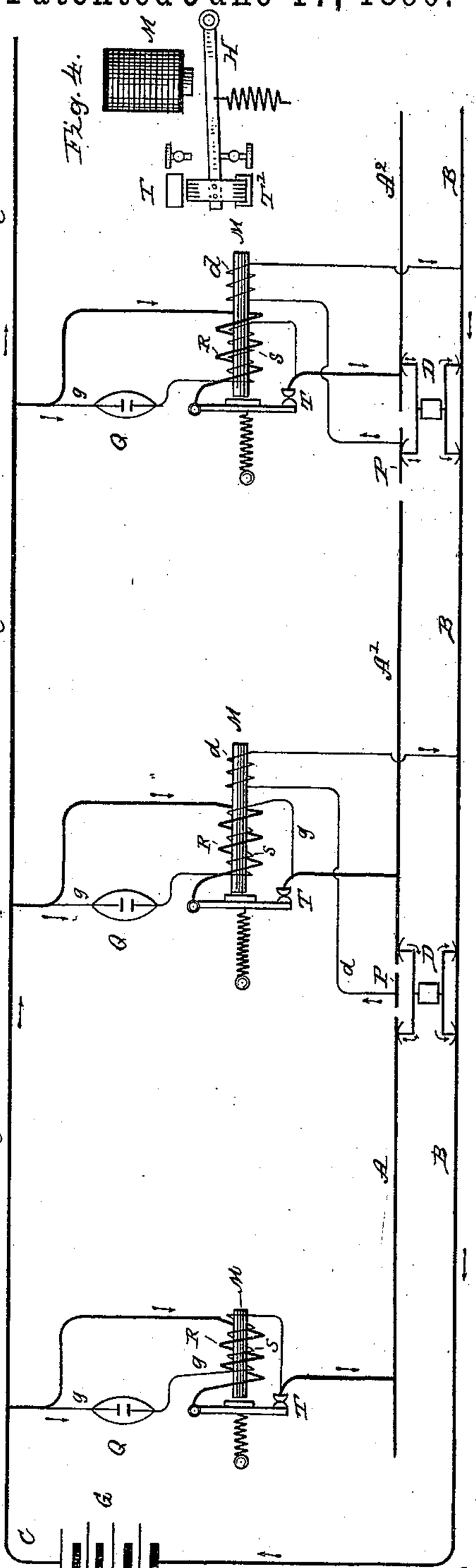

Fig. 3.

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UNITED STATES PATENT OFFICE.

MERLE J. WIGHTMAN, OF HARTFORD, CONNECTICUT.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 430,329, dated June 17, 1890.

Application filed April 1, 1885. Serial No. 160,856. (No model.)

To all whom it may concern:

Be it known that I, MERLE J. WIGHTMAN, a citizen of the United States, and a resident of Hartford, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Electric Railways, of which the following is a specification.

My invention relates to arrangements of conductors, switches, &c., for supplying current to the motors of electric railways; and its object is to avoid and compensate for certain disadvantages that apply to the present systems, and which consist, first, of the liability to loss of current from leakage; second, the danger from persons and animals coming in contact with the supply-conductors, and, third, the danger of the conductors becoming short-circuited.

My invention is designed especially for application to those systems where the rails of the railway are utilized as the supply or feeding conductors for the motors traveling thereon; but my invention is also of advantage for application to other arrangements of conductors—as, for instance, those in which an overhead wire is employed as a supply-conductor and the rails are utilized as a return-conductor, or to other arrangements of such supply and return conductors.

I have herein shown my invention applied to a system in which I divide what I shall term the "feed-conductor" into sections and combine therewith a well-insulated supply-main connected to said sections by branches that are normally open or are of such high resistance that said sections are, to all intents and purposes, practically insulated from the supply-main. To connect the sections to the supply-main, when the motor reaches a section I employ electric switches operated by electro-magnets whose coils are in branches of high resistance, and which branches are normally open, but are completed by the motor on entering the section. The branches containing the coils of the switch-magnets may be, as will be hereinafter described, branches from a second or supplemental conductor. The circuit-connections for said branches to a return-conductor may be completed through the connections by which current is supplied to the electric motor and from the motor to a suitable return-conductor, or, as will be obvious, they might be entirely independent connections completed through other circuit-closing devices carried by the motor in such way that upon the motor's entering the section the circuit of the switch-magnet will be closed and the switch operated.

