(No Model.) 2 Sheets—Sheet 1.

A. B. HERRICK.

RHEOSTAT.

No. 504,160. Patented Aug. 29, 1893.

FIG. 1.

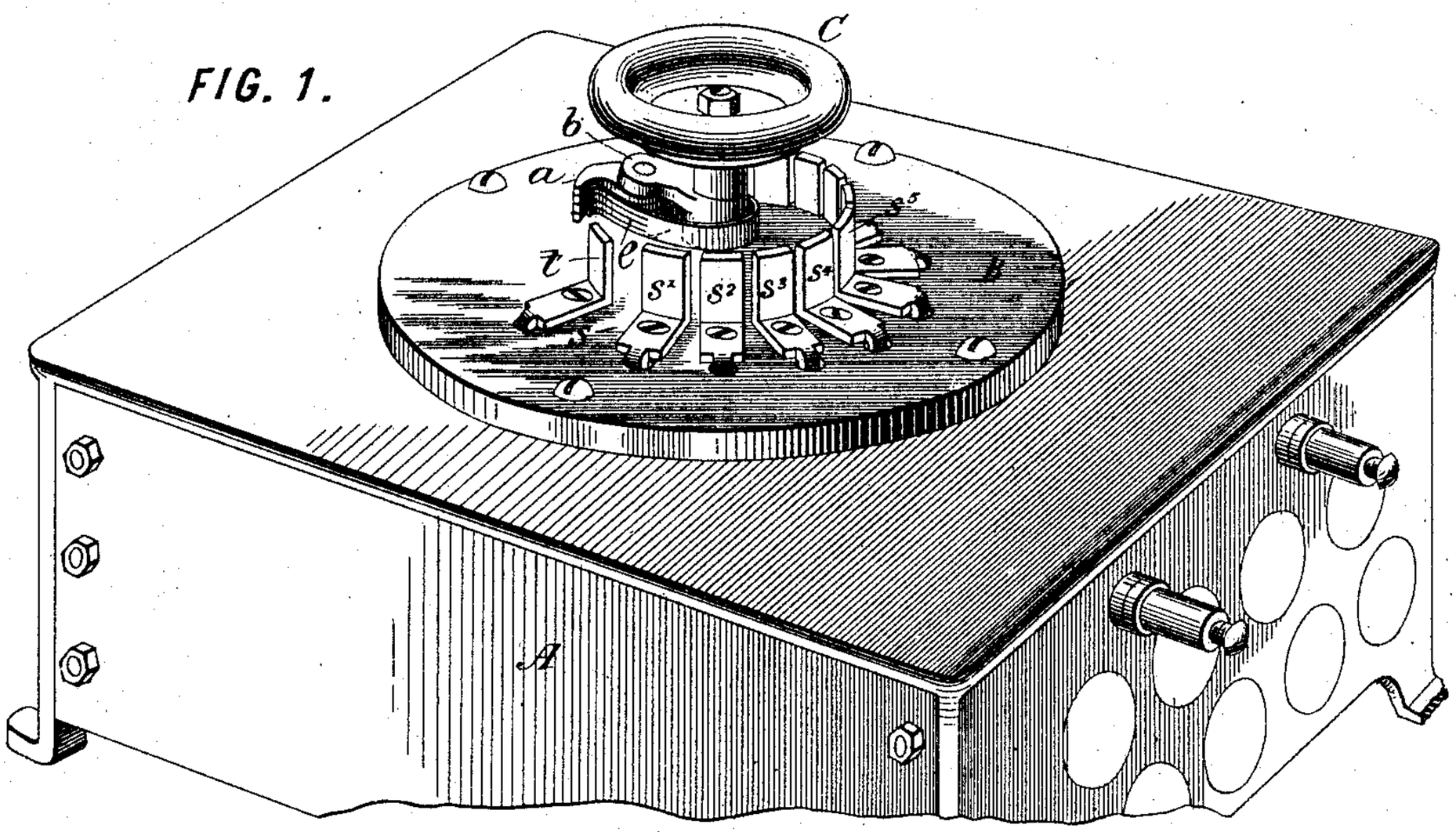
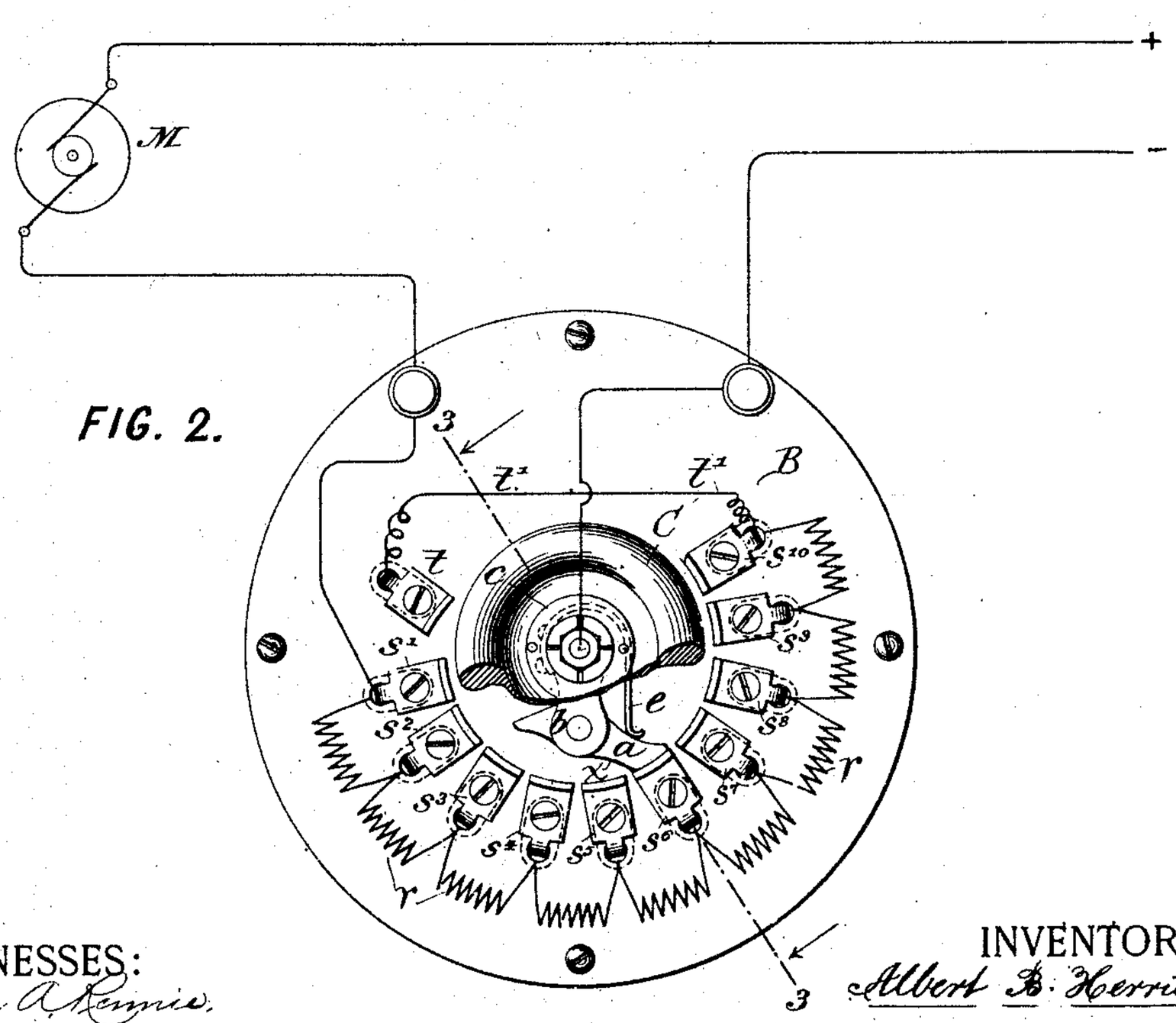


