(No Model.)

3 Sheets—Sheet 1.

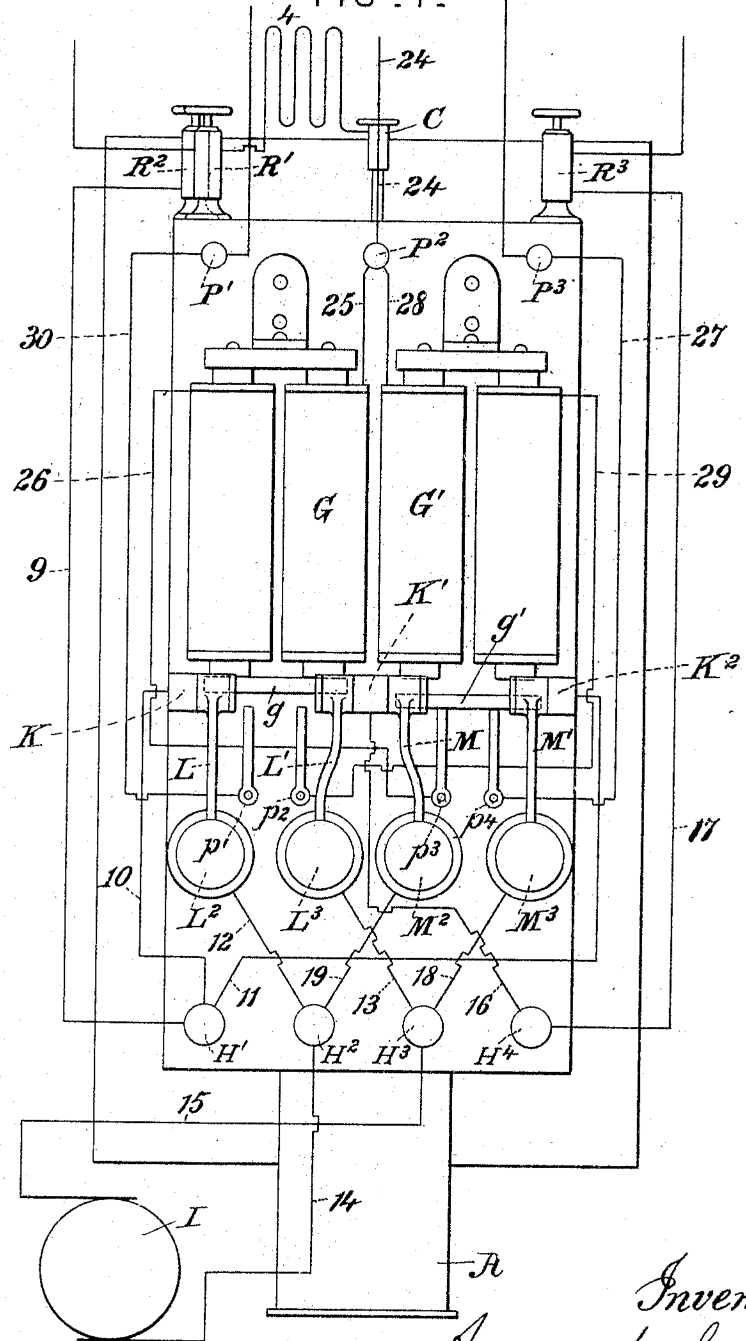
A. M. COYLE.

AUTOMATIC ELECTRIC SWITCH.

No. 492,786.

Patented Mar. 7, 1893.

FIG. 1.