My invention consists in placing in the branch from the insulated main to the feed-conductor a device consisting, essentially, of two plates or electrodes normally separated from one another by a thin layer of insulating medium of such thickness, however, that when a motor enters a section and completes a circuit across to the return-conductor the current shall be of sufficient potential to force its way across the space between said electrodes and thus allow current to pass in sufficient amount through the circuit of the switch-magnet to energize the same and thereby operate the switch and complete the normal branch connection between the supply-main and the particular section of feed-conductor upon which the motor may for the time being be running. In combination with said magnet or switch I prefer to use an auxiliary magnetic coil of low resistance, which is placed in the circuit completed by the action of the switch, and therefore acts to hold said switch in position to keep the circuit closed through the branch connection of low resistance to the electric motor while the latter is upon any particular section. I also use in my system certain arrangements of "block-magnet," whereby a motor upon any section may automatically "block" the adjoining preceding section or sections, so that any motor entering upon the latter shall be incapable of receiving any current from the supply-main. I also use in combination, preferably, with the switch electro-magnet a supplemental coil of high resistance connected as will hereinafter be described, so that an electric motor in passing from one section to another shall complete the circuit automatically to the section upon which it is about to enter before it breaks its circuit.

In Figure 1 I have illustrated diagrammatically the simplest arrangements of circuits

and switches for carrying out my invention. In Fig. 2 I have illustrated diagrammatically the modification in which I employ a supplemental main conductor for operating the switches in place of the supply-main through which the current is supplied to the electric motors upon the rails. In Fig. 3 I have illustrated diagrammatically a further modification, in which a supplemental coil is employed upon the switch-magnet for preventing sparking as the motor passes from one section to another. Fig. 4 illustrates a detail of construction.

In the various diagrams the letters A B indicate the rails of a railway that are employed as the supply-conductors for an electric motor—as, for instance D, moving over the line of rails—the connections to said motor from the rails or feed-conductors being made in any desired manner.

At G is indicated a source of electricity—such, for instance, as a dynamo-electric generator, one pole of which is connected to the line of rails B, forming the metallic return from the electric motors, while the other pole is connected to an electric conductor C, strung upon poles by the side of the track, or otherwise arranged, and insulated as highly as possible by proper means.

A A′ A^2 indicate sections of rail employed as the feed-conductors for the electric motor. These sections are of any desired length, but will vary under various conditions. Where the insulation is bad, they should of course be comparatively short. Each of the sections A A′ A^2 is connected with the supply-main C by a separate branch.

At No. 2, Fig. 1, I have illustrated the arrangement of switch whereby desired connections may be effected when a motor comes upon a section and is to draw off current from the supply-main.

M indicates a core of the electro-magnet, and N a simple form of switch-lever, that consists in the present case of the armature-lever for the electro-magnet. T indicates the front contact-stop for said armature-lever. The armature is provided with a suitable retractor that normally tends to hold the lever away from its stop. In the figure the parts are shown in contact, because it is supposed that there is an electromotor upon the section A′.

The branch through which the current is supplied for operating the motor is a normally-open branch and is formed between the insulated conductor C and the section A′, as indicated, through the lever N, contact T, and a coil R upon the electro-magnet, which coil is of low resistance and has the function of holding the parts of the switch in contact so long as the electromotor is on the section A′. When the motor is off the section, the normal connections are from the conductor C through a device Q, that I term a "vacuum-bulb," and a coil S of high resistance upon the core M. The coil S constitutes, in fact, the coil of the switch electro-magnet. The bulb Q consists of a receptacle of any desired kind partially exhausted of air and containing two plates or conducting-surfaces *b b′*, separated from one another by a small interval and connected with conductors *a a*, that are sealed in the bulb. The distance between the electrodes is such that whenever an electric motor enters upon the section A′, so as to complete the connection between the section A′ and the return B, current may force itself across the space between *b b′* and through the insulating medium, consisting of the partially-rarefied air, and thence through the coils of the electro-magnet M. When this occurs, the switch N is drawn up into contact with the stop T, thereby completing a lower resistance-circuit between B and A′ through the lever and coarse-wire coil R, so that current may be supplied to operate the motor in the ordinary way. So long as the motor remains upon the section the current flowing in the coils R holds the switch in proper position; but when the motor leaves the section the breakage of the connection from A′ to the return-conductor B permits the switch N to be withdrawn to its normal position, so as to break the short circuit of the branch between C and A′ and restore the parts to a normal condition in which, owing to the resistance in the vacuum-globe, the conductor C is, to all intents and purposes, disconnected from or removed from operative connection with the section of conductor A′.