FIG. 2.



WITNESSES:
John A. Kennie.
Fred Whitty

INVENTOR:
Albert B. Herrick,
By his Attorneys,
Arthur G. Brazer & Co.

(No Model.) 2 Sheets—Sheet 2.

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No. 504,160. Patented Aug. 29, 1893.

FIG. 3.

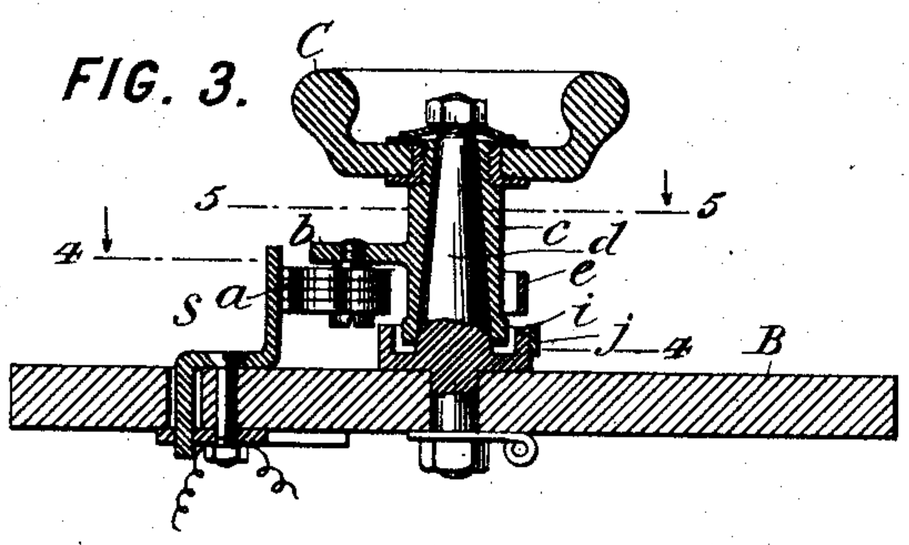


FIG. 4.

