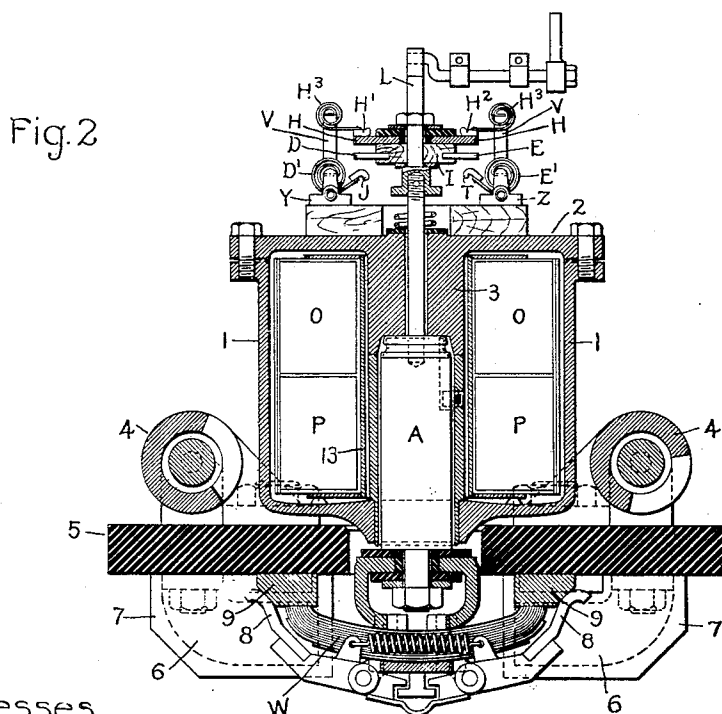
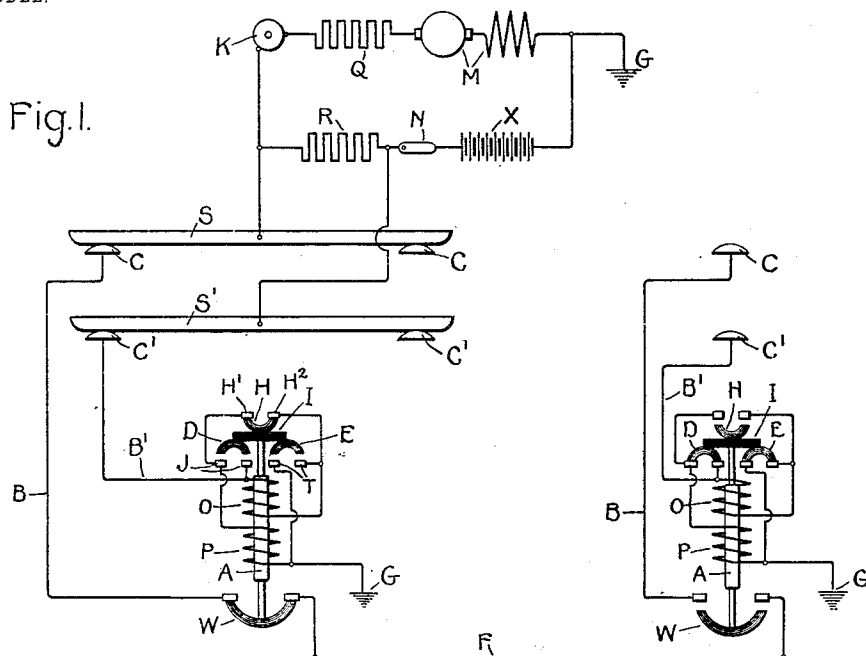


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ELECTROMAGNETIC SWITCH FOR ELECTRIC RAILWAYS.

APPLICATION FILED MAY 1, 1901.

NO MODEL.



Witnesses.

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UNITED STATES PATENT OFFICE.

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ELECTROMAGNETIC SWITCH FOR ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 735,170, dated August 4, 1903.

