E. THOMSON.

RESISTANCE UNIT.

APPLICATION FILED DEC. 2, 1904.

945,993. Patented Jan. 11, 1910.

Fig. 1.

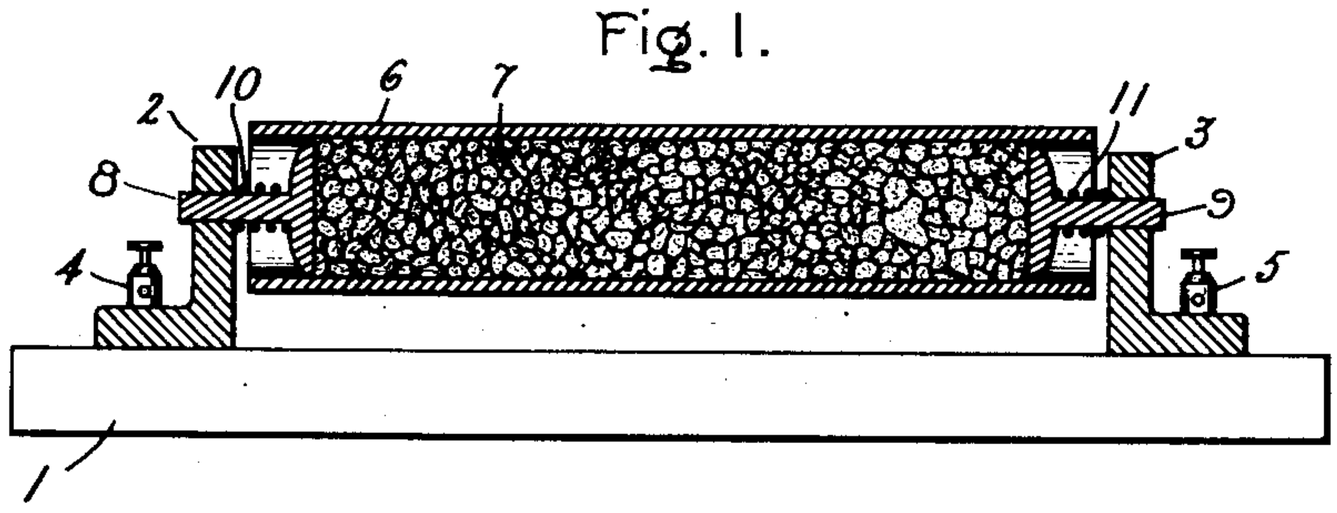


Fig. 2.

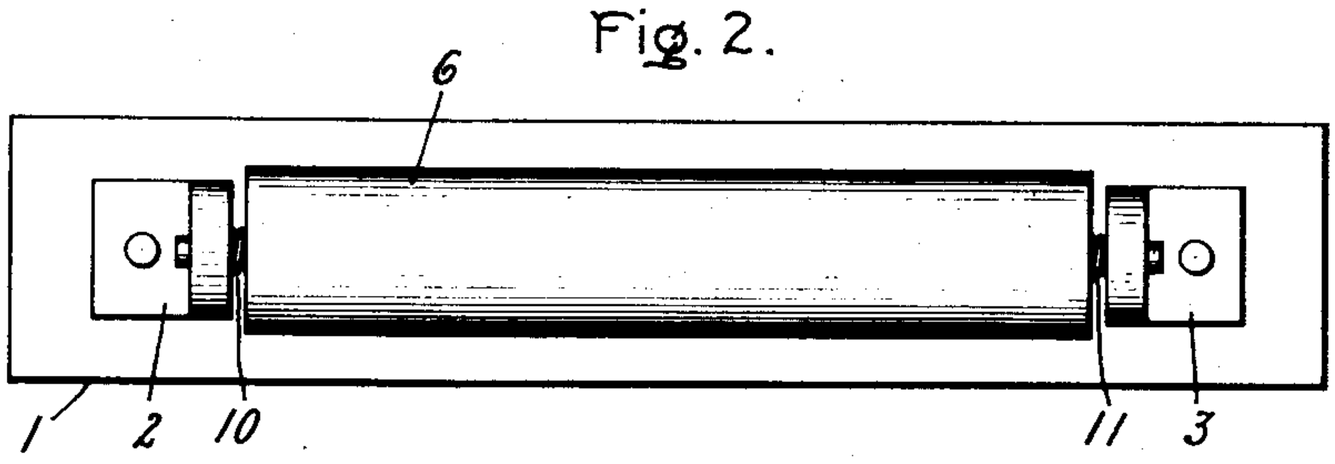


Fig. 3.