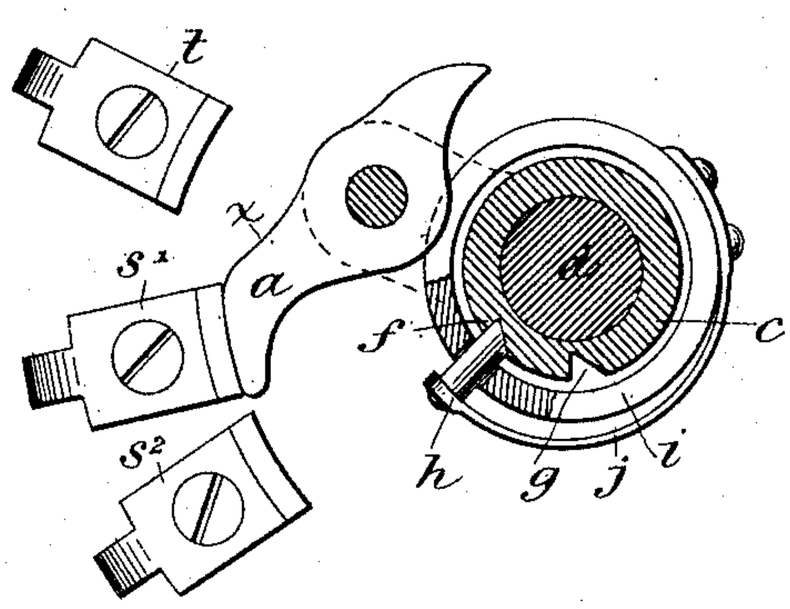


FIG. 5.

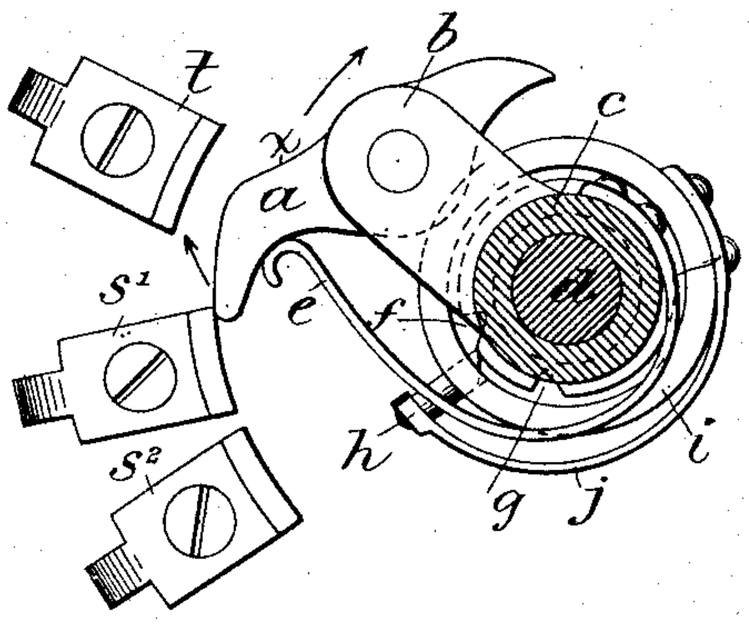


FIG. 6.

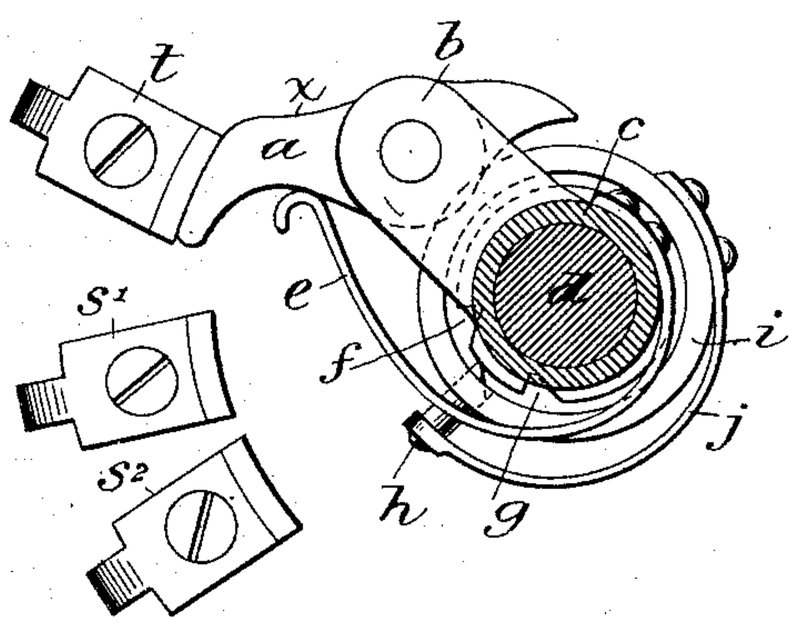


FIG. 7.