Application filed May 1, 1901. Serial No. 58,247. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL B. STEWART, Jr., a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electromagnetic Switches for Electric Railways, of which the following is a specification.

This invention relates to a novel electromagnetically-actuated electric switch, with especial reference to use for sectional-conductor railway systems; and the invention relates also to a novel combination of elements, including the new electromagnets, in such a railway.

The invention consists in a novel means which operates in connection with the magnet whereby the magnetization can be maintained and the switch held in the position to which it has been moved by the magnet with a less current than that required to effectively energize the magnet with a maximum air-gap.

The invention consists, further, in a novel combination, with the above, of the circuits and auxiliary devices of a sectional-conductor railway whereby the auxiliary source for initially energizing the magnets may be of low potential with respect to the line voltage, but may be also properly protected from the higher-potential line-current.

It is well known that it requires less current-flow through a magnet-coil to hold its armature closed than is required to initially move the armature from its open position, and the idea has been suggested of inserting a resistance in series with the magnet-coil after the magnet has drawn up its armature or core for the purpose of reducing the current. I have conceived the idea of dispensing with the use of such dead resistance by dividing the energizing-coil into two separate portions which are normally connected in parallel when the magnet is not energized. In other words, there is in reality a plurality of separate coils for each magnet, although in general two coils would be found sufficient for the purpose. A suitable switching device is arranged to normally connect the two coils in parallel and when the magnet is energized to be actuated thereby to connect the coils in series with each other. By this means sub-

stantially the same result is accomplished as by connecting dead resistance in series with a single magnet-coil without the necessity of employing separate and wasteful resistance. It is clear that in the parallel connection of two coils the total flow of current or the total energy will be four times and the magnetomotive force twice that in the series connection. Conversely, in the series position the total flow of current or the total energy will be one-quarter and the magnetomotive force one-half that in the parallel position. However, this reduction is not so great but that the armature or core and the electric switch actuated thereby will be held in the position to which they have been moved.

An electromagnetic switch of the above-described nature is well adapted for use as an element in sectional-conductor railway systems. I have conceived the idea of employing it in combination with the system disclosed in the patent to Crehore, No. 536,828, and have found that when employed with said system in the manner hereinafter set forth it coöperates therewith to produce a new and useful improvement on such system, inasmuch as it provides a means for reducing the current flowing through the switch-magnets after the magnets have closed their respective switches, as well as permits the use of a lower-potential auxiliary source of current for initially energizing the switch-magnet. As described in the patent referred to, the electromagnets which close the switch connect the conductor-sections with the main or feeder when energized by current flowing in shunt to the car-motors. A resistance is interposed in such shunts for the purpose of limiting the flow of current in the magnet-coils, and an auxiliary source of current (a secondary battery in the example shown) is connected in series with the resistance and in a branch or shunt around the magnet-coil, whereby the resistance also serves to protect the battery from the full-line current flowing in the motor-circuit when the feeder-switch is closed by the magnet. The resistance also serves a useful purpose in charging the battery from the motor-circuit. With this arrangement it is clear that the same amount of current will flow through the magnet-coils

after they have closed their feeder-switches as before; but an important result is obtained in that a low-potential battery could be employed, since it was directly connected with the magnet-coils and not through the resistance. The ability to use a low-potential battery or other auxiliary source is important in systems of this nature, because the number of cells and the consequent attention and expense are materially reduced.