In order to avoid the danger and the escape and waste of current that might arise from the accidental short-circuiting of a section, as A^2, through the return B, I employ an arrangement of switch indicated at No. 3, and consisting of a switch-lever N′, of any desired kind, whose back contact-stop T′ serves to complete the branch from the conductor C to the section A^2, that is normally closed and that serves to convey sufficient current to enable the switch to be operated whenever a motor enters on the section. Normally, as indicated, the circuit from C is through the coarse wire or coil R^2 on the electro-magnet that operates the switch N′, and thence through the switch N′ and the contact-stop T′. The retractor of the switch N′ is so adjusted that if the circuit be closed through the electric motor only the amount of current flowing will be insufficient to operate the switch and open the circuit at T′. If, however, a bar of conducting material or any other short-circuiting device be applied to the section A^2, so as to complete the circuit of low resistance between the same and the return-conductor B, sufficient current will then flow through the coil R^2 to overcome the retractor of the switch N′, and thus open the circuit of the coil applied to the electro-magnet in such way as to draw the switch up. The second coil S^2 upon the core is in a circuit of comparatively high resistance from C to A^2, and the current flowing in said coil

when the short circuit is made between A^2 and B will be sufficient to hold the switch against the influence of its retractor and to thus keep the branch of low resistance through T′ broken. As will be seen, the switch, in fact, operates to substitute for the low-resistance branch a high-resistance branch, consisting, essentially, of the fine wire S^2, and thus prevents leakage so long as the short-circuiting conductor is applied to the section A or return B. Upon the removal of the short-circuit conductor the switch-retractor returns the parts to the normal position.

The devices Nos. 2 and 3 are designed to be used in combination, and are illustrated and described here separately only for the sake of simplicity. At No. 1 I have shown the manner in which they may be combined. It will be sufficient to describe the circuits in detail to make clear the manner in which they act individually to perform the desired operations. When no motor is on the section A, the retractors for the two switches N N′ hold them against their back stops, so that the circuit through the switch N and the front stop T therefor is broken, while the circuit through the back stop T′ for the switch N′ will be closed. The connection then is to the vacuum-bulb Q, thence to the high-resistance wire S upon the magnet-core M, thence to the switch-lever N′, through the back contact T′ therefor, and to the section of feed-conductor A. There is also, as will be seen, a connection from the switch-lever N′, through the high-resistance coil S^2 of magnet M′, to the section A; but the current or circuit through such coil is obviously normally short-circuited at the contact T′. When the motor enters upon the section A, the current that passes between the electrodes *b b′* and through the coil S operates upon the switch N and closes the circuit at T, thereby establishing the branch of low resistance, by which current is supplied in sufficient amount to operate the motor. This branch is from the conductor through switch N and contact T′ and coarse-wire coil R, thence to coarse-wire coil R^2, switch-lever N′, contact T′, and to section A. The magnet M′ might be also made to act on the switch N and to assist in the above operation. When the motor leaves the section, the parts resume their normal position, as has been before described. In the above operation the switch N′ remains at rest, because with the resistance of the motor in the circuit between the section A and the return B, current does not pass in sufficient amount to overcome the retractor of said switch. If, however, at any time a short circuit is formed from A to B, the switch N is operated in the same way as when the motor passes upon the section, thus establishing a circuit through the coils R and R^2, as before described. Owing to the low resistance, current passes, however, through the coils R R^2 in sufficient amount to operate the switch-lever N′ and break the circuit at T′. The current now, being obliged to pass from R^2 through the fine-wire coil S^2 on electro-magnet M′, energizes the cores M′ and M sufficiently to hold the switch N′ away from its back stop T′. The coil S^2 being of high resistance, it, together with the coils R R^2, included in series with it, make up a comparatively high resistance included in the branch from C to A, and thus prevent the great escape of current from section A to the return B. On removal of the short connection the parts will resume their normal condition.