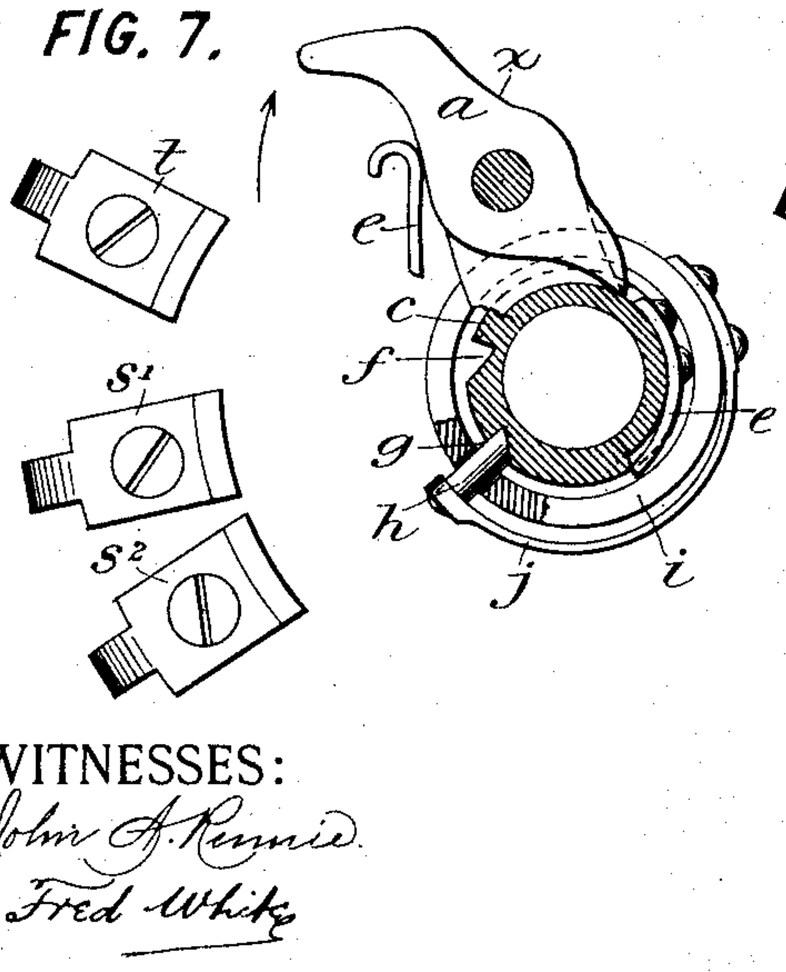
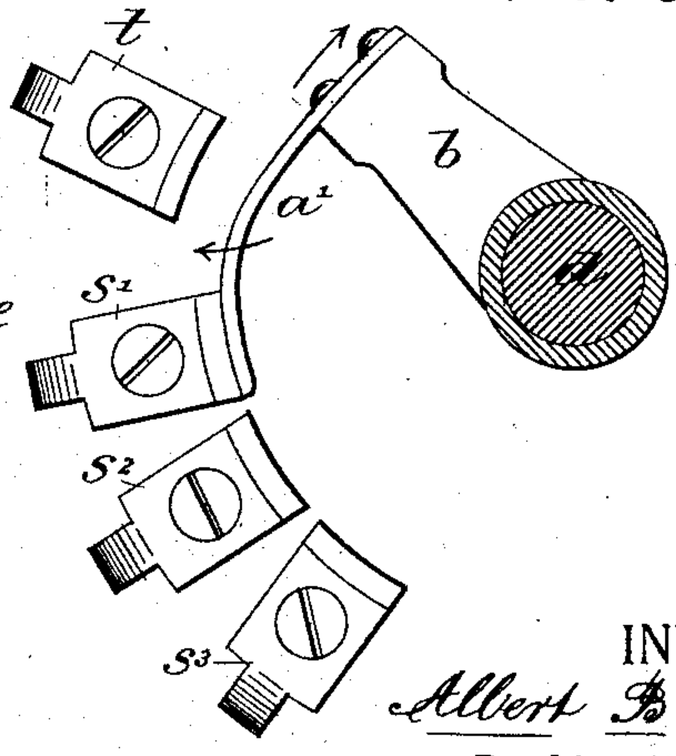


FIG. 8.



