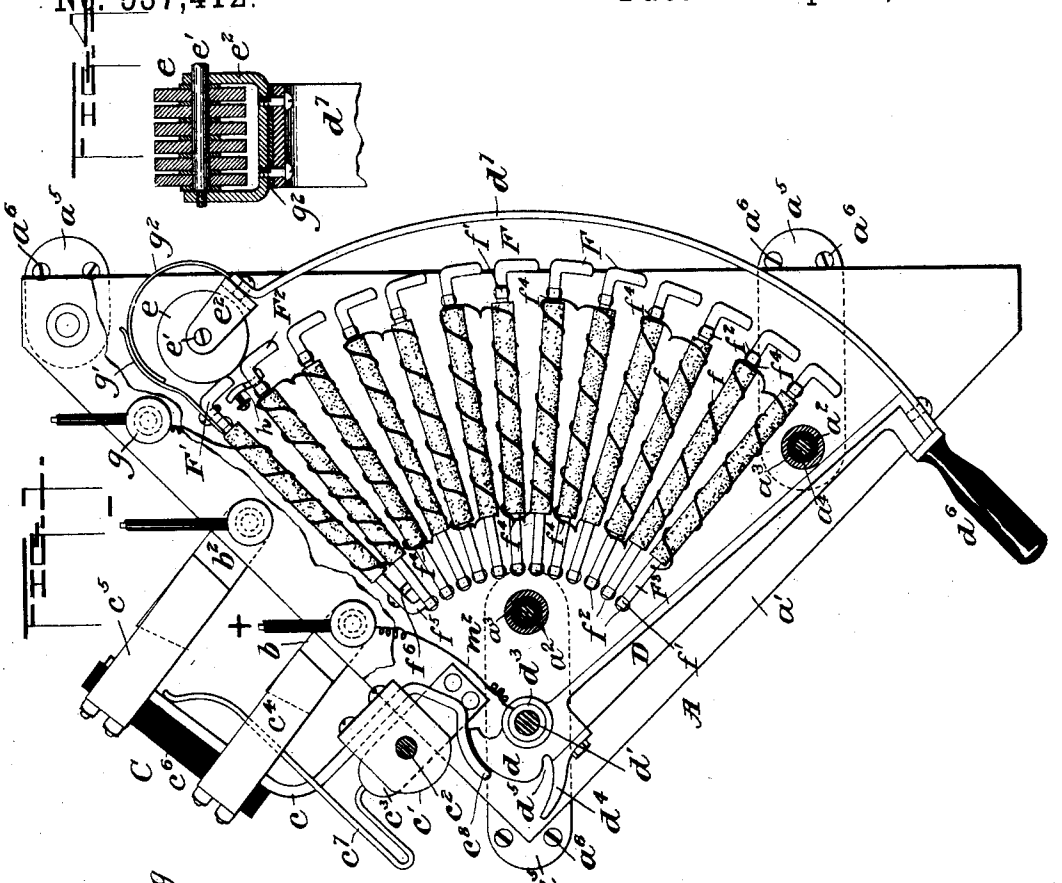
(No Model.)

3 Sheets—Sheet 1.

J. C. FYFE.

RHEOSTAT.

No. 537,412. Patented Apr. 9, 1895.



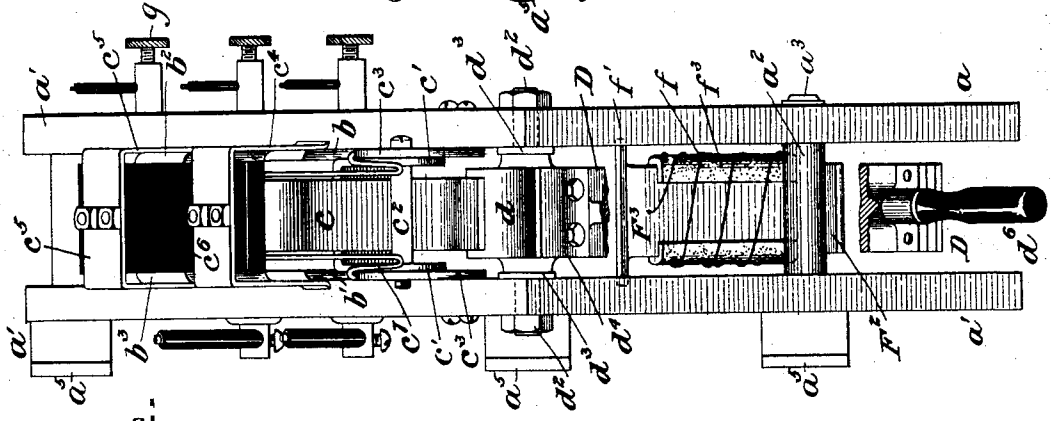


FIG. 2.

