No. 625,232. Patented May 16, 1899.

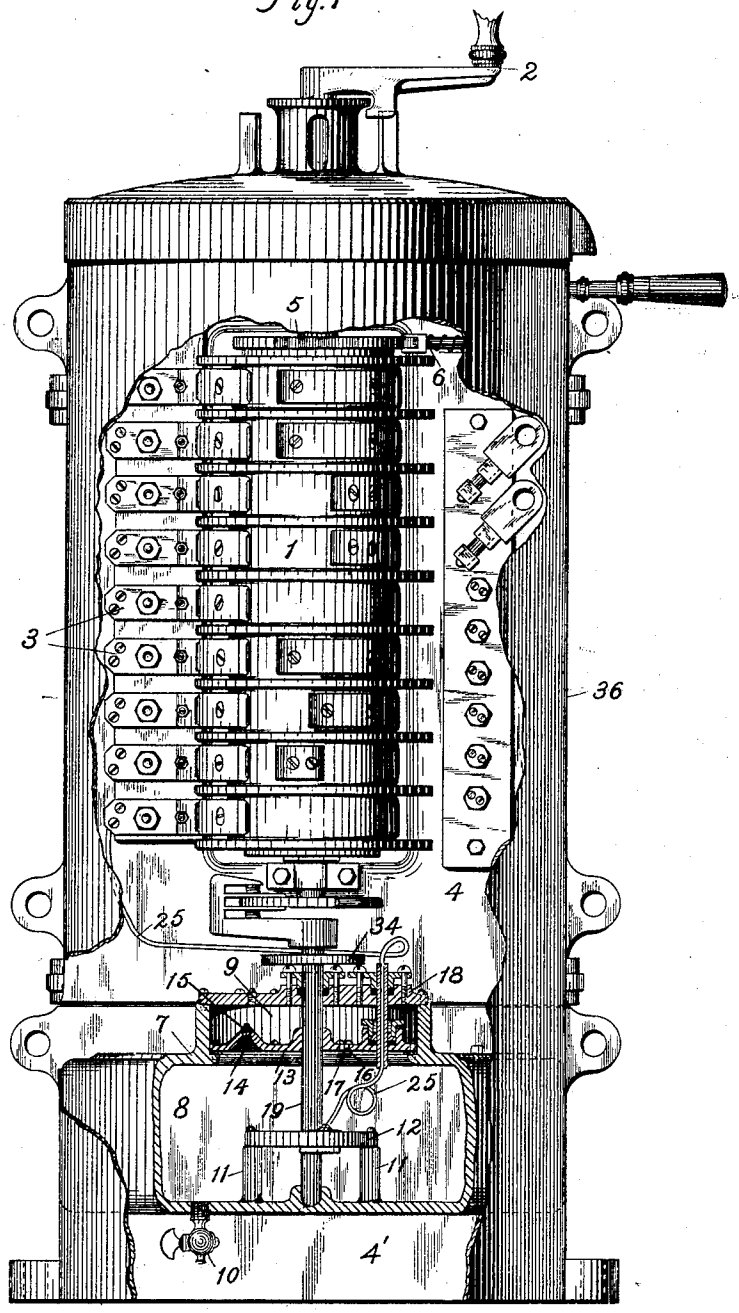
A. J. WURTS.

NON-ARCING CONTROLLER FOR ELECTRIC MOTORS.

(Application filed Jan. 31, 1895.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1



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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

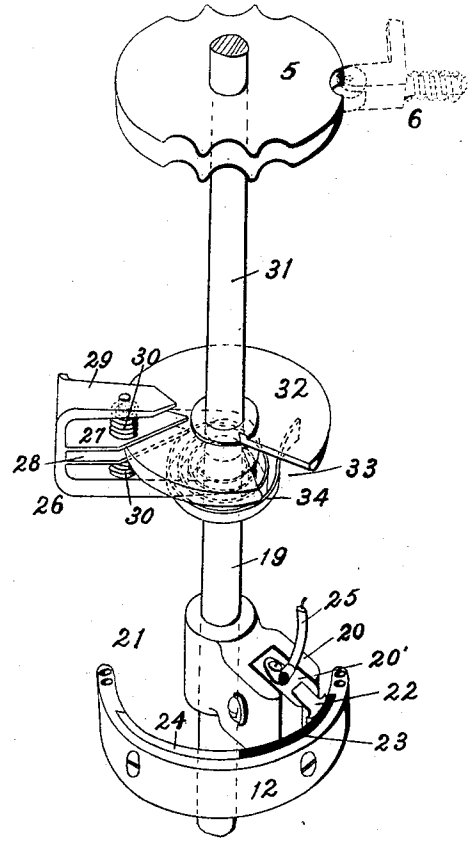
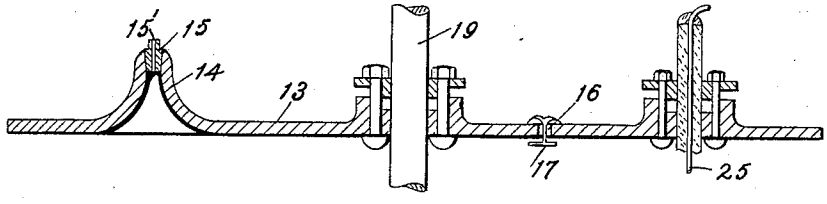


Fig. 3.



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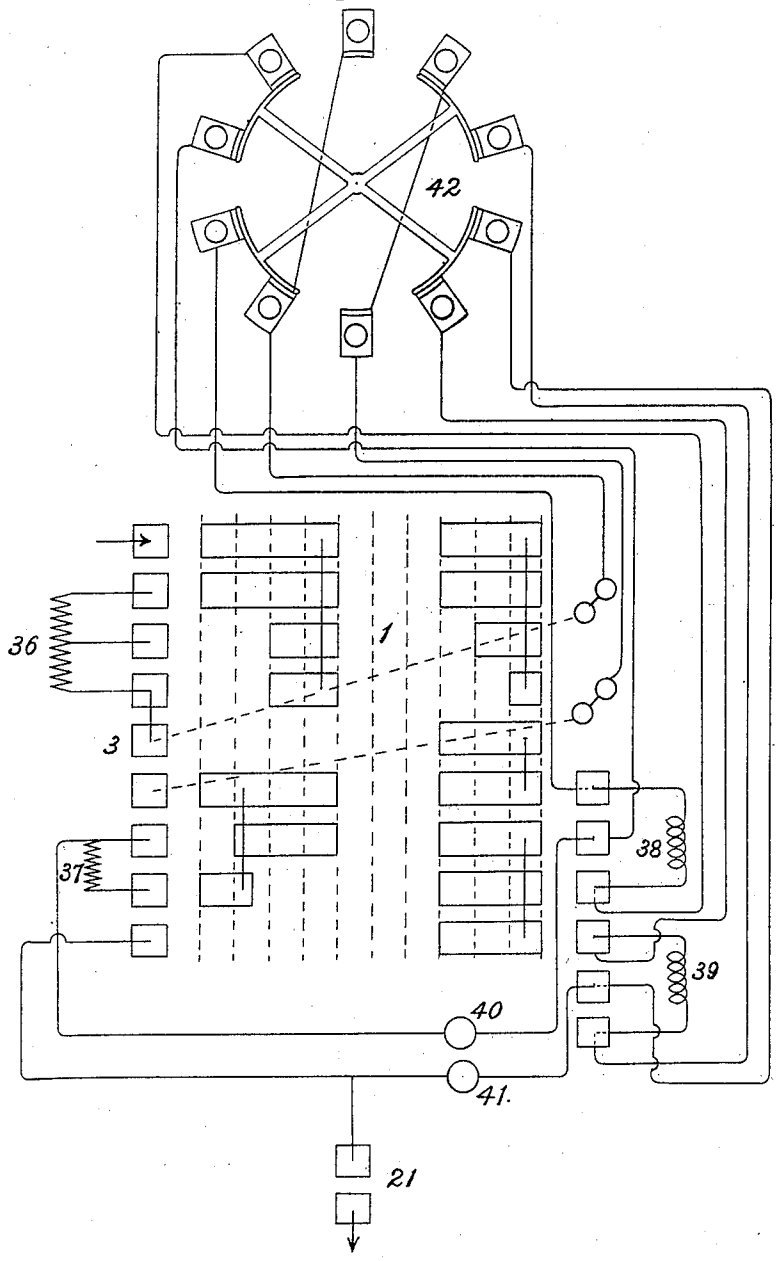
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(No Model.) 3 Sheets—Sheet 3.

Fig. 4.



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UNITED STATES PATENT OFFICE.

ALEXANDER JAY WURTS, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, OF SAME PLACE.

NON-ARCING CONTROLLER FOR ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 625,232, dated May 16, 1899.

Application filed January 31, 1895. Serial No. 536,824. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER JAY WURTS, a citizen of the United States, residing in Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Non-Arcing Controllers for Electric Motors, (Case No. 631,) of which the following is a specification.

My invention relates to controllers for electric motors, and has particular reference to those known as "series-multiple" controllers employed in connection with electric cars operated by two electric motors, though in many respects capable of wider and more general application.

One object of my invention is to provide a controller in which arcing between the usual stationary and movable controller-contacts when changes in the connections are made for changes in speed shall be obviated by opening the circuit when necessary by means of a single switch isolated from such controller-contacts.

A further object of the invention is to provide means whereby arcing between the terminals of the isolated switch shall be suppressed or reduced to the smallest practicable limits.

In the accompanying drawings, Figure 1 is a front elevation of a controller constructed in accordance with my invention, the wiring being omitted and parts being broken away in order to show the internal construction. Fig. 2 is a detail perspective view of a portion of the apparatus. Fig. 3 is a sectional view of the receptacle-partition, and Fig. 4 is a diagram of the motor and controller circuits.

Reference being now had to the details of the apparatus as shown in the drawings, 1 is the controller-drum provided with the usual contact-strips, and 2 the actuating-handle therefor.

3 are the usual stationary contacts, which coöperate with the strips on the controller-drum, and 4 is the base on which these parts are mounted and by which they are supported.

5 is a notched disk rigidly attached to the upper end of the controller-drum, and 6 the spring-pressed pawl coöperating therewith.

All of the parts thus far described are of the usual construction now employed in connection with the Westinghouse system and not of my invention.

4′ is a supplemental base designed to form a continuation of the base 4 and to serve as a support for the receptacle 7, these two parts preferably constituting a single casting. The receptacle 7 comprises a main chamber 8 and an auxiliary chamber 9, located above said main chamber. This chamber 8 is filled with liquid, and in the construction shown the auxiliary chamber 9 will also be partially filled therewith. The character of this liquid and the results effected by it in connection with the coöperating apparatus will be hereinafter more fully set forth.

The bottom wall of the chamber 8 is provided with a draw-off cock or faucet 10 and with upwardly-projecting posts 11, which may be conveniently formed integral therewith, and supported upon these posts 11 is a curved plate 12, these parts being fastened and rigidly held together, preferably by means of screws or bolts, as shown in the drawings.

The main portion of the plate 12 and the posts 11 might be cast together as an integral part of the chamber 8; but as it is sometimes desirable to remove the plate from the receptacle I prefer the construction shown in the drawings. The auxiliary chamber 9 is separated from the main chamber 8 by a partition 13, firmly fastened to its seat by screws, as shown in the drawings, or by any other convenient means. This partition is preferably provided with an upwardly-projecting bulge 14, in the upper portion of which is a screw-plug 15, through which extends a pin-hole or restricted opening 15′, as clearly shown in Fig. 3. At another point in the partition 13 is located a somewhat larger opening 16, provided with a valve 17. The cover 18 of the auxiliary chamber 9 is fastened firmly to its seat, preferably by means of screws, as shown in the drawings. A vertical shaft 19 is stepped into the bottom wall of the chamber 8 and extends upwardly through the partition 13 and

cover 18, the latter being provided with a stuffing-box, as indicated. This shaft 19 is preferably eccentrically located with reference to the plate 12, for reasons which will be hereinafter stated.

Rigidly mounted on the shaft 19, near its lower end, in the same horizontal plane with the curved plate 12, is the contact-bearing arm 20 of the switch 21. This arm 20 supports an insulated block 20′, having a movable contact-piece 22, preferably pressed outwardly by means of a spring (not shown) in the manner usual in such devices. A portion of the inner surface of the plate 12 is provided with a curved plate or strip of insulating material 23. This strip I prefer to construct of lignum-vitæ; but it may be of any smooth hard insulating material. A contact-strip 24, of conducting material, preferably copper, is attached to the inner side of the plate 12 in such manner as to form a continuation of the insulating-strip 23. A flexible conductor 25 is fastened at one end to the block 20′ in such manner as to make electrical connection therewith. This insulated conductor extends upward through the auxiliary chamber, and its outer end is in electrical connection with the last stationary contact of the controller, thus connecting the controller proper and the isolated switch in series. The partition 13 and cover 18 are provided with suitable stuffing-boxes and packing, as shown. The upper end of the shaft 19 is provided with an arm 26, rigidly attached thereto, its outer end projecting upwardly and inwardly. The upwardly-projecting portion is provided with two inwardly-projecting friction-plates 27 and 28, substantially parallel to the inwardly-projecting portion 29 of the arm 26. Springs 30 are preferably placed between the plates 27 and 28 and the adjacent portions of the arm 26.

The shaft 31, on which the controller-drum is rigidly mounted, carries at its lower end a disk 32, provided with a notch or opening 33. This disk is embraced by the plates 27 and 28, the frictional engagement between these parts being such that they will ordinarily move together. The notch 33 is preferably enough wider than the engaging portions of the plates 27 and 28 so that when the disk is moved to bring the notch between these plates the latter will be free to move backward independently of the disk. This backward movement will be effected by the coiled spring 34, one end of which is attached to the shaft 19 and the other to the supporting-base 4. It will thus be seen that the disk and the arm 26, with its attachments, together constitute a friction-clutch of peculiar construction. If desired, either the disk or the inner faces of the plates 27 and 28, or both, may be covered with leather or other material which will give a suitable frictional contact surface or surfaces, as is common and well known in this class of devices, the action of the springs 30 being such as to take up any wear that may take place between these parts. The entire apparatus thus far described is protected by means of a suitable cover 36.

In Fig. 4 of the drawings the controller-drum is shown developed at 1, the stationary contacts at 3, the resistances at 36 and 37, the motor field-magnets at 38 and 39, the armatures at 40 and 41, the reversing-switch at 43, and the isolated switch at 21, these several parts being illustrated diagrammatically merely to show the circuits through the controller.

I desire now to refer more particularly to the mode of operation and function of the apparatus supported by the supplemental base 4′. It is well known that when electric circuits carrying currents of any considerable volume are interrupted arcs are formed between the separated terminals, the production and maintenance thereof being due, apparently, to the vaporization of a portion of the metal of which the terminals are composed, this vaporized metal serving as a conducting-path for the arc. In apparatus in which the circuits are completed and broken at frequent intervals the contacts become materially impaired by reason of the arcing which takes place between them unless the arcs are suppressed or immediately extinguished. Even if the arcs be blown out immediately after they are formed the injury to the contacts, though materially lessened, is not entirely obviated. The knowledge that a path of greater or less conductivity is necessary for the formation and maintenance of an arc led me to experiment with a view to securing some means whereby the formation of such conducting-path should be prevented. As the result of such experiments I have found that if the electrodes between which an arc tends to form be submerged in a body of liquid of sufficiently high resistance to preclude the short-circuiting of the switch thereby and such body of liquid be so confined as to preclude the displacement of any material part of it, the formation of any considerable quantity of conducting gas or vapor will be prevented. It is essential that the chamber containing the liquid be strong enough to resist a high degree of pressure and that it be completely filled with the liquid in order that there may be no room for the formation of conducting gas at the terminals of the switch located in it. All liquids being substantially non-compressible any one that is not a good conductor of electricity may be employed in this connection. Water, for example, is well adapted for this purpose at all temperatures at which it retains its liquid form. In apparatus which is to be used out of doors in widely-varying temperatures, however, it is necessary to employ a liquid which will not freeze. As sparks are likely to be produced to a greater or less extent at the terminals, it is also desirable to employ a liquid which will not become carbonized to any considerable extent thereby and which is non-combustible. Furthermore, as a switch of this kind is particularly in-

tended and adapted for use in circuits carrying currents of large volume it is of material advantage to use a liquid which will serve to shunt a small portion of the current around the switch when it is opened.

While all the conditions above enumerated are not always present and need not necessarily be provided for under all circumstances, yet I deem it desirable to employ a liquid which will give satisfactory results under all possible conditions of practice. I have found as a result of my experiments that glycerin is such a liquid, and I therefore prefer to use it, though I do not desire to limit my invention to any particular kind of liquid, there being, as has already been stated, a considerable number which would give satisfactory results under proper working conditions.

The operation of the apparatus is as follows: Assuming the parts to be in the position indicated in Figs. 1 and 2 of the drawings, if the controller-drum be rotated from right to left the frictional engagement between the plates 27 and 28 and the disk 32 will cause the arm 26 to move with the disk until the contact-piece 22 of the switch 21 comes into engagement with the contact-strip 24, thus completing the circuit through the apparatus. At this point the roller of the pawl 6 will be in the first working notch of the disk 5 and the stationary contacts 3 of the controller will be in the first position with reference to the contact-strips on the controller-drum. The current will enter at the first or upper stationary contact, pass through the motors and resistances in series, and out through the switch 21, as indicated in Fig. 4, the stationary contact 24 being connected to the ground. The circuits through the apparatus at the various positions of the controller-drum will be readily understood without a detailed description thereof. The shaft 19 being eccentrically located with reference to the curved plate 12, the contact-piece 22 will bind against the strips 23 and 24 at the extremities of its movement, and in the position of the contacts just described this will insure the movement of the disk 32 between the plates 27 and 28 until the stationary controller-contacts are just about to leave the fourth position on the controller-drum. When this position is reached, the plates 27 and 28 will come into the notch 33 in the disk 32, and will be quickly thrown to the right by means of the spring 34, thus bringing the contact 22 of the switch onto the insulating-strip 23. A further rotation of the controller-drum from right to left serves to move the arm 26 again to the left, and thus brings the parts 22 and 24 into contact just before the stationary controller-contacts come into the eighth position on the drum (indicated by dotted lines in Fig. 4) to connect the motors in parallel. This movement takes place against the stress of the spring 34, as before. These parts will be held in this position during the further movement of the controller-drum until it reaches its limit of movement from right to left and the motors are connected in parallel without resistance. Any movement of the controller-drum in the reverse direction, however, will bring the contact-piece 22 back onto the insulating-strip 23 before the circuit is broken at the drum, thus providing for the entire reversal of the drum upon open circuit instead of retracing in the inverse order the steps which had previously been taken in inserting the resistance and making the necessary circuit changes, as has been the practice in controllers heretofore employed for governing railway-motors. The construction of apparatus whereby this result may be accomplished is obviously subject to considerable variations, and hence I do not regard the particular means employed as material. The result attained, however, is important, as will be readily understood by any one skilled in the art, and the employment of some means whereby it may be secured will obviate the necessity of employing means for suppressing or reducing the arcs which would otherwise form or tend to form between the separated contacts and will insure the preservation of the engaging surfaces of such contacts in good condition.

It will be readily understood from this construction and arrangement of apparatus that any arcing which tends to take place upon the separation of contacts must occur between the contacts 22 and 24 instead of between the controller-drum contact-strips and the stationary contacts coöperating therewith, as has been the case in controllers as heretofore constructed. This feature of my invention, which involves the employment of an isolated switch in series with the controller proper, I regard as an important one, irrespective of any particular means for suppressing or reducing the arc at that point. In fact, it is a valuable improvement if no arc suppressing or reducing means be employed, since there are only two contacts to be renewed provided they should become so injured by arcing that new ones should be necessary. Referring now more particularly to the operation of this isolated switch when the contacts 22 and 24 are separated, the vapor which tends to form and which in ordinary switches does form to such an extent as to support an injurious arc is very materially reduced, if not altogether suppressed. The character of the liquid, as has been already stated, is preferably such that it constitutes a shunt-path around the separated terminals for a small portion of the current in the circuit, and thus reduces to that extent the amount of current to be interrupted at the switch-terminals. The breaking of this small shunted current at the contacts of the controller proper obviously will not produce injurious arcs. As the amount of space occupied by a given body of liquid will vary to a greater or less extent, according to its temperature, I provide the pin-hole 15′ in the screw-plug 15 for the escape of such small quantity of liquid into the chamber 9 as may

be necessitated by the expansion of that contained in the chamber 8. This plug 15 is located in an upwardly-projecting bulge in the partition in order that if there are any air-bubbles in the chamber 8 they may seek this highest point in the chamber, and thus pass out into the auxiliary chamber. The valve 17 is so constructed that it will be forced to its seat by the exertion of pressure inside the chamber 8, thus preventing the escape of liquid through the opening 16. After the switch has been opened any liquid which may have been forced from the chamber 8 into the auxiliary chamber 9 will flow back through the opening 16. I have found by means of practical tests applied to a switch of this character that the circuit may be made and broken a very great many times without injuring either of the terminals so as to impair in any manner or degree their successful operation, which as switch-terminals subjected to the same number of breaks under ordinary conditions would become so seriously impaired as to render the operation of the switch extremely difficult, if not actually impossible.

While I have illustrated and described specific apparatus for carrying out my invention, I desire it to be distinctly understood that my invention is not limited to these specific details, but that it might be embodied in other apparatus which would be the equivalent of that shown and described. It will also be understood that the isolated switch above described is adapted and intended for use in other relations than that in which it is here shown.

I claim as my invention—

1. The combination in an electric controller of a switch and an auxiliary switch in circuit therewith having its contact portions immersed in an arc-extinguishing medium.

2. In an electric controller, in combination, a switch having a plurality of contacts and adapted to control the course of the electric current, an auxiliary switch in circuit with the controlling-switch and surrounded by an arc-extinguishing medium.

3. The combination with a controller-drum and coöperating stationary contacts, of a switch located in the main circuit and a confined body of glycerin surrounding said switch and serving to prevent the formation of destructive arcs when the switch is opened, substantially as described.

4. A switch-inclosing main chamber and a superimposed auxiliary chamber, the partition separating said chambers being provided with a restricted opening and with a larger valved opening, substantially as described.

5. A liquid-containing receptacle comprising a main chamber and an auxiliary chamber, a restricted opening for the passage of liquid from the main to the auxiliary chamber, a larger valved opening for the return of the liquid to the main chamber, and means for withdrawing liquid from the main chamber, in combination with a switch in said main chamber and means for actuating the same, substantially as described.

6. A liquid-containing receptacle comprising a main chamber filled with liquid and an auxiliary chamber separated therefrom by a partition, said partition having a valved outlet and an upwardly-bulged portion provided with a restricted outlet, in combination with a switch in said main chamber and means extending outside of the receptacle for operating said switch, substantially as described.

7. In a controller for electric motors, the combination with the controller-drum and the stationary contacts of an isolated switch in the main circuit surrounded by a confined body of high-resistance liquid and connections between the switch and controller-drum, substantially as described.

8. In a controller, the combination with the controller-drum, of an isolated switch and a friction-clutch between the said parts, substantially as described.

9. In a series-multiple controller, the combination with the controller-drum, of an isolated switch, and a clutch the respective members of which are rigidly connected with the drum and with the movable member of the switch, said clutch being provided with means whereby the switch is automatically opened before the change from series to multiple connection is made, substantially as described.

10. In a series-multiple controller, the combination with the controller-drum, of an isolated switch in the main circuit, a clutch the members of which are respectively connected to the movable member of the switch and to the controller-drum and have a movable frictional engagement with each other and means for preventing injurious arcing at the switch-terminals, substantially as described.

11. In a series-multiple controller, a clutch comprising a notched disk and a plate narrower than the notch and having frictional engagement with the disk, substantially as described.

12. In a series-multiple controller, a clutch comprising a notched disk and two connected plates of less width than the notch and bearing frictionally against the two sides of the disk, substantially as described.

13. The combination with the stationary contacts and the controller-drum, of a receptacle having a main chamber filled with liquid and a superimposed auxiliary chamber communicating therewith by means of a restricted opening and a larger opening provided with an automatically-closing valve, a switch in said main chamber and a friction-clutch interposed between the controller-drum and the movable member of the switch, substantially as described.

14. In a controller for electric motors, the combination with the usual circuit-changing movable and stationary contacts, of an isolated switch in the main circuit and a confined body of high-resistance liquid surrounding the same, substantially as described.

15. A series-multiple controller for electric motors comprising a current-modifying and circuit-changing switch, a circuit opening and closing switch in series therewith and a controlling connection between the said switches actuated by the first-named switch when moved in one direction, during either series or multiple connection, to close the second switch and maintain it closed and when moved in the opposite direction from any point to effect the opening of the said second switch and the maintenance of the same in open position until the movement of the first switch is reversed.

16. A series-multiple controller for electric motors comprising a drum provided with contacts, a set of stationary contacts coöperating therewith, an isolated switch in the motor-circuit, and means whereby said switch is actuated to open the circuit upon the reversal of the controller-drum and to maintain the same open during such reverse movement, said switch being also automatically opened prior to the change from series to multiple connection.

In testimony whereof I have hereunto subscribed my name this 29th day of January, A. D. 1895.

ALEXANDER JAY WURTS.

Witnesses:
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J. WILLIAM SMITH.