WITNESSES:
John A. Rennie.
Fred White

INVENTOR:
Albert B. Herrick,
By his Attorneys,
Arthur G. Fraser & Co

UNITED STATES PATENT OFFICE.

ALBERT B. HERRICK, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, OF BOSTON, MASSACHUSETTS.

RHEOSTAT.

SPECIFICATION forming part of Letters Patent No. 504,160, dated August 29, 1893.

Application filed July 22, 1892. Serial No. 440,897. (No model.)

To all whom it may concern:

Be it known that I, ALBERT B. HERRICK, a citizen of the United States, residing at Schenectady, in the county of Schenectady and State of New York, have invented certain new and useful Improvements in Resistance-Switches for Electro-Motors, &c., of which the following is a specification.

This invention provides an improved construction of resistance switch designed especially for controlling the starting and stopping of electro-motors, but applicable also to other uses.

My improved starting box switch is designed to overcome the difficulties heretofore experienced by reason of arcing across the contact segments when moving the switch to interpose higher resistance.

It is well known that motors starting from a state of rest receive ordinarily too great a current by reason of the absence of counter electro-motive force, to compensate for which it is necessary to interpose sufficient resistance to reduce the current to the proper volume, the resistance being diminished as the speed of the motor increases, until when the motor has attained its full speed and is consequently generating its full counter electro-motive force, the resistance is wholly cut out. To accomplish this result, a series of resistances is employed connected through interposed contact segments arranged to be touched successively by a contact arm or brush which is moved by the operator. In starting the motor, the arm is first brought against the first segment so that all resistance is in series with the motor, and as the speed of the latter increases the arm is moved successively from one segment to the next, a portion of the resistance being cut out by each movement, until when the motor reaches full speed the arm is on the final segment, whereby the resistance is wholly or nearly short-circuited. With the ordinary construction of switch it is necessary in order to stop the motor to cause the contact arm to move backward over the series of segments, so that at each segment it throws serially into circuit with the motor an additional resistance until the terminal segment of highest resistance is reached, past which the arm may be moved to break the circuit and stop the motor. The movements of the switch in direction to reduce the resistances are unaccompanied by sparking or arcing, since the arm moves from a segment of lower to one of higher potential. But the opposite movements of the arm to introduce increasing resistances are accompanied by arcing between the segments upon the breaking of contact with the respective segments by the contact arm because the arm passes from higher to lower potentials. This arcing is injurious to the segments and contact arm, as is well known. My invention obviates the arcing due to this cause by such construction of the switch that the backward movement of the arm for increasing the resistance is unnecessary. I so construct the switch that the arm moves always in one direction. In starting it passes onto a terminal contact segment of highest resistance, and is moved thence over the successive segments of the series during the operation of starting the motor, until when the latter has attained full speed the arm rests upon the terminal segment of lowest resistance, on which it remains while the motor is running. To stop the motor the arm is given a further movement in the same direction, so that it is carried beyond and out of contact with this latter terminal segment to break the circuit. Instead, however, of breaking the circuit immediately, the current is first reduced by throwing in the highest resistance, or any suitably high resistance, and immediately afterward the circuit is broken. To accomplish this, I provide a supplemental contact segment beyond the terminal segment of lowest resistance, the supplemental segment being connected through a high resistance, preferably by being joined to the terminal segment of highest resistance in the series. To avoid arcing, when the contact arm is moved from the terminal segment of lowest resistance to the supplemental segment, the contact arm is provided with a spring for pressing it against the segments, and the supplemental segment is placed sufficiently far from the adjacent terminal segment to cause the arm to snap or fly from the one to the other, its movement being so quick that an arc following it is drawn out or attenuated, and upon the arm

striking the supplemental segment is extinguished. The same construction of the arm serves to extinguish the arc upon the final movement by which the circuit is broken.

Figure 1 of the accompanying drawings is a perspective view of a motor starting box provided with a switch constructed according to my invention in its preferred form. Fig. 2 is a plan of the switch, the circuit connections being shown in diagram. Fig. 3 is a vertical transverse section of the switch cut in the plane of the line 3—3 in Fig. 2. Figs. 4, 5, 6 and 7 are fragmentary plan views partly in horizontal section showing different successive positions of the contact arm. Fig. 8 shows a modification.

Referring to Fig. 1, let A designate the resistance box, the construction of which is immaterial to my invention, and B designate the switch as a whole.

The switch B is constructed with a series of contact segments *s s*, with resistance coils *r r* connected between them. These segments are arranged in circular manner, and are swept by a movable contact arm *a*, which is carried by a suitable carrier, conveniently constructed as an arm *b* projecting from a spindle *c* which is turned by a suitable handle C. In the construction shown, the spindle *c* is made as a tubular sleeve and turns on a fixed post *d*, but this is not necessary, as any other construction may be substituted. The arm *a* is pressed outwardly by a spring *e*. To insure better contact, the arm *a* is subdivided, being made up of a series of independent fingers, and the spring *e* is likewise subdivided into separate tongues which press independently against the respective fingers or subdivisions of the arm.