While I do not claim to be the first to provide means for automatically reducing the flow of current through the magnet-coil which actuates an electric switch, as this has been done in other ways than by the connection of the double coils in parallel and series, I believe that I am the first to conceive the idea of providing an automatic means for reducing the current-flow through the magnet, in combination with a resistance and an auxiliary source in shunt to the car-motors, between which resistance and auxiliary source the lead to the magnet is connected. The resistance in this case serves, as before, to protect the auxiliary source from the line-current and for charging a battery when a battery is used as the auxiliary source, and the resistance serves, furthermore, to prevent an absolute short circuit around the car-motors at the instant of transition as the magnet-coils for each switch pass from their parallel to their series connection. This resistance should be so proportioned as to properly discharge its functions as described without involving a serious loss of energy. In fact, the resistance should be designed with great care, because if it is higher than the resistance of either coil a greater amount of energy will be used in the series connection of the coils to hold the switch closed than is used in their parallel connection to close the switch. After the switch is thus closed the magnet-coils are in series, and thus sufficient resistance to reduce the current to the desired degree is included in their circuit, which is the equivalent of the dead resistance which it was necessary to use in the simple Crehore system not provided with an automatic means for reducing the flow of current through the switch-magnet.

Of the drawings, Figure 1 is a diagrammatic illustration of the circuits and apparatus; and Fig. 2 is a vertical section, partly in elevation, of one of the feeder-switches which is electromagnetically equipped in accordance with the invention.

The service conductor-sections from which current is supplied to the car-motors M by the collector-shoe S are shown in Fig. 1 as surface-contact studs C. The conductor-sections to which current is supplied by the collector-shoe S' are shown as studs C'. The studs C are adapted to be connected with the feeder or main F by the gravity-switches W, and the studs C' are permanently connected through the electromagnets which raise and close the switches W to the return, as to ground at G. The car-motors (typified at M)

are also connected with the return, as to the ground at G, which may be the track-rail or any other suitable return, and the supply of current thereto is regulated by the controller K, which may be of any suitable well-known construction, such as a series-parallel controller, and shown herein in combination with a regulating resistance Q. The shoe S', which engages with the auxiliary conductor sections or studs C', is connected in shunt around the car-motors through a resistance R. In series with this resistance and in a branch around the shoe S, and consequently around the switch-magnets, which are supplied with current through the shoe S', is connected an auxiliary source of current, such as the storage battery X, which may be connected to the ground connection of the motors or to any other suitable return. A switch N is interposed between the battery and the resistance R.

Each electromagnet which controls one of the feeder-switches W is provided with a plurality of energizing-coils, preferably two, (shown at O and P,) which coils are connected with the studs C' by the conductors B' and to the return at G. When the switch W is maintained by gravity in its open position, as shown at the right in Fig. 1, the coils O and P are connected in parallel by the switch-pieces D and E, carried by the insulating-support I. When the magnet is energized, as shown at the left in Fig. 1, either by the battery X or from the line, the switch W is closed and the parallel connection of the coils O and P is broken, because the switch-pieces D and E, the insulating-support I of which is carried by the magnet-core A, and the switch-piece H, also carried by the insulating-support I, are raised to connect the coils in series, whereby the flow of current through them is reduced to twenty-five per cent. of that flowing through them in their parallel connection. In the switches W (shown in Fig. 1) the core A must have considerable momentum in order to open the switches D and E and close the switch H; but a device will be hereinafter described with respect to Fig. 2 by which less momentum is requisite. Assuming that each coil has a resistance of fifty ohms, that there is no exterior resistance in series with them, and that there is a potential difference between the studs C' and the return of five hundred volts, then when the coils are connected in parallel, as shown at the right in Fig. 1, a current of ten amperes will flow through each coil, the total flow of current through the magnet being twenty amperes. If each coil is composed of two hundred turns, the magnet will therefore have four thousand ampere-turns when the coils are connected in parallel. Therefore when the coils are energized the switch W will be instantly closed with considerable energy and the coils will be connected in series by the switching device described above. With the coils in series there will be a flow

of five amperes, and the magnet will have two thousand ampere-turns. Thus the switch W will be held closed by one-half the magnetomotive force and one-quarter of the energy which was required to close it when the coils were in parallel. Furthermore, it will be possible to close the switch with the same force with a potential supplied by the auxiliary source of considerably less than five hundred volts.