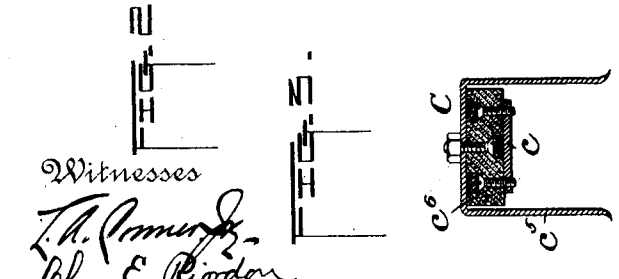


FIG. 3.

Witnesses

T. A. Connolly

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(No Model.)

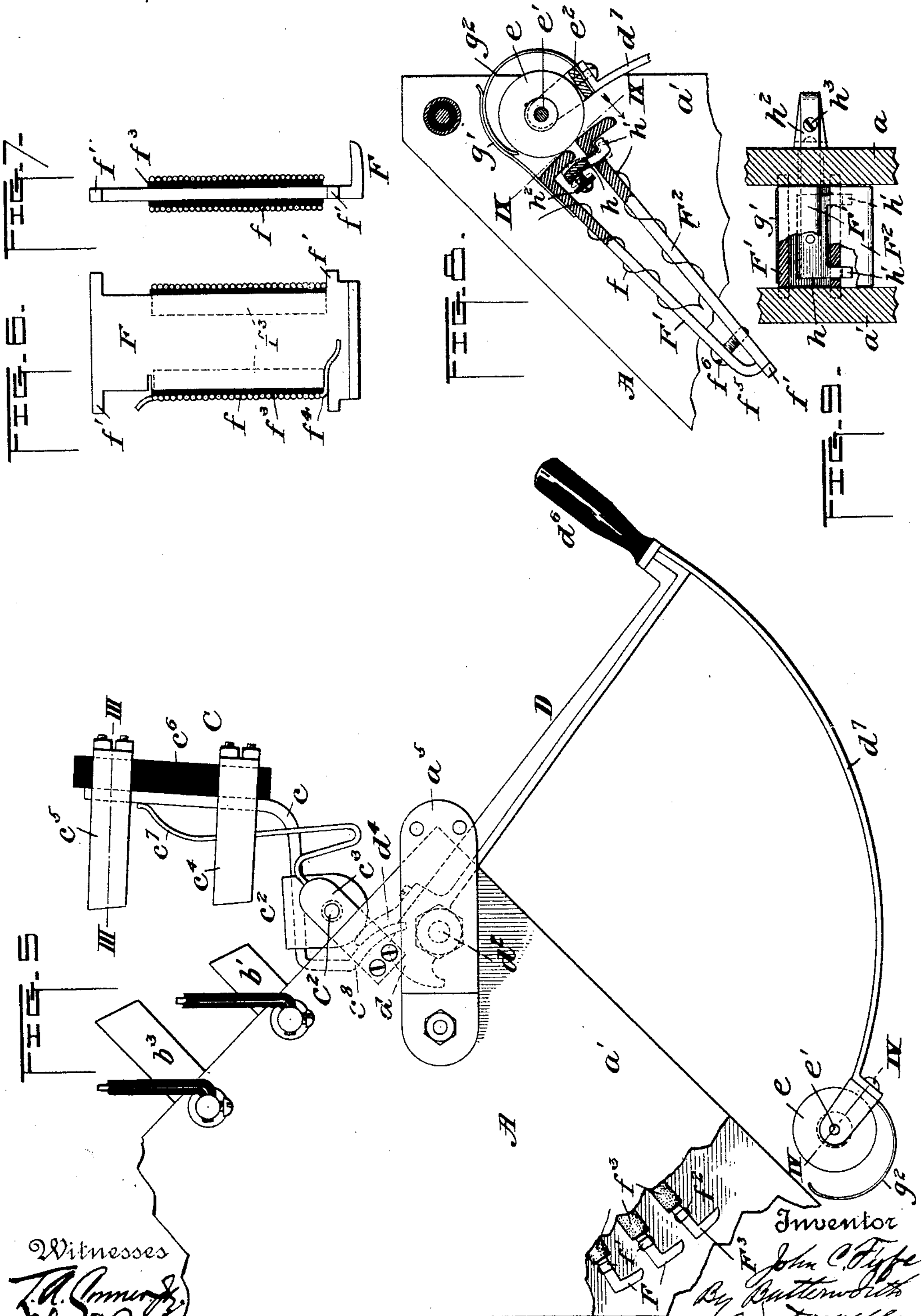
3 Sheets—Sheet 2.