In the construction shown, the contact segments *s s* are constructed with upturned ends arranged in juxtaposition so as to constitute an intermittent cylindrical flange, and the contact arm *a* is mounted to press radially outward against the upturned ends of the segments. Other constructions and relative arrangements of the segments and contact arm may, however, be substituted, it being only necessary that the segments shall be arranged successively in a circular series, and that the contact arm shall press against them so as to afford a good electrical contact.

The contact segments *s s* constitute a resistance series as in any ordinary resistance box. Ten segments are shown in the drawings with nine interposed resistances *r*, but other numbers may be used instead, depending upon the degree of subdivision that is desired. To distinguish them, the segments are numbered respectively from s' to s^{10}. The segment s' is connected directly with the motor or its armature M, so that when the contact arm is touching this segment, all the resistances *r* are short-circuited. This segment s' is consequently the segment of lowest resistance, while the opposite terminal segment s^{10} is the segment of highest resistance.

In addition to the series of segments s' to s^{10}, I provide a supplemental contact segment lettered *t*. This segment is arranged just beyond the terminal segment s' and is slightly removed therefrom, or arranged slightly farther from the center as shown. This supplemental segment *t* is connected to the motor or its armature through a suitably high resistance, preferably through the maximum resistance of the series. This result is most conveniently effected by connecting it with the high resistance terminal s^{10}, which is done as shown in Fig. 2, by a wire t'. Between the supplemental segment *t* and the initial terminal segment s^{10} of the resistance series, is a wide space which I will call an open-circuiting space.

The operation is as follows:—Before starting, the contact arm stands in the open-circuiting space. In order to start the motor, the handle is turned to the right so as to bring this arm into contact with the terminal segment s^{10}, thereby interposing the maximum resistance in series with the motor. As the motor acquires speed, the handle is further turned to the right, causing the contact arm to touch successively the segments s^9 s^8, &c., of successively lower resistance, thereby cutting out the resistance step by step, until when the motor has acquired full speed the contact arm is brought onto the terminal segment s' of minimum resistance, thereby cutting out all resistance except that of the conductors and the motor itself. The switch will remain in this position while the motor is running. To stop the motor, the switch handle is turned further to the right, so that the contact arm passes beyond the terminal segment s' and makes momentary contact with the supplemental segment *t*, thereby introducing the maximum resistance into series with the motor, and consequently greatly reducing the current. This movement from a segment of high potential to one of much lower potential is accompanied by a spark, or in case of a circuit of high voltage by an arc, but by reason of the location of the segment *t*, and the construction of the contact arm with a spring as described, the arm on breaking contact with the terminal segment s' flies or snaps quickly across and outward to the segment *t*, in the manner illustrated in Fig. 5, so that by this quick movement the arc is attenuated and extinguished. Immediately thereafter, by the continued movement of the handle C, the arm is carried across and past the segment *t*, and upon breaking of the contact therewith is caused to again fly outwardly under the impulse of this spring, so that by a second snap action, as indicated in Fig. 7, the circuit is finally broken. This movement leaves the contact arm in the open-circuiting space in the position shown in Fig. 7, where it remains until the switch is further moved in the same direction for starting the motor again. In the course of this further movement, the contact arm encounters

the initial terminal segment s^{10}, by moving against which it is pressed inwardly to recommence its travel around the contact faces of the resistance segments. To enable the arm to be thus pressed in by the initial segment, it is constructed with a gently beveled or inclined advancing face x.

It will be seen that by my improved construction of switch there is no occasion for moving the contact arm backward or in direction from a segment of lower to one of higher resistance, such as would cause sparking or arcing between the segments. The only movements where such arcing is likely to occur, namely, upon parting contact with the segments s' and t, are accompanied by a snap action of the arm such as instantly extinguishes any arc that might form.