Assuming that the switch N has just been closed to complete the circuit through the battery and the coils O and P of the left-hand switch W, the switch W has been closed by the battery-current and the coils O and P have been connected in series, current will flow through the switch W and the branch B to the stud C, the shoe S, and the controller K. Some of the current will be shunted through the resistance R, shoe S', and stud C' to the series coils of the magnet to hold the switch closed. The resistance R is sufficient to prevent injury to the battery X before the switch N can be opened, and consequently this switch can be left closed a sufficient length of time to charge the battery, when it may be opened until it is again desired to pick up a switch when the car is at rest. Current may now be admitted to the car-motors by the operation of the controller K, and the car may proceed in either direction, according to the position of the reversing-switch of the controller.

In the position shown the shoes S and S' are in engagement with the center studs C and C' as well as the left-hand stud C and C'. These center studs are connected to the switch and its coils in a manner similar to those at the left and the right, and the switch for these center studs in the position of the shoes shown will be closed, as is the left-hand switch. Assuming that the car travels to the right, the shoe S will engage the right-hand stud C in position to receive the current therefrom. The right-hand switch W will be closed by the engagement of the shoe S' with the right-hand stud C', and the switch-coils O and P will be connected in series to hold the switch closed. The resistance R is proportioned so that a considerable current is supplied to the coils O and P when the shoe S' engages the right-hand stud C', whereby the switch can be quickly closed. The resistance R has another function, which will be mentioned in connection with Fig. 2.

In Fig. 2 is shown a novel electromagnetic switch of which no features will be claimed herein except those which form a part of the present invention, the other features being covered in a separate application, filed May 20, 1902, Serial No. 108,283. In general this switch comprises an insulating-base 5, upon which is mounted a magnetic casing 1, which is provided with a cover 2, which has a portion 3 extending as a stationary core into a non-magnetic spool 13, on which are wound two energizing-coils O and P. The magnet-

core A carries a switch or contact brush W, which engages with contacts 9, secured to the base 5. The core A carries also auxiliary contacts 8, which are so mounted that they leave the contacts 9 after the brush W leaves said contacts, and thereby form the customary secondary break which protects the brush W from injury due to arcing. Blow-out magnets 4 are mounted on the base 5 and are adapted to be connected in series with the contacts 9. The pole-pieces 6 of the magnets extend below the casing adjacent to the contacts 9, and insulating-chutes 7 are provided for the pole-pieces. The core A carries at its upper end a rod L, on which is mounted an insulating-support I. This support carries on opposite sides two contacts D and E, and on its upper part an annular switch-piece H, suitably insulated from the rod L. On suitable supports Y at the left are mounted two spiral springs D', one behind the other, so that only one appears in the drawings, and each of these springs carries at its end a carbon contact J, the carbon contacts being also located one behind the other, so that only one appears in the drawings, and being bridged by the switch-piece D and are the same parts as those similarly lettered in Fig. 1. Mounted on suitable supports Z at the right are two spiral springs E', mounted one behind the other, so that only one appears in the drawings, each of which springs carries at its end a carbon contact T, the two contacts being also located one behind the other, so that only one appears in the drawings, and being bridged by the switch-piece E, said parts being the same as those similarly lettered in Fig. 1. On independent supports V are mounted at the left and right two spiral springs H³, carrying at their ends carbon contacts H' and H², which are bridged by the annular switch-piece H, said parts being the same as those similarly lettered in Fig. 1. In Fig. 2 the switch is closed, the brush W being in engagement with the contacts 9 and the magnet-coils O and P being energized and being connected in series through the annular switch-piece H, which bridges the contacts H' and H². When the switch W is open and the two contacts J (only one of which is shown) are bridged by the contact D and the two contacts T (only one of which is shown) are bridged by the switch-piece E, the coils O and P will be connected in parallel. When they are energized in their parallel positions, the core A will be raised and the contacts D and E and H with it. The springs D' and E', which carry contacts J and T, and the springs H³, which carry the contacts H' and H², are so arranged that the contacts J and T will follow up the switch-pieces D and E until the switch-piece H bridges the contacts H' and H². As will be clear by reference to Fig. 1, there would then be an instantaneous short circuit around the car-motors but for the resistance R, which is permanently connected between the motor-circuit