J. C. FYFE.

RHEOSTAT.

No. 537,412.

Patented Apr. 9, 1895.



Witnesses

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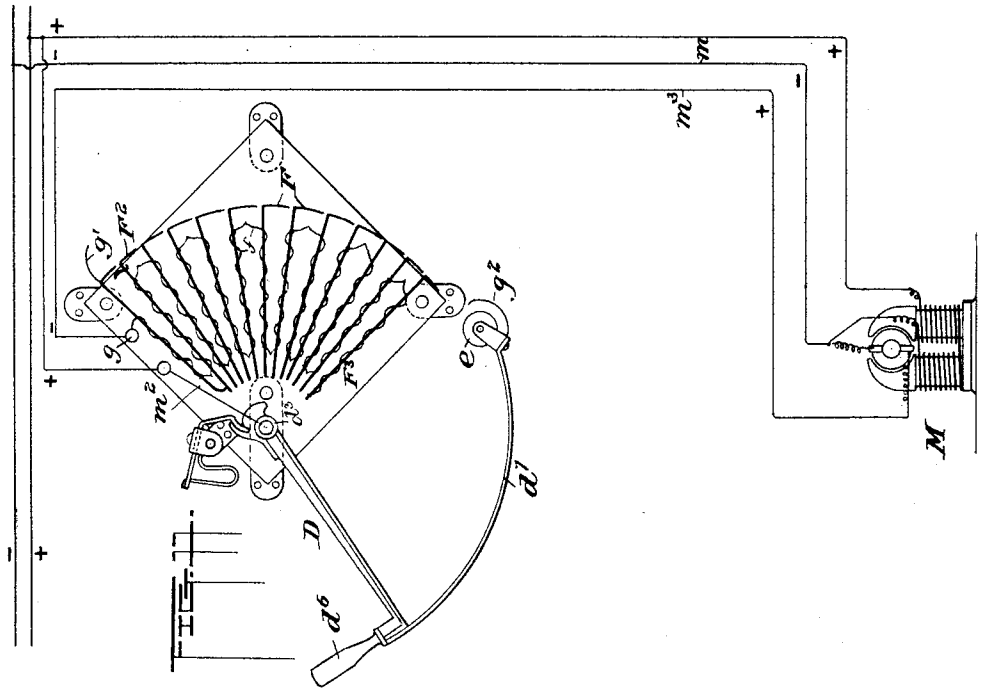
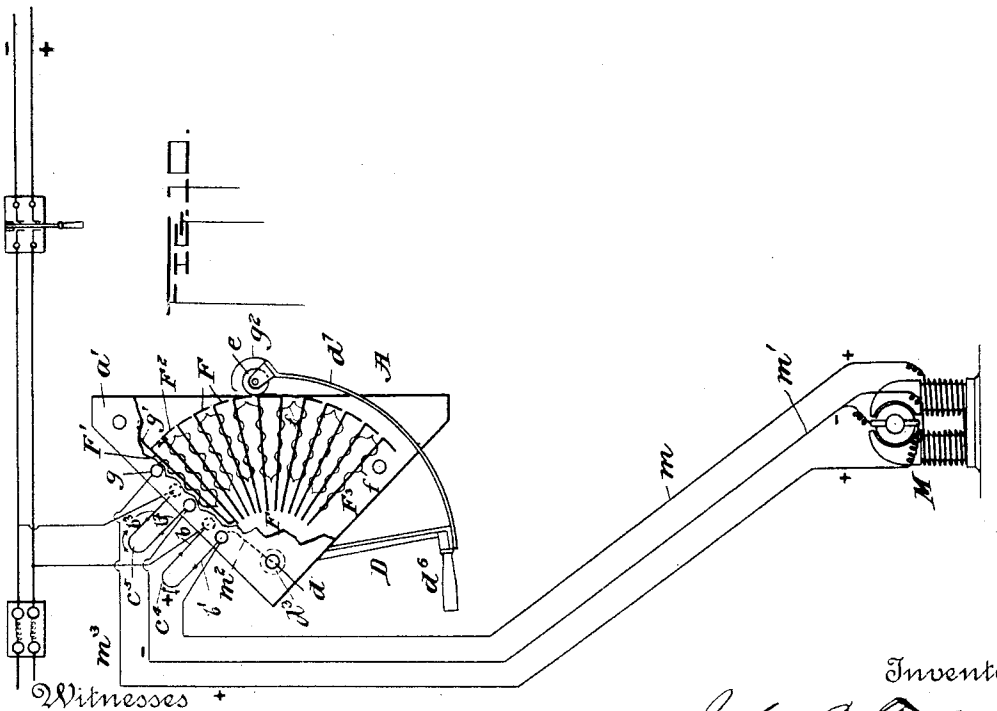
(No Model.) 3 Sheets—Sheet 3.

