F. R. M. CUTCHEON.

ELECTRIC VOLTAGE REGULATOR.

APPLICATION FILED AUG. 22, 1908.

947,055.

Patented Jan. 18, 1910.

Fig. 2

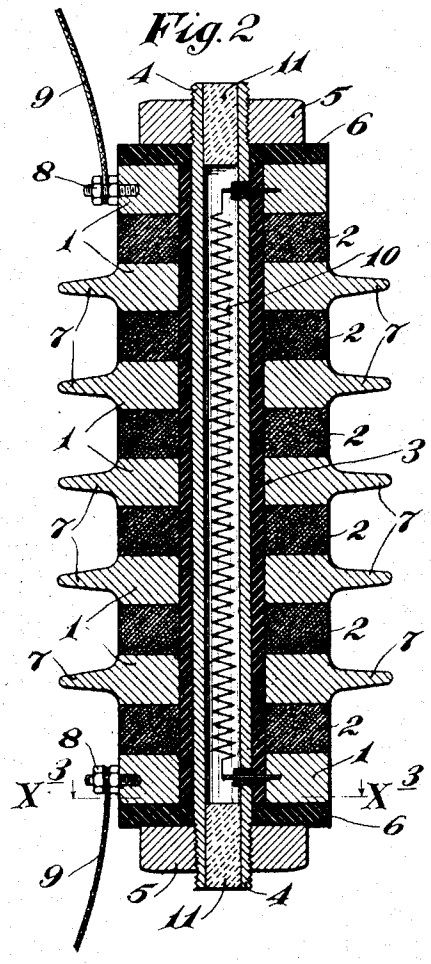


Fig. 1

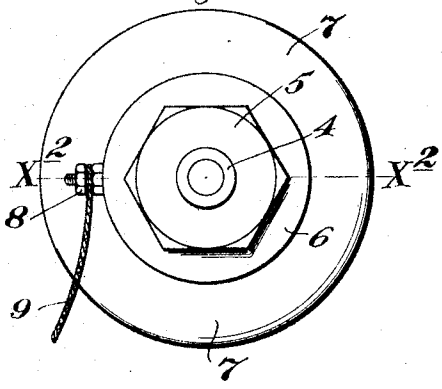
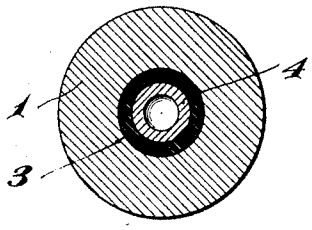


Fig. 3



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UNITED STATES PATENT OFFICE.

FREDERICK R. M. CUTCHEON, OF ST. PAUL, MINNESOTA.

ELECTRIC-VOLTAGE REGULATOR.

947,055. Specification of Letters Patent. Patented Jan. 18, 1910.

Application filed August 22, 1908. Serial No. 449,846.

To all whom it may concern:

Be it known that I, FREDERICK R. M. CUTCHEON, a citizen of the United States, residing at St. Paul, in the county of Ramsey and State of Minnesota, have invented certain new and useful Improvements in Electric-Voltage Regulators; 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.

My invention has for its especial object to provide an improved voltage regulator, of simple construction and small cost, and to this end it consists of the novel devices and combinations of devices, hereinafter described and defined in the claims.

There is no practical automatic regulator to regulate the voltage of the individual consumer, compensating for the variations in line loss in the distributing mains and house wiring. This is one of the most difficult problems with which the central station engineer has to contend. It is possible, with the existing station regulators, to adjust the regulation so that the consumer having the lowest voltage will get satisfactory regulation and sufficient voltage; but if this is done there will always be some consumers whose voltage is too high. The natural and simplest method of reducing this voltage is to insert a resistance in the consumer's service wires. However, we are then confronted with this dilemma, that if a few lights only are turned on, a considerable resistance is required to cut the voltage down to the normal lamp voltage, while if this resistance is used when a large number of lamps are turned on, the voltage will be cut down too far. It is therefore necessary to provide a resistance which will decrease as the current flowing increases. This may be done through rheostats of either the wire wound or liquid type operated either by magnetic solenoids or small motors, but such devices are expensive in first cost and maintenance and prone to get out of order.

The device which I have devised to accomplish this purpose consists of a number of contact resistances composed preferably of elements having different coefficients of expansion, such for example as brass and carbon rings, cylinders or disks, alternated in a pile and arranged so as to be held loosely in contact, when cold, and to be forced into contact with increasing force, as the temperature thereof is increased. Otherwise stated, the contact or resistance members, when loosely engaged, have imperfect contact, but this contact is made more perfect by increasing pressure, and of course the resistance to the current decreases as the contacts become more perfect.

When current is passed through the pile, heat is generated, at each contact, as well as in the conductors themselves, and this heat causes the brass contacts to expand, while the iron frame not being exposed directly to the heat, remains cooler, and having a lower coefficient of expansion, does not expand nearly as much as the brass. Consequently a certain pressure will be caused between the carbon and brass contacts, and this pressure is proportional to or varies with the amount of expansion, which, in turn, varies with the temperature, and the temperature rises or falls as the current increases or decreases. The resistance of the pile decreases as the expanding pressure increases; hence, the more current there is flowing through the pile, the smaller the resistance of the pile will be, which is the characteristic previously specified for a resistance to be used to absorb excess voltage on an individual service.

With the pile constructed as above described, the contacts being loose, if a considerable load is switched on, there might be an arc of destructive character started between the contacts. To avoid this, I use an auxiliary fixed resistance, in multiple with the pile, and of such dimensions that the current passing through it can not supply more than the minimum allowable voltage to the wiring system, and so arranged that the heat developed in the auxiliary resistance will assist in producing expansion of the brass contacts. The pile will then pass enough additional current to raise the voltage to approximately the normal amount.

Any metal having a high co-efficient of expansion and a comparatively high melting point may be substituted for brass in the above device, and any metal with a low coefficient of expansion and great tensile strength may be substituted for iron in the so called frame.

The improved voltage regulator in one form which in practice has been found efficient for the purposes had in view is illustrated in the accompanying drawing, wherein like characters indicate like parts throughout the several views.

Referring to the drawings: Figure 1 is a plan view of the improved regulator. Fig. 2 is a vertical section taken on the line x^2 x^2 of Fig. 1; and Fig. 3 is a horizontal section taken on the line x^3 x^3 of Fig. 2.

In this arrangement, the alternated metal and carbon contact members of the pile are in the form of rings indicated, respectively, by the numerals 1 and 2, and these are placed around an insulating sleeve 3 through which an iron tube 4 is passed. The ends of the tube 4 are threaded and nuts 5 work thereon with insulating disks 6 being interposed between the said nuts and the adjacent end members of the metal contact rings 1. The metal contact rings 1 are preferably formed with projecting heat radiating ribs 7 for the purpose of adapting the pile to cool rapidly. The end members of the metal contact rings 1 are provided with binding screws 8 to one of which one of the consumer's service wires 9 is connected, the other wire 9 being connected to the house wiring.

The auxiliary resistance, above referred to, is, in this construction, in the form of a coiled iron wire 10 located within but insulated from the metal tube 4, with its ends connected to the two end members of the metal contact rings 1. In Fig. 2, the ends of the tube 4 are shown as plugged, by a filling of cement or plaster paris which, in practice, would be preferably made to completely fill the tube 4, so as to thereby form a good insulation between the said tube and the said auxiliary resistance wire 10. In the above described arrangement, the metal tube 4 and nuts 5 constitute the frame for holding the contact members of the pile together and for limiting or resisting the expansion of the contact members 7 and 2, and hence, causing the same to press together under increased force and increasing temperature so as to thereby give a more complete contact and, hence, a decreasing resistance under increasing current flow and consequent increased heat action and expansion of the said contact members. The auxiliary resistance 10 being inclosed will raise the temperature rapidly at starting and bring the pile quickly into action.

In practice, it may be desirable to use more or less fixed resistance in series with the pile, so that the drop of potential through the regulator will not be too small at full load.

What I claim is:—

1. A voltage regulator comprising a plurality of contiguous expansible conductor members normally having imperfect contact with one another, and means for opposing the expansion of said members, whereby an increase in temperature due to the current flow through said conductor members will effect a corresponding increase in the contact pressure between the several members and a decrease in the electrical resistance of the series.

2. In a voltage regulator, the combination with a multiplicity of loosely engaged expansible contact members connected in a supply circuit, and normally having imperfect contact, of a frame for resisting expansion of the said contact members, whereby under increasing current flow therethrough, said contact members will be expanded and forced into engagement under increased pressure, thereby rendering the contact between said members more perfect and decreasing the electrical resistance.

3. In a voltage regulator, the combination with a multiplicity of contacts connected into an electrical supply circuit and arranged to be engaged under increasing pressure, when expanded, and to thereby afford a decreasing electrical resistance under increasing current flow therethrough, and an auxiliary resistance connected in multiple with said contacts for insuring the proper current flow when the said contacts are cold and loosely engaged.

4. In a voltage regulator, the combination with a multiplicity of loosely engaged contacts connected in a supply circuit, of a frame for resisting expansion of said contacts, whereby under increasing current flow therethrough, said contacts will be engaged under increasing pressure and thereby afford a decreasing electrical resistance, and an auxiliary electrical resistance connected in multiple with said contacts, for insuring a proper current flow when said contacts are cold and loosely engaged.

5. In a voltage regulator, the combination with a multiplicity of alternated carbon and metal contacts connected in a supply circuit, of a frame for resisting expansion of said contacts, whereby, under increasing current flow therethrough, said contacts will be engaged under increasing pressure and thereby afford a decreasing electrical resistance, and an auxiliary resistance connected in multiple with said contacts for insuring the proper current flow when said contacts are cold and loosely engaged.

6. In a voltage regulator, the combination with a metal tube, of a multiplicity of contact rings, surrounding but insulated from said tube, and loosely engaged abutments, such as nuts on the ends of the said tube, for resisting expansion of the said contact rings, circuit connections to the end members of said contact rings, and an auxiliary resistance wire located within said tube and connected in said circuit, in multiple with said contact rings, for insuring proper current flow, when said contacts are cold.

7. A voltage regulator comprising a series of contiguous conductor members having different coefficients of expansion and being

normally in imperfect contact with one another, and means for opposing the expansion of said members, whereby an increase in temperature due to the current flow through said conductor members will effect a corresponding increase in the contact pressure between the several members and a decrease in the electrical resistance of the series.

8. In a voltage regulator, the combination with a multiplicity of alternated carbon and metal contacts connected in a supply circuit, of a frame for resisting expansion of said contacts, whereby, under increasing current flow therethrough, said contacts will be engaged under increasing pressure and thereby afford a decreasing electrical resistance.

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

FREDERICK R. M. CUTCHEON.

Witnesses:

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