I have shown the magnet M as arranged to act upon the lever N′; but this is obviously not necessary, and I might depend entirely upon the electro-magnet M′ for the purpose of actuating the switch N′ upon the formation of a short circuit from A to B.

In Fig. 2 I have shown an arrangement whereby the switch may be operated to close the branch of low resistance from C to the various sections by means of current supplied on a conductor independent of C and leading from the same source G or from an independent source G′. Such supplemental conductor is indicated at *g*, and it is connected by branches *g′* g^2 g^3 through coils of high resistance S upon suitable electro-magnets for operating switch H, and thence through back contact-stops T′ for said switches with the various sections A A′, &c. In this arrangement the conductors C and *g* have a common return B, and the connection for the high-resistance coils to the return B is completed through the same parts—to wit, sections A A′—through which the supply-current for operating the motors flows from the conductor C. Independent circuits and connections might, however, be used for this purpose. The coils S are of sufficiently high resistance to prevent any considerable escape of current from the conductor *g*, and, if desired, the same end might be still better attained by the interposition in the branches of the vacuum-globes described in connection with Fig. 1.

The switches H are operated by means of the current which is permitted to flow across from the conductor *g* to the return B upon the entrance of a motor upon any section of track. When so operated, they close the circuit in obvious manner through a low-resistance coil R, analogous to that already described, and to front contact T, the switch-lever H, and the section A A, &c., the current in said coarse-wire coil serving to hold the switch in proper position while the motor is on any particular section. The switches and arrangements of contacts shown are merely typical of such devices. It would of course be preferable to use sliding or friction contacts in practice and to arrange them in such way that circuit be established at T before circuit is broken at T′. Such an arrangement is indicated in Fig. 4. The branches from conductor *g* being completed through the back contact of the switch H, it is obvious that so long as a motor is on a section there can be

no escape of current from the conductor *g* to the return B, inasmuch as the branch will remain open while the current is being supplied from the supply-main C to the motor.

At Nos. 3 and 4, Fig. 2, I have shown an automatic blocking arrangement, whereby the presence of an electric motor upon any section will prevent current from flowing to a motor that may in the meantime enter upon an adjoining section, as a section at the rear. Such a device consists of an electro-magnet L of any desired kind, whose coils are in a circuit of high resistance between a section, as A^3, and an adjoining section, as A^2, and at which latter the magnet is located, and the return-conductor B. The circuit may be made of high resistance by making the coils of the electro-magnet L of very fine wire. The electro-magnet L operates upon an electric switch W, the contacts of which are indicated at T^2, which switch is in the circuit, including the coil S, that operates the switch for completing a connection to the section A^2 from the supply-main C, as clearly shown. The switch W consists of an ordinary armature-lever having its back contact-stops connected into the circuit from the conductor *g* through the fine-wire coil S, back contact-stop T′, switch-lever H, and to supply-section A^2. When a motor, as D, is upon the section A^3, the current supplied from the main C divides through said motor and through the electro-magnet L. The resistance in the circuit L is sufficiently high to prevent any undue diversion of current from the motor. The electro-magnet L is thereby operated so as to move the switch W and break the circuit of the coil S, so that if a motor now enters upon the section A^2 the switch H cannot be operated, owing to the break at the points T^2, and no current can therefore be supplied to such motor from the line C.

In Fig. 3 is shown the device by means of which the spark which occurs when the motor leaves a section may be prevented. To accomplish this, it is obviously necessary to establish the circuit between the main C and the section upon which the motor is about to enter before such motor leaves the preceding section. For this purpose I employ a short section of conductor P, from which a connection is taken to the return-conductor B through a coil of wire *d*, which constitutes the coil of an electro-magnet serving to actuate the switch, by which connection is completed between the supply-main C and the next section A′. The coil *d* is a high-resistance coil, and is preferably applied to the core of the electro-magnet upon which is applied the coil in the connection containing the vacuum-bulb Q; or, in other words, it is applied to the core of the switch-magnet. When a motor passes from section A to section A′ it will for an instant span the break between the section A and the sub-section P. At this time the coil *d* becomes a shunt of high resistance to the motor-circuit, and a part of the current passing from A to B will pass through the said coil *d*, so as to energize the magnet M and operate the switch that serves to complete the branch of low resistance, as indicated, from the supply-main C to the section A′. Thus a motor on leaving section A does not break its connection with the conductor C until a circuit to the section A′ is made, and a spark is thus prevented. It is obvious that the sub-section P might be arranged in different ways to complete the circuit from the section A to B when the motor passes over. I do not limit myself in this respect, and other devices might be employed for forming the desired connection without departing from the spirit of my invention.