J. C. FYFE.

RHEOSTAT.

No. 537,412. Patented Apr. 9, 1895.





Witnesses

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UNITED STATES PATENT OFFICE.

JOHN C. FYFE, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-HALF TO JAMES HAYES, OF SAME PLACE.

RHEOSTAT.

SPECIFICATION forming part of Letters Patent No. 537,412, dated April 9, 1895.

Application filed January 24, 1895. Serial No. 536,080. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. FYFE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Rheostats; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to rheostats, but more particularly to those known as starting-boxes for electric motors.

For some time the fire inspectors have, in many places, required that the starting-boxes for electric motors shall be made to open the motor circuits automatically; that a double pole switch shall be placed between and in circuit with the starting-box and the main or leading in wires; and that this switch must always be opened after the motor is stopped to avoid the danger of fires from grounds, lightning and the like. This later requirement has resulted in more or less disaster and annoyance at the electric power stations, as the error frequently occurs of first throwing the starting-box into circuit, thereby closing the armature circuit of the motor, and afterward closing the switch by which the full force of the current is suddenly thrown on the motor, without having first had the benefit of the cushion of the resistance in the starting-box and allowing the armature to get into motion. Such mistake results in the instantaneous short circuiting of the system and often "blowing" the fuses at the power station, as they may be already loaded nearly to their full capacity, thereby temporarily disabling the entire system.

The primary object of my invention is to overcome this objectionable feature by providing means whereby the "making" of the armature circuit is prevented until the switch is closed; to provide means for simultaneously closing the switch and the motor armature circuit; and to provide a switch through which the negative and positive feed-wire circuits must be closed before the resistance and motor armature circuit can be closed.

Other important objects are to provide an electro-magnet through which the current may pass; to provide a more perfect contact, and at the same time less friction and wearing of the contacts; to provide a direct magnetic contact permitting the use of iron contacts which are preferably in the form of rollers, thereby allowing free action of the contact arm which may, if in the proper position, fall of its own weight when released by the current falling below the required strength; to utilize the bare magnet core or contact plate as a terminal to the sections of the resistance; to aid, by magnetic adhesion or attraction, the usual spring-actuated contacts, thereby reducing the spring tension on the contact arm to a minimum; to provide electro-magnetic contacts, the windings of which form sections of the resistance; and to provide conductors for the current which may be utilized for many other purposes than for a rheostat or starting-box, by applying its heretofore wasted energy to assist in insuring its own circuit completeness at the contacts.

Further objects of the invention are to provide a magnectic arc-rupturing factor; to provide ample ventilation, a fire-proof support to each coil of resistance, and an automatically operated switch; to provide a maximum and a minimum release for the contact arm; and to provide means to insure safety in case of overloading of the contact.

With these and other objects in view, the invention consists in the means substantially as hereinafter described and more particularly pointed out in the claims at the end of the description.

Referring to the accompanying drawings, forming a part of this specification, Figure 1 is a side elevation of a starting-box with the front plate partly broken away to enable the underlying parts to be seen, the resistance being shown diagrammatically. Fig. 2 is an end elevation with the contact lever partly broken away to show the initial contact plate. Fig. 3 is a sectional view on the line III—III of Fig. 5, illustrating the spring contacts of the switch and the manner of insulating said contacts from the supporting bracket or arm. Fig. 4 is a section through the contact roller,

taken on the line IV—IV of Fig. 5. Fig. 5 is a fragmentary view looking from the side of the starting-box opposite that of Fig. 1, illustrating the circuits open, and how the end of the switch-supporting arm interlocks with that of the contact arm. Fig. 6 is a detail sectional view through one of the resistance coils showing the contact plate in elevation. Fig. 7 is an end elevation of a contact plate the resistance being in section. Fig. 8 is a fragmentary view partly in section, illustrating the minimum and maximum release for the contact. Fig. 9 is a sectional view, partly broken away, taken on the line IX—IX of Fig. 8. Fig. 10 is a diagrammatic view, illustrating the application of my invention for controlling an electric motor; and Fig. 11 is a diagrammatic view of a modified form of my invention.