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his attorneys

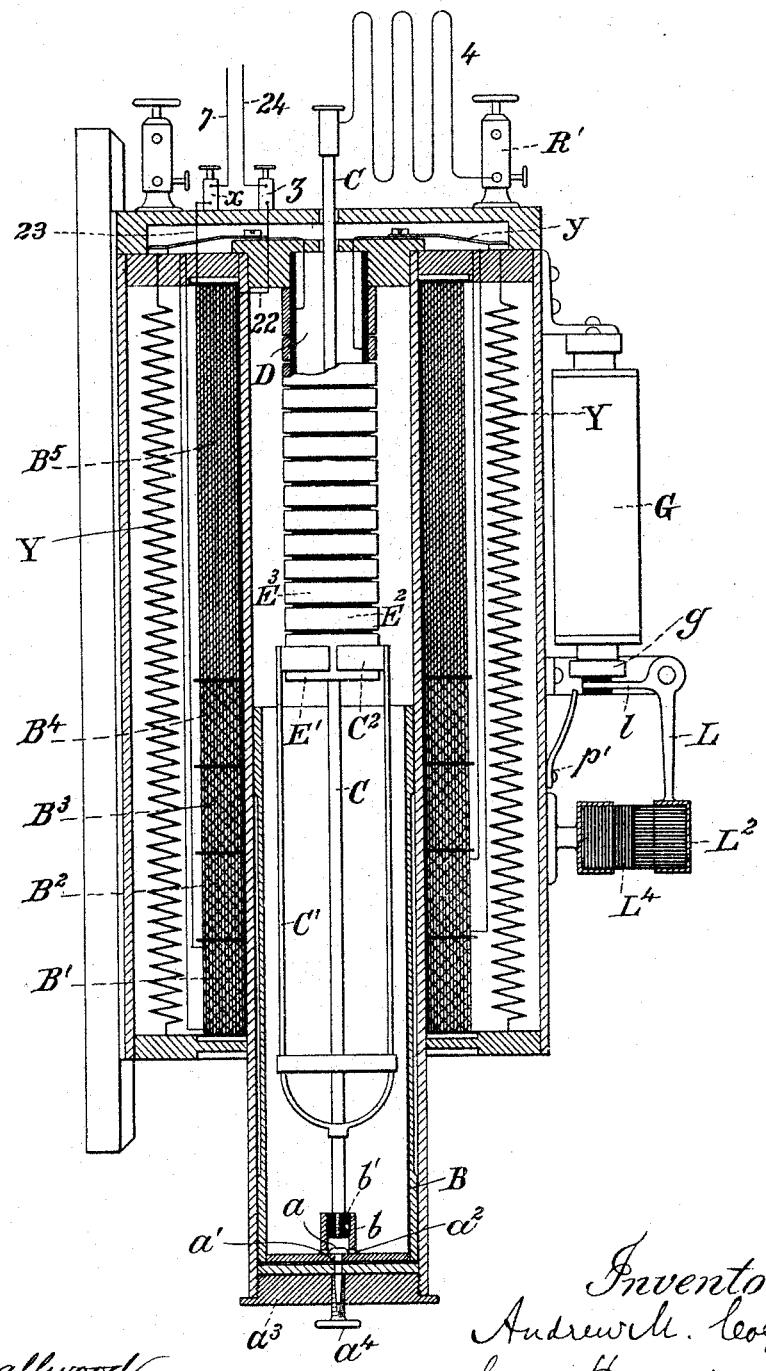
(No Model.) 3 Sheets—Sheet 2.

A. M. COYLE.

AUTOMATIC ELECTRIC SWITCH.

No. 492,786. Patented Mar. 7, 1893.

FIG. 2.



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(No Model.) 3 Sheets—Sheet 3.

A. M. COYLE.

AUTOMATIC ELECTRIC SWITCH.