I will more fully explain the purpose of the introduction in my improved rheostat of the supplemental contact t and its resistance. It is well known that upon breaking the circuit of an electro-motor while in operation or being driven by the magneto inductive effect of an electric current, the self-induction of the armature generates momentarily an extremely high electro-motive force which is liable to cause a discharge short-circuiting the coils of the armature, and thereby burning out or injuring the motor. In ordinary resistance boxes this result is avoided by gradually interposing resistance and thereby cutting down the current circulating in the armature-coils, the maximum resistance being thus introduced before the circuit is broken, so that upon the breaking of the circuit the motor is receiving much less current than when under load, and consequently its self-induction is so reduced that at the instant of breaking the inductive discharge has so low an electro-motive force as to be well within the capacity of the insulation of the armature. This introduction of resistance is effected by sweeping the contact arm of the rheostat backward over the segments to the same effect as though the contact arm of my rheostat were turned back so as to sweep over the segments in the contrary direction, and finally break contact with the segment s^{10} of highest resistance or lowest potential. But this backward movement is attended by the disadvantage that in passing from each segment to the next, an arc tends to follow the arm, thereby damaging the switch. My invention avoids this latter result by moving the contact arm always forward and never backward, and consequently by breaking the circuit from the segment s' of lowest or no resistance, while to prevent the injuring of the electro-motor by reason of the self-inductive discharge, I provide that the operation of breaking the circuit shall first momentarily introduce the maximum resistance, or any suitable high resistance by reason of the contact of the arm with the supplemental segment t, so that the current traversing the motor shall be very materially reduced. The contact arm in snapping from the segment s' draws an arc after it which is attenuated by the rapid snap action of the arm in flying to the segment t, so that the resistance of the arc thus drawn out becomes so high that upon the arm reaching the segment t, the arc is instantly extinguished by the closing of the circuit through the resistance connected with this segment, the difference of potentials between the segments s' and t being insufficient to maintain the arc when the latter has been thus attenuated by the snap action of the arm. The armature necessarily remains in contact with the segment t for a moment while it is being moved over it, and during this time the current traversing the motor is so reduced that its self-inductive capacity is cut down to a point where upon the final breaking of the circuit the electro-motive force due to the self-induction shall not be sufficient to damage the motor. The potential is also so reduced that at the final snap action there is much less tendency to draw an arc, and the arc which follows the arm is quickly extinguished by the rapid snap action thereof.

This invention introduces a new principle in rheostats or resistance switches for controlling electro-motors, in that the breaking of the circuit although effected from the segment of highest potential and without any backward sweep of the arm to introduce successive resistances, is made to momentarily introduce a sufficiently high resistance before the final breaking of the circuit, as to so reduce the self-induction that no harm can result when the final break occurs.

In order during the operation of starting the motor to prevent the contact arm being accidentally carried too far so as to move it beyond the position of full contact with the final segment s', I provide a latch device adapted to arrest the contact arm when it reaches this segment and hold it there securely during the normal running of the motor. I also provide a similar latch device for holding the contact arm in place when turned to the open-circuiting space to stop the motor, in order that it may not be accidentally displaced while the motor is at rest. Various constructions of more or less positively acting snaps or catches might be provided for accomplishing this purpose. The construction that I have adopted for this purpose is shown in Figs. 4, 6 and 7. The base of the spindle c is formed with two notches f and g in different angular positions. A bolt or catch piece h is arranged to move through a hole in a stationary collar i, and adapted to enter either of these notches, being pressed inward to engage therewith by a spring j. When the contact arm is brought into contact with segment s', the first notch f comes into coincidence with the end of the bolt h, which snaps into this notch, as shown in Fig. 4, and consequently holds the spindle and arm immovably in place with a strength dependent upon the depth and steepness of the notch and the

tension of the spring *i*. The catch device should engage with sufficient firmness to prevent any possible accidental turning, and to require the exercise of some strength to turn the handle further. Upon strength being thus applied to continue the rotation of the handle, the advancing movement of the rotary spindle expels the bolt *h*, which remains retracted, as shown in Fig. 6, until the contact arm reaches the open-circuiting position shown in Fig. 7, in which position the second notch *g* comes into coincidence with the bolt, and the latter snaps into place, so that the spindle is again held firmly in position until strength is applied to forcibly turn the handle again to the right.

It will be observed that the notches *f g* are angular constituting in effect ratchet notches, the bolt *h* being also angular and constituting in effect a pawl. Hence when either of these notches is engaged by the bolt, the contact of their abrupt sides prevents the switch spindle being turned backward. The switch is designed never to be turned in any but a forward direction, and turning it backward would result in some degree of sparking or arcing while traversing the contacts *s'* to s^{10}, or might result in mechanical injury if turned backward from the open-circuiting position shown in Fig. 7. The construction of the notches with abrupt sides prevents the possibility of such injury by preventing the turning of the switch backward from either of the two positions in which it is designed to be left standing. In case in either of these positions the operator were to attempt to turn it in the wrong direction, his effort would simply result in unscrewing the handle C from the spindle *c*, since the handle is united to the spindle by a right-hand screwthread.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. A resistance switch for an electro motor comprising contact segments with interposed resistances, and a contact arm traversing said segments, relatively arranged and constructed to progressively decrease the resistance by a movement in one direction, and by a further movement in the same direction to first suddenly introduce a high resistance and afterward break the circuit.