In the drawings, A may designate a frame of any preferred form or construction, but preferably composed of two plates of slate or other suitable material a and a', which are held apart by the sleeves a^2 through which are passed the binding bolts a^3. These bolts may be separated from the sleeves by a lining of asbestos or other insulation a^4 as an extra precaution against grounds and the like, and pass through the plates and the supporting feet a^5 at proper points to properly bind the whole together, the said supporting feet being adapted to be secured to an insulated switch board, or its equivalent, by the screws a^6.

Secured to the inner sides of the plates a and a' are the positive switch contacts b, b', and the negative switch contacts b^2, b^3, arranged above said positive contacts, each contact being connected with its respective binding post secured to the outer surface of the frame plates. Arranged to engage these contacts is a double pole switch C having a supporting arm c secured to a bracket c' which is pivoted at c^2 to standards c^3 extending outwardly from the plates a and a'. This switch preferably comprises a pair of U-shaped spring contacts c^4, c^5, insulated from each other and from the supporting arm c by a block of insulation c^6, preferably of slate, to which the spring contacts and the supporting arm are secured by screws or otherwise, the said screws or fastening devices being properly insulated to prevent leakage between adjacent parts. The spring contacts of the switch are adapted to span the positive and negative contacts and are normally pressed out of engagement therewith by a spring c^7 one end of which bears against the under surface of the supporting arm, while the opposite ends are secured to the standards c^3. The supporting arm c has its inner end c^8, curved and extending into the frame between the plates a and a' adapted to bear on the cam-shaped end d of a contact arm D.

The contact arm D is rotatably supported on a pin or shaft d', which has its ends preferably screw-threaded and passed through the plates to which it is secured by the nuts d^2; the said arm being separated from the plates a and a' by metallic washers d^3. This arm is provided with a suitable projection d^4 adjacent to its cam-shaped end d which serves to form an abrupt recess d^5 in which the curved end c^8 of the supporting arm is adapted to fit when the switch is open to limit the outward movement of said switch and the downward movement of said contact arm, thereby forming an interlocking connection between the two, as shown in Fig. 5. The outer end of the contact arm may be provided with a handle d^6, of any preferred form, and has extending therefrom a bow-spring d^7, on the end of which is arranged the contact rollers e. This contact e is preferably composed of a series of disks of magnetizable metal, preferably iron, separated from each other by close fitting washers to insure contact with their support and prevent possible fusion between any pairs, and are loosely mounted to rotate on a stud or pin e' carried by a bracket e^2 which is secured to or formed integrally with the bow-spring d^7, as best shown in Fig. 4. These disks are loosely fitted to the pin e' to permit a multiplicity of contacts at each of the attracting contact-plates or cores F.

The contact plates or cores F may be of any desired width, length or thickness according to the resistance f wound upon them, which is determined by the voltage and the required capacity. These contact plates are preferably punched or otherwise formed from soft strap iron and are arranged so that each core or plate forms a radius with the pin d' as the center; the said plates or cores being bent downward at their outer ends to form a better contact surface for the rollers e, and having projecting lugs f' on opposite sides thereof, which are inserted into corresponding apertures f^2 in the inner sides of the plates a and a' of the frame, by which they are rigidly held from displacement.

The resistance f is preferably prepared in accordance with the process disclosed in the patent granted to myself, No. 528,539, of November 6, 1894. In the present case I may use a piece of insulation f^3, preferably asbestos, saturated with silicate of soda and pasted over each edge of the contact plate where the resistance is to be wound, and of sufficient thickness to suspend the resistance across the sides of the cores F, thus permitting ventilation, as best shown in Fig. 2. The cotton covered resistance or coil is now wound on each insulated contact plate or core, after first being saturated with the silicate, the ends of each coil being cleansed and having one of its ends forced into a slit f^4 (Fig. 6) enough, however, of the end remaining to make connection with the adjacent coil. These are now subjected to sufficient heat to burn the cotton covering and crystallize the silicate, when they are ready to be assembled as heretofore explained. The coils or resistances f preferably comprise one layer of wire,

and alternate both as to their connection with the adjacent coil and as to their connection with the slits in the plates or cores. If these plates were not connected with their respective resistance coils, the plates would become simple magnets when the current passed through the coils, but as they are connected to one end of their respective coils, they become contact magnets, or magnetic contacts. The contact rollers *e* serve to bridge two adjacent plates, thus short circuiting the otherwise open magnetic circuit, creating thereby a magnetic circuit through said plates and rollers, which varies in intensity according to the position of said rollers and the amount of resistance in circuit.

The upper contact plate F′ needs no connection with its respective coil as its inner end is bent downward at f^5 and by a screw f^6 is attached to the adjacent plate F^2, thus getting its connection through said latter plate. The binding together of the lower ends of these plates not only constitutes an electric connection, but also completes one-half of the magnetic circuit, the latter creating thereby a material increase in magnetic power. The object then of the position given to the other contact magnets is obvious, as it will be seen that to allow them all to touch at their lower ends would short circuit the resistance, but as they are placed as close as practicable yet at a safe distance apart, they derive, (by exposing to each other as much of the sides of their inner ends as possible) a material increase in their magnetic value, over what it would be were they placed parallel. The plates F′ and F^2 need not be wound with iron wire, as preferably used on the others, but with copper wire of sufficient capacity to constantly carry the maximum load in ampères required, the end of the coil of the plate or core F′ being connected to the binding post *g*.

For releasing the contact rollers *e* when the current is reduced in strength I preferably provide a spring contact *g′* secured to and extending outwardly from the contact plate F′ which is adapted to abut against a curved contact spring g^2, carried by the bow-spring d^7 of the contact arm when the full force of the current is utilized. These contact springs oppose the attraction of the magnets formed by the plates F′ and F^2 so that when the current is reduced from any cause sufficiently to allow the springs to overcome the attraction of the magnet the contact arm will fall of its own weight. These contact springs form a minimum release, and serve to insure a passage for the current under a heavy load.

To prevent injury from an overload or undue ampère strain being thrown into the current either by overloading the motor, by lightning, grounds or short circuits either in the generator or across the negative and positive wires or connections, I provide a maximum release comprising an armature *h* adapted to shunt the magnetic field formed by the magnetized plates F′ and F^2, as best shown in Figs. 8 and 9. This armature or magnetic shunt *h* is preferably made of iron, and has two projecting ends *h′*, *h′*, which are bent upward and pass through countersunk apertures in the upper portion of the plate F^2; the countersinking giving free movement to the magnetic shunt, while the bent ends of said magnet shunt serve to hold and limit the movement of the same. The outer end of the magnetic shunt is adapted to contact with the plate F′ and is attached to the end of a bent spring h^2 which passes through one of the plates and is secured to the outer surface of said plate, the bent portion of the spring having an adjusting screw h^3 for varying the resistance of said spring. The magnetic shunt has a greater surface exposed to the magnet than the contact, which is, in this case, round. By placing the magnetic shunt with one end in contact with one of the poles and having a superior contact surface at the other end within reach and in influence of the surplus magnetism, will, upon gaining sufficient power to overcome the adjusted tension spring, attract the shunt magnet *h* and instantly divert sufficient of the magnetic current to cause the contact to roll away or fall of its own weight. This places the resistance in circuit, thus reducing the heavy current ampères which caused the release of the contact rollers.

The operation of the device will be readily understood from the foregoing description and the accompanying drawings. It will be seen should the parts be in the position shown in Fig. 5 and the positive and negative contacts connected with the positive and negative wires of the line, that by moving the contact lever D, the end of the supporting arm *c* of the switch will be released and the cam-shaped end *d* of said lever caused to force the switch against the tention of the spring c^7 to close the circuit through the positive and negative contacts before the contact roller *e* has reached the initial contact plate F^3. As will be seen, by tracing the circuit in Fig. 10, for a shunt wound motor, the field circuit through the motor has been closed with the main or line wires, by the spring contact c^4 of the switch, wires *m*, field of the motor M, wire *m′* to the negative switch contact b^2, spring contact c^5, contact b^3, to the line, thus energizing the field for the armature when the circuit is closed, which occurs with all the resistance in series by continuing the movement of the lever D till the contact rollers *e* engage the initial contact plate or core F^3. In forcing the rollers thus, the spring bow d^7 causes the rollers *e* to bear on the magnet contacts, according to the inward tension of said spring and the added adhesion of the now magnetized contacts. The circuits being established, through the resistance, the current passes from the positive switch contact *b* or its binding post, wire m^2 leading therefrom to the washers d^3 which bear against the contact arm through the contact arm D, rollers *e*, contact plate or core, its resistance *f*, the

remaining coils, to the binding post g, wire m^3, through armature to wire m' and to the negative contact b^3, spring contact c^5, contact b^2, then to the line. As has been described one end of each resistance coil connects with its respective contact plate or core; and as the contact rollers e pass upward over them, the said contact plates are one at a time cut out of the armature circuit, thus reducing the resistance and increasing the power of the motor. When the rollers e have reached the position, shown in Fig. 1, the rheostat resistance is now out of circuit and the motor is at its full capacity, and the current is passing not only through the contact plates F', F^2, but through the spring contacts g^2 and g' to said plates. Should the current be now reduced or increased in strength, from any cause, sufficient to allow the contact arm to fall and open the circuit as heretofore explained, the switch spring c^7 bearing against the supporting arm c will cause the curved end of said arm to slide over the cam-faced end d of the contact arm D, without, however, moving the switch contacts until the abrupt recess d^5 is reached, when the end c^8 of the supporting arm slides into said recess, allowing the switch spring to throw the switch open suddenly. The constant upward pressure of the switch spring has no effect on the switch or contact arm D until the abrupt recess is reached, which occurs, as seen in Fig. 5, when the line between the centers of the pins c^3 and d' has been crossed, or not in direct line with the pressure of said spring. At the point of crossing, the contact rollers e have not reached the initial contact. Thus the switch does not open or begin to open until the resistance is nearly all again in the circuit. Before the switch contacts have reached the "breaking" point, the contact rollers e leave the initial contact plate, and any excessive spark or arc, if any at all, occurs at this contact point, which is magnetized by its resistance winding, the combined magnetic arc-rupturing effect of which, together with the resistance which reduces the ampères, renders the spark harmless, thus making a magnetic arc-rupturer at this point.

It is obvious that I may use many of the parts for other purposes than for a starting-box or rheostat; nor do I confine myself to the number of poles the switch may have, for when the system demands it, a single, double, triple, or other suitable switch may be employed if desired.

In some cases the switch may be dispensed with entirely, as illustrated in Fig. 11. Here the device is shown as simply controlling the armature circuit of an electro-motor, while the field may be excited directly from the mains or in any other proper manner. The supporting arm c is somewhat shorter than when the switch is employed but is otherwise similar to that of the preferred form. The frame plates are shown square which is the form preferably employed in large starting-boxes and rheostats, where greater length of contact plates is desired. Instead of allowing the contact arm to fall by gravity, a spring may be supplied to return the same to open position, or different contacts may be supplied if desired.

I may dispense with some of the parts, or substitute other constructions for those shown, and I therefore do not wish to confine myself to the exact construction shown, as this may be changed in some instances, without departing from the spirit of my invention.

I have described the rolling contact as comprising a series of rollers e, but it is obvious that I may employ a single roller if so desired.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a device of the character described, the combination with suitable resistance, of a switch adapted to be thrown into and complete the circuit with the mains before the resistance can be placed in circuit, and means for preventing the opening of the switch before the resistance circuit is open, substantially as described.

2. In a rheostat or starting-box for electric motors, the combination with a suitable resistance, of a switch controlling the mains or leading in and leading out wires, said switch being adapted to be thrown into circuit with said mains before the resistance can be placed in circuit, means for simultaneously operating the switch and placing the resistance in circuit after the switch has been closed, and means for automatically opening the switch after the resistance is open, substantially as described.

3. In a rheostat or starting-box for electric motors, the combination with an electric motor and a suitable resistance included in the armature circuit of said motor, of a switch controlling the mains or leading in wires, said switch being adapted to be thrown into and complete the circuit with said mains and the field circuit of the motor, means for simultaneously operating the switch and placing the resistance in circuit after the switch has been closed, and means for automatically opening the switch after the resistance is open, substantially as described.

4. In a rheostat, the combination with a suitable resistance, of a switch controlling the mains or leading in and leading out wires, said switch being adapted to be thrown into circuit with said mains before the resistance can be placed in circuit, an arm adapted to close or open the resistance circuit and for simultaneously closing the switch before the resistance is placed in circuit, together with a spring for automatically opening the switch after the resistance is open, substantially as described.

5. In a rheostat, the combination with suitable resistance, of a contact arm adapted to close or open the resistance circuit, a switch operated by said arm for throwing said switch

into circuit with the mains, together with an interlocking connection between said arm and the switch for limiting the outward movement of the same, substantially as described.

6. The combination with suitable resistance, of a contact arm adapted to close or open the resistance circuit, and a second arm for simultaneously operating the first-mentioned arm and having an interlocking connection with said contact arm for limiting its outward movement, substantially as described.

7. In a rheostat, the combination with suitable resistance, of a double pole switch adapted to be thrown into and complete the circuit with the mains before the resistance can be placed in circuit, a contact arm for operating said switch and for closing or opening the resistance circuit, together with means for preventing the opening of said switch before the resistance circuit can be opened, substantially as described.

8. The combination, with a pivoted arm having a cam-shaped end and an abrupt recess in said end, of a second arm having one of its ends curved and adapted to bear upon and be operated by the cam-shaped end of the first mentioned arm and to enter the recess in said end to form an interlocking connection therewith, together with a spring for opening said second arm, substantially as described.

9. In a rheostat, the combination with a suitable support, of a switch comprising a pair of U-shaped spring contacts insulated from each other and adapted to be thrown into circuit with the mains, an arm pivoted to the support and insulated from said spring contacts, a spring arranged to automatically open said switch at a predetermined point together with a second arm for placing the switch in circuit with the mains and for controlling the movement of said spring, substantially as described.

10. In a rheostat, a magnetic contact comprising a core, an insulating medium partly surrounding said core forming an open space thereby, and a resistance coil passing around the insulation and suspended over the open space to permit ventilation, substantially as described.

11. In a rheostat, a contact comprising a core of soft iron, and a section of the resistance surrounding said core and insulated therefrom, the said core forming one terminal for said resistance, whereby the said core may serve as a magnet and convey the current, substantially as described.

12. In a rheostat, the combination with a series of magnetic contacts, of a magnetizable contact adapted to engage said magnetic contacts, substantially as described.

13. In a rheostat, the combination with a series of magnetic contacts forming terminals for sections of the resistance circuit and to convey the current to said resistance sections, of a series of rolling magnetizable contacts adapted to close or open said resistance circuit, substantially as described.

14. In a rheostat, the combination with a series of magnetic contacts forming terminals for the resistance circuit, of a magnetizable contact adapted to close or open said resistance circuit, together with a minimum release for forcing said contact away from its magnetic contact when the circuit is sufficiently reduced in strength, substantially as described.

15. In a rheostat, the combination with a series of magnetic contacts forming terminals for the resistance circuit, of a magnetizable contact adapted to close or open said resistance circuit, together with a maximum release for allowing said contact to recede from its magnetic contact when the circuit is increased beyond a predetermined point, substantially as described.

16. In a rheostat, a magnetic contact forming a terminal for a section of the resistance, and to convey the current to said section of resistance substantially as described.

17. In a rheostat, the combination with a series of magnetic contacts forming terminals for the resistance circuit, of a magnetizable contact adapted to close or open said resistance circuit, together with a minimum release comprising a spring secured to one of the magnetic contacts and adapted to abut against a second spring carried by the contact, substantially as described.

18. The combination with a magnetic contact, of a contact adapted to engage said magnetic contact and be held thereby, together with a magnet shunt for short circuiting the magnetic field of said magnetic contact for releasing said contact, substantially as described.

19. The combination, with a magnetic contact having a north and a south pole adjacent to each other, of a contact adapted to engage said magnetic contact and be held thereby, together with a spring-retained magnet shunt engaging one pole and adapted to be placed in contact with the other pole to short circuit the magnetic field to release said contact when the magnetic attraction is sufficient to overcome the tension of the spring, substantially as described.

20. In a rheostat the combination with a magnetic contact formed by the resistance passing around the same and having a north and a south pole adjacent to each other, of a rolling contact adapted to engage said magnetic contact and be held thereby, a magnet shunt engaging one pole and adapted to be placed in contact with the other pole, and a spring for normally holding the magnet shunt open, whereby the magnetic contact may be short circuited to release the rolling contact, substantially as described.

21. In a rheostat, the combination with a series of magnetic contacts forming terminals

for the resistance circuit, of an arm carrying a magnetizable contact adapted to open and close the resistance circuit, together with means for permitting the arm to open the resistance circuit, substantially as described.

22. In a rheostat, the combination with a series of magnetic contacts radially arranged and having their inner ends exposed to each other and forming terminals for the resistance circuit, together with a magnetizable contact for opening and closing the resistance circuit, substantially as described.

23. In a rheostat, the combination with a suitable resistance, of an arm, and a series of contact disks adjacent to each other and loosely mounted upon a single stud and rotatably held on said arm adapted to open or close the resistance circuit, substantially as described.

24. In a rheostat, the combination with a series of magnetic contacts forming terminals for the resistance circuit, of a rolling magnetizable contact adapted to close or open said resistance circuit, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN C. FYFE.

Witnesses:
W. E. McHENRY,
JAMES HAYES.