and the magnet-coils. The core A, however, will have sufficient momentum by the impulse given it by the energization of the coils O and P in parallel to carry the switch-pieces D and E off from the contacts J and T, thus leaving the switch-piece H bridging the contacts H' and H² and connecting the coils in series. The spiral springs serve to reduce to a minimum the distance through which the core A must be carried by momentum while no current is flowing through the magnet-coils.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination with an electric switch which it is desired to move and to maintain for a time in the position to which it has been moved, of an electromagnetic apparatus for this purpose, a plurality of energizing-coils for said apparatus, and a switching device controlled by the movable member of said apparatus, which device normally connects said coils in parallel, and when the switch is moved by the apparatus to the desired position, connects the coils in series to maintain the switch in the desired position with less current.

2. In an electric railway, the combination with the feeder, of conductor-sections, electromagnetic switches for connecting said sections with the feeder, a plurality of energizing-coils for each switch-magnet, and a switching device controlled by the movable magnet member, which device normally connects said coils in parallel, and when the switch is closed, connects the coils in series to hold the switch closed with less current.

3. In an electric railway, the combination with the feeder, of service conductor-sections, electromagnetic switches connecting said sections with the feeder, auxiliary conductor-sections connected with the coils of the switch-magnets, means for automatically reducing the flow of current through the magnet-coils after they have actuated their respective switches, an auxiliary source of current connected to the magnet-coils in shunt to the car-motors, and a resistance connected between the service conductor-sections and the auxiliary conductor-sections, whereby an auxiliary source can be used of lower potential than that of the line.

4. In an electric railway, the combination with the feeder, of service conductor-sections, electromagnetic feeder-switches for connecting said sections with the feeder, a plurality of energizing-coils for each switch-magnet, auxiliary conductor-sections connected to

said coils, and a switching device controlled by each magnet, which device normally connects the coils of its magnet in parallel, and when the feeder-switch actuated by that magnet is closed, connects the coils in series to hold the feeder-switch closed with less current.

5. In an electric railway, the combination with the feeder, of service conductor-sections, electromagnetic feeder-switches for connecting said sections with the feeder, a plurality of energizing-coils for each switch-magnet, auxiliary conductor-sections connected with said coils, a switching device for each feeder-switch, which device normally connects the magnet-coils of said switch in parallel, and when the feeder-switch is closed, short-circuits the coils and then connects them in series, an auxiliary source of current connected to the magnet-coils in shunt to the car-motors, and a resistance connected across between the service conductor-sections and the auxiliary conductor-sections.

6. The combination with an electric switch, of an electromagnet therefor provided with a plurality of energizing-coils, a corresponding number of switches which normally connect their respective coils in parallel, and which are opened when the magnet is energized; and a switch which when the magnet is energized closes a circuit which connects the coils in series.

7. The combination with an electromagnet provided with a plurality of energizing-coils, of a corresponding number of switches which normally connect their respective coils in parallel, a switch which normally keeps open a series circuit through the coils, and spring contacts for all of said switches, whereby the coils will continuously receive current except at the instant when all the switches are closed.

8. The combination with an electric switch, of an electromagnet therefor which has its energizing-circuit subdivided, the divided portions being normally connected in parallel when no current is flowing, in combination with means controlled by the magnet, whereby the divided portions of the energizing-coils are connected in series when the magnet is energized.

In witness whereof I have hereunto set my hand this 29th day of April, 1901.

SAMUEL B. STEWART, JR.

Witnesses:

BENJAMIN B. HULL,
FRED RUSS.