2. A resistance-switch for cutting out an electro-motor, &c., consisting of a conducting segment and arm constituting circuit-breaking contacts, combined with a segment connected through a high resistance, arranged to be touched momentarily by the arm in its circuit-breaking movement, whereby to momentarily cut down the current before finally breaking the circuit, and thereby to reduce the self-inductive discharge from the motor.

3. A resistance-switch for an electro-motor comprising contact segments with interposed resistances, connected to one circuit terminal and a contact arm connected to the opposite circuit terminal traversing said segments, relatively arranged and constructed to slide when moving from segments of relatively lower to those of higher potential, and to snap when moving from a segment of higher to one of relatively lower potential.

4. A resistance-switch comprising a series of contact-segments with interposed resistances, graduated from a maximum resistance at one terminal segment to a minimum resistance at the opposite terminal, a supplemental segment beyond the latter terminal, connected to interpose a high resistance, and an open-circuiting space beyond this supplemental segment, combined with a spring-pressed contact-arm constructed to sweep over the segments in direction from that of maximum resistance to that of minimum resistance, so that the interposed resistance is progressively diminished, to move past the latter to the supplemental segment, and to sweep beyond this segment by a snap action to avoid arcing in breaking the circuit.

5. A resistance-switch comprising a circularly-arranged series of contact segments with interposed resistances, graduated from a maximum resistance at the initial terminal of the series to a minimum resistance at the final terminal, a supplemental segment beyond the lateral terminal, connected to interpose a high resistance, and an open-circuiting space between said supplemental segment and the initial terminal, combined with a contact-arm movable over the series of segments in a rotative direction from the initial to the final terminal, from the latter to said supplemental segment, and from that across the open-circuiting space to the initial terminal again.

6. A resistance-switch comprising a circularly-arranged series of contact segments with interposed resistances, graduated from a maximum resistance at the initial terminal of the series to a minimum resistance at the final terminal, and an open-circuiting space between the terminals, combined with a contact-arm movable over the series of segments in a rotative direction from the initial to the final terminal, and from the latter across the open-circuiting space to the initial terminal again, and constructed to part contact with the final terminal segment by a snap action to avoid arcing, and a spring catch, constructed with engaging inclines adapted to hold the contact-arm in position when in contact with said final terminal, and yieldingly resist its further movement to break the circuit.

7. A resistance-switch comprising a circularly-arranged series of contact segments with interposed resistances, graduated from a maximum resistance at the initial terminal of the series to a minimum resistance at the final terminal, and an open-circuiting space between the terminals, combined with a contact-arm movable over the series of segments in a rotative direction from the initial to the final terminal, and from the latter across the open-circuiting space to the initial terminal again, and constructed to part contact with the final

terminal segment by a snap action to avoid arcing, and a spring catch, constructed with engaging inclines adapted to hold the contact-arm in position when standing in said open-circuiting space, and yieldingly resist its further movement to said initial terminal to close the circuit.

8. A resistance-switch comprising a circularly-arranged series of contact segments with interposed resistances, graduated from a maximum resistance at the initial terminal of the series to a minimum resistance at the final terminal, a supplemental segment beyond the latter terminal, connected to interpose a high resistance, and an open-circuiting space between said supplemental segment and the initial terminal, combined with a contact-arm movable over the series of segments in a rotative direction from the initial to the final terminal, from the latter to said supplemental segment, and from that across the open-circuiting space to the initial terminal again, and a spring catch-device adapted to hold the contact-arm when in contact with said final terminal, and again when it reaches said open-circuiting space, to resist its further movement.

9. A resistance-switch comprising a series of contact-segments with interposed resistances, a supplemental segment of high resistance beyond the terminal segment of lowest resistance, and an open-circuiting space between said supplemental segment and the terminal segment of highest resistance, combined with a contact-arm adapted to move over the segments in one direction, a spindle carrying said arm, and a catch-device consisting of a spring bolt pressing toward said spindle, and notches in the spindle coinciding with said bolt when the arm is on the segment of lowest resistance and in the open-circuiting space.

10. A resistance-switch comprising a series of circularly-arranged contact-segments and an open-circuiting space, combined with a contact-device consisting of a rotative carrier and a contact-arm carried thereby and pressing against said segments, said arm formed to touch the segments in the rear of its connection with the carrier, so as to trail over the segments, and having an inclined advancing side, whereby when it flies out into said open-circuiting space, and is again moved against the series of segments the initial segment serves to press it back and bring it again into engagement with the contact faces of the segments.

11. A resistance switch comprising a series of contact segments with interposed resistances and an open-circuiting space, combined with a contact arm adapted to move over the segments rotatively in forward direction, a spindle carrying said arm, an operating handle fixed to said spindle and a ratchet catch device for preventing the backward rotation of the spindle consisting of a spring pawl engaging abrupt notches.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

ALBERT B. HERRICK.

Witnesses:
HENRY F. MARX,
ALBERT F. GANZ.