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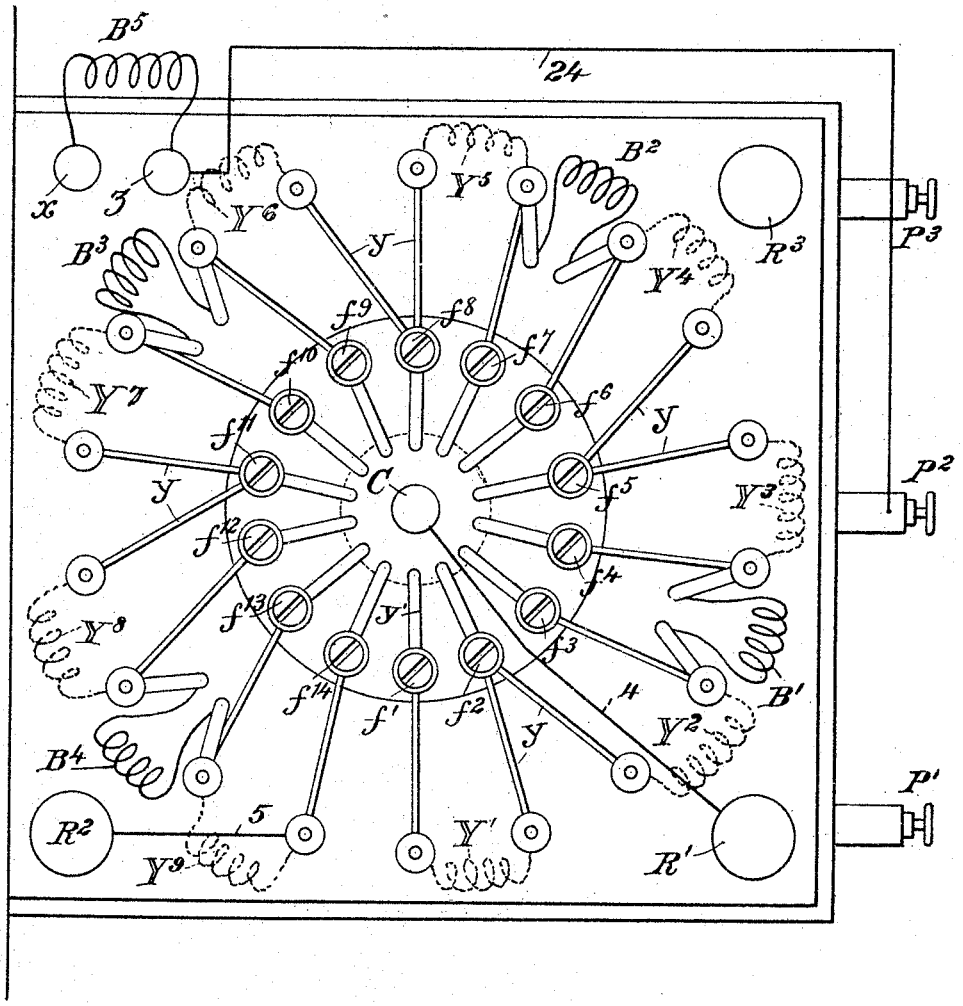
FIG. 3.



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UNITED STATES PATENT OFFICE.

ANDREW M. COYLE, OF BALTIMORE, MARYLAND, ASSIGNOR TO THE STANDARD SCREW ELEVATOR MANUFACTURING COMPANY, OF SAME PLACE.

AUTOMATIC ELECTRIC SWITCH.

SPECIFICATION forming part of Letters Patent No. 492,786, dated March 7, 1893.

Application filed February 18, 1892. Serial No. 422,027. (No model.)

To all whom it may concern:

Be it known that I, ANDREW M. COYLE, of Baltimore, Maryland, have invented a new and useful Improvement in Automatic Electric Switches, which improvement is fully set forth in the following specification.

This invention has reference to the construction of electric switches, designed particularly for controlling the current to electro motors, so as to start, stop and reverse the same; though it is applicable wholly or in part to other uses.

The general object of the invention is to provide a convenient and efficient apparatus for cutting out successively a series of resistances, included in the main circuit when there is no current thereon, so that when the circuit is closed to start the motor, the current is at first relatively feeble, when the armature begins to rotate, and is gradually increased in force by the successive removal of the resistances, as the armature shaft gains momentum. Apparatus for the same general purpose have heretofore been devised, and, as is well understood, they are employed to prevent damage to the motor by throwing the full strength of current into the armature coils when the motor is at rest.