I do not limit myself to the particular forms or constructions of switch that I have shown, those illustrated being merely typical of switch devices, whereby the connections described may be effected. The form of the electro-magnet may also, obviously, be varied without departing from the spirit of the invention. The vacuum-bulb Q is only one of a number of devices that might be employed for the purpose described. This will be obvious when it is considered that the essential characteristic of the same in the connection set forth is the utilization of a thin layer of non-conducting material or other medium interposed between two conducting-surfaces or electrodes of proper thickness to ordinarily prevent the passage of current from one electrode to the other, but upon the establishment of a sufficiently high potential to permit current to break across the space, so as to operate the devices in the circuit connected to said electrodes.

What I claim as my invention is—

1. The combination, in an electric-railway system, with a section of feed-conductor and an electro-magnet in a branch between said section and a line-conductor, of a block electro-magnet in a circuit of high resistance connected to an adjoining section.

2. The combination, in an electric-railway system, of a supply-main well insulated, a feed-conductor divided into sections having normally-open low-resistance connections to the supply-main, electro-magnets for completing said low-resistance connections, and a block-magnet controlling the circuit of said switch-magnets.

3. The combination, in an electric-railway system, with a section of feed-conductor, of an electric switch for connecting the same to a supply-main, an electro-magnet for actuating the switch, and a block electro-magnet controlling the circuit of said switch-magnet, as and for the purpose described.

4. The combination, in an electric-railway system, of electro magnets and switches for establishing a connection between sections of feed-conductor and a well-insulated supply-main, said electro-magnets being in branches or circuits in which are included two or more conducting plates, surfaces, or electrodes sepa-

rated from one another by a thin layer of an insulating medium or substance, across which current may force its way on the establishment of a connection by the entrance of a motor upon the section of track.

5. In an electric-railway system, the combination of switch electro-magnets for establishing the connection of the several sections with a supply-source and vacuum-bulbs containing separated electrodes in the circuit of the switch-magnets, as and for the purpose described.

6. The combination, in an electric-railway system, of a supply-main, branches of low resistance normally open and connected to the sections of conductor from which current is fed to the motors, and electro-magnetic switches having coils in circuits or branches of high resistance between the feed-sections and the supply-main, said switches serving to close the low-resistance branches when a motor enters upon the section.

7. The combination, with the section of supply-conductor normally disconnected from or out of operative electrical connection with the supply main, of the electro-magnetic switches having coils normally connected to the several sections in branches of high resistance from said supply-main, said switches controlling the circuits, whereby the sections of conductor may be connected to the supply-main, as and for the purpose described.

8. The combination, with the sections of conductor A′ A^2 A^3, each extending substantially the whole length of a feed-section for the electric railway, of switch electro-magnets in normally-connected branches of high resistance leading from a supply-conductor to said sections of conductor A′ A^2 A^3 and switches controlled by said magnets for severally making a low-resistance connection between the insulated supply-conductor and the several sections of conductor from which current is fed to the motors.

9. In an electric-railway system, the combination, with a line-supply conductor, of electro-magnetic coils in normally-open low-resistance branches from said conductor, as described, for keeping the same closed while the motor is on a section until the circuit is broken to the return-conductor by the motors leaving a section, and switch-magnet coils in branches of high resistance leading direct from the same line-conductor to the sections of feed-conductors A A′, &c.

Signed at Hartford, in the county of Hartford and State of Connecticut, this 24th day of March, A. D. 1885.

MERLE J. WIGHTMAN.

Witnesses:
H. M. LINNELL,
CHAS. E. DUSTIN.