According to the present invention the switching in and out of the resistances is effected by the movement of the soft iron core or plunger of a solenoid, said core carrying a contact spring or brush which is adapted to travel over a series of fixed contact plates, the resistances being severally connected with these plates in such manner that they are cut out *seriatim* as the movable spring or brush passes from one contact plate to the next. The solenoid has a series of coils, those which first attract the core being included in the main circuit when the solenoid is quiescent, but being successively cut out by the motion of the core itself. Thus, the lowermost coil (if the core is arranged to be drawn upwardly by the attraction of the solenoid, otherwise the top coil) is, after the core has moved a certain distance, automatically cut out and so on for each of the main circuit coils. By this arrangement the center of magnetic density is constantly shifted upward (or downward as the case may be) as the core advances, and consequently the latter can be given a much longer movement than could be obtained with an ordinary solenoid of equal length. Another advantage gained by this arrangement is that a portion of the winding of the solenoid is utilized as a resistance.

The core or plunger is provided with a pneumatic check, comprising a valve which closes an orifice in the lower end of the plunger when the latter moves under the pull of the magnet, and opens so as to oppose no resistance to the plunger when it is returning to its normal position.

The invention as thus far described is susceptible of use with any suitable form of hand or automatic switch, which can be turned to send the current through the motor in either direction, or to cut the latter off altogether; but the invention as a whole includes a special arrangement of electro-magnetic devices for automatically opening and closing the circuit. This part of the invention comprises two electro-magnets in parallel branches of a secondary circuit, which circuit includes one of the coils of the solenoid, so that as long as the circuit of either switch-magnet remains closed the core of the solenoid will be held in that position which cuts the rheostat entirely out of circuit. The armature of each magnet, moreover, controls contacts in the circuit of the other magnet, so that in reversing the motor the main circuit must be entirely broken and the core allowed to resume its normal position (switching in all the resistances) before a current can be sent through the motor in the opposite direction.

In the accompanying drawings which form part of this specification, Figure 1 is a front elevation of an apparatus constructed in accordance with my invention. Fig. 2 is a vertical section thereof, and Fig. 3 is a top view, partly diagrammatic showing the electric circuits.

A represents a tube of brass or other non-magnetic metal. Around it are five coils B' B^2 B^3 B^4 and B^5, the last being of fine wire and the others of coarse wire.

B represents a soft iron core or plunger working within the tube A. Core B is hollow and is closed at its lower end.

C represents a rod running down through the core B and attached to the thimble or socket b at the bottom thereof, being however, electrically insulated by the bushing b'. Thimble b incloses a small valve a covering the aperture a' in the end of core B. It also has small lateral apertures a^2 which establish a communication between the aperture a' and the interior of the core. The cap a^3 closing the brass tube A has a central perforation, in which is a split regulating screw a^4. The object of this construction is to prevent the plunger or core B from rising abruptly when the current is turned on, the only entrance for air being through the contracted passage containing screw a^4. When the core descends, however, valve a opens, permitting air in the tube to pass freely into the core, so that the air does not retard the descent of the plunger.

D represents a tube of hard rubber or other insulating material extending partway down through tube A. To the outside of tube D is attached a series of brass rings E', E^2 E^3 &c. The rod C has a metal loop C' carrying at its upper end semi-circular spring contacts or brushes C^2, adapted to slide over and make electrical connection successively with the rings E' E^2 &c., the object being to cut out one by one the resistances Y, which are included in the circuit when the current is turned on.

The resistance coils Y are shown as arranged in the case or box around the solenoid, and each is connected by a wire y with one of the ring contacts E' E^2. When there is no current through the apparatus, the circuit beginning at post R' runs by flexible conductor 4 to the rod C, loop C', contacts C^2 and lower ring E'. This ring is connected by a wire y' with binding screw f' (see Fig. 3), each ring E^2 E^3 &c., being connected in like manner with a corresponding binding screw f^2 f^3 &c.

Between screws f' and f^2 is connected one of the resistance coils indicated in Fig. 3 by the dotted line Y', and between f^2 and f^3 a second resistance Y^2; but between f^3 and f^4 is connected the lowermost coil B' of the solenoid. Thence the circuit may be readily followed through resistances Y^3 Y^4, coil B^2 of the solenoid, resistances Y^5 Y^6, coil B^3, resistances Y^7 Y^8, coil B^4 and resistance Y^9, whence the circuit proceeds by wire 5 to binding post R^2, and thence to the motor, as will be presently shown. As the core B rises, and contacts C^2 pass from ring E' to ring E^2, the resistance Y' is cut out, and so on successively the several resistances as well as the coils B' B^2 B^3 B^4, are cut out until all are eliminated. This construction has several important advantages. In the first place, the coils of the solenoid are utilized as resistances in the motor circuit, and by cutting out these coils successively, beginning at the bottom, the stroke or path of movement of the core B may be greatly increased, the effect being practically to raise the active part of the magnetic field as the core rises. The fine wire coil B^5 is not in the main circuit but is connected in a separate branch as will be hereinafter explained. From what precedes, it will be understood that when the main circuit is broken, and the mortor at rest, the plunger or core B is in its lowest position as shown in Fig. 2, and that when the said main circuit is closed the core B rises under the magnetic attraction of the solenoid, successively cutting out the resistances and the solenoid coils B' to B^4 inclusive.

The means for closing the main circuit so as to send the current through the motor in either direction will now be explained. I have already traced the main circuit from post R' through the resistances and coils B' &c., to post R^2. From the post R^2 a wire 9 leads to binding post H' at the lowest part of the box (Fig. 1). There are three other binding posts, H^2 H^3 H^4. The last serves for the return wire, while to the posts H^2 H^3 the wires 14, 15 leading to the brushes of motor I are respectively connected. From post H' a wire 10 leads to the arm K and another wire 11 to the arm K^2. To the arms K K' are pivoted the switch levers L L', these levers being insulated from one another. On the horizontal arms l of the levers is carried the armature g of the switch magnet G. The levers L L' carry at their lower ends caps L^2 L^3 containing each a carbon contact piece, and to the side of the box are attached complementary carbon contacts L^4. The arms or brackets K K' are attached to the side of the inclosing case of the solenoid, and the bell-crank or angular levers L L' are pivoted thereto, as shown in such manner that the levers can tilt in one direction to bring the fixed carbons into contact with the stationary carbons, or in the other direction to break the contact. Normally the weight of the armature is such as to hold the movable contacts away from the fixed contacts. When however, the magnet G is excited, the circuit is closed through these contacts, as shown in Fig. 2. Wire 12 connects the fixed carbon L^4 with post H^2, and wire 13 connects the adjacent contact (corresponding to the movable contact L^3) with post H^3. The magnet G' is provided with arrangements similar to those of magnet G, the switch arms being represented by the letters M M', and the cups by the letters M^2 M^3. The connections of the main circuit can now be traced through the switch mechanism. From post H' it proceeds by wire 10 to arm K, lever L, cup and carbon L^2, fixed carbon L^4, wire 12, post H^2 to the motor by wire 14. Returning by wire 15 it proceeds by the post H^3, wire 13, cup L^3, lever L', arm K', wire 16, post H^4 and wire 17 to post R^3, to which the return wire

of the main circuit is connected. When the circuit of magnet G is open and that of G′ closed, the main circuit is completed from post H′ through the motor by wire 11, arm K^2, switch lever M′ M^3 and wire 18 to the binding post H^3. The direction of the current is now reversed, flowing through the motor by wire 15, and returning by wire 14 to post H^2, thence by wire 19 to switch lever M M^2, arm K′, and wire 16 to the return binding post H^4.

The circuits of magnets G G′ (which contain suitable push buttons or other circuit closers at the points from which the automatic switch is to be controlled) will now be traced. On the top of the case are two posts *x z;* one terminal of the controlling circuit is connected to post *x*. Thence wire 23 (Fig. 2) runs to the fine wire coil B^5 of the solenoid, from which the return wire 22 leads to post *z*. The latter is connected by wire 24 with post P^2 (Fig. 1). Wire 25 leads thence to the coils of magnet G from which wire 26 connects with spring p^3. The companion spring p^4 is connected by wire 27 with post P^3. When the circuit of magnet G′ is open its armature *g′* rests upon and connects the springs p^3 p^4 (as shown in Fig. 1). But when the coils of magnet G′ are excited the circuit of the companion magnet G is broken between the springs p^3 p^4. The circuit of magnet G′ proceeds from the post P^2 (where the circuits of the two magnets branch or divide) by wire 28 to the coils of magnet G′, thence by wire 29 to spring p^2, armature *g* of magnet G, spring *p′* and wire 30 to post P′. Inasmuch as the fine wire coil B^5 of the solenoid is in that part of the secondary or controlling circuit which is common to both magnets G and G′, the core or plunger B will always be sustained in its highest position so long as the secondary circuit is closed through either of the switch magnets.

The operation of the apparatus as a whole will be readily understood. To start the motor the user closes the secondary circuit through magnet G or G′ according to the direction in which it is desired to rotate the armature shaft. The current flows through the fine wire coil B^5 and through the coils say of magnet G, which thereupon attracts its armature, breaking the circuit of magnet G′ at the spring p' p^2, and closing the main circuit through the switch arms L^2 L^3. At this moment all the resistances and the short coils B′—B^4 of the solenoid are in circuit, but as the core B ascends, it cuts these out successively, so that the full strength of the current is turned into the motor by degrees. To reverse the motor, the circuit of magnet G′ must be closed, but this cannot be done abruptly and while the resistances are cut out, for the reason that, it is necessary first to open the circuit of magnet G. Until that is done the circuit of magnet G′ remains open at the springs p^3 p^4. When the circuit of magnet G is broken, coil B^5 of the solenoid is thrown out of circuit and the plunger B descends by gravity, the valve opening so that the air in tube A passes freely through the socket *b*, opposing no resistance to the descent of the plunger.

It will be obvious to skilled electricians that parts of the invention may be used separately and that details of construction and arrangements of parts may be varied without departing from the spirit of the invention.

I claim as my invention and desire to secure by Letters Patent—

1. The combination of an electric circuit, a series of resistances having their terminals connected to fixed contact-plates, a solenoid having a series of independent coils also connected to contact plates, a spring or brush permanently connected in said circuit and carried by the core of said solenoid so as to make contact successively with the terminal plates of said resistances and coils, cutting them out one by one, substantially as described.

2. The combination of an electric circuit, a series of resistances having their terminals connected with fixed contact plates, a solenoid having several independent coils connected in series with said resistances, and having also a coil connected in a separate circuit, and a contact spring or brush carried by the core of said solenoid, and adapted when the core is attracted to make contact successively with said contact plates thereby cutting out said resistances and also the coils of the solenoid connected therewith, substantially as described.

3. The combination of an electric circuit, an electro-motor therein, a series of resistances, a solenoid whose core when attracted thereby, cuts out said resistances, a pair of switch magnets in separate branches of a secondary circuit, including one coil of said solenoid, and switch-levers, one controlled by each of said magnets, for making, breaking or reversing the connections of said motor with the main circuit, substantially as described.

4. The combination of the main electric circuit, an electro motor adapted for connection therein, a series of resistances, a solenoid for switching out said resistances *seriatim* when the circuit is closed through said motor, a pair of switch magnets in separate branches of a secondary circuit, switches controlled by said magnets for making, breaking and reversing the connections of said motor with the main circuit, the circuit of each magnet having contacts which are broken when the armature of the companion magnet is attracted, substantially as and for the purpose set forth.

5. The combination with an electric circuit and with switch mechanism for opening and closing the same, of a solenoid having several independent coils, a core carrying a spring contact or brush connected in said cir-

cuit, a series of resistance coils including one or more of the solenoid coils, and terminal plates with which said resistances are connected, said plates being arranged in the path of the spring contact or brush carried by the core, whereby the resistances are switched in and out of circuit, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ANDREW M. COYLE.

Witnesses:
PHILIP MAURO,
JONATHAN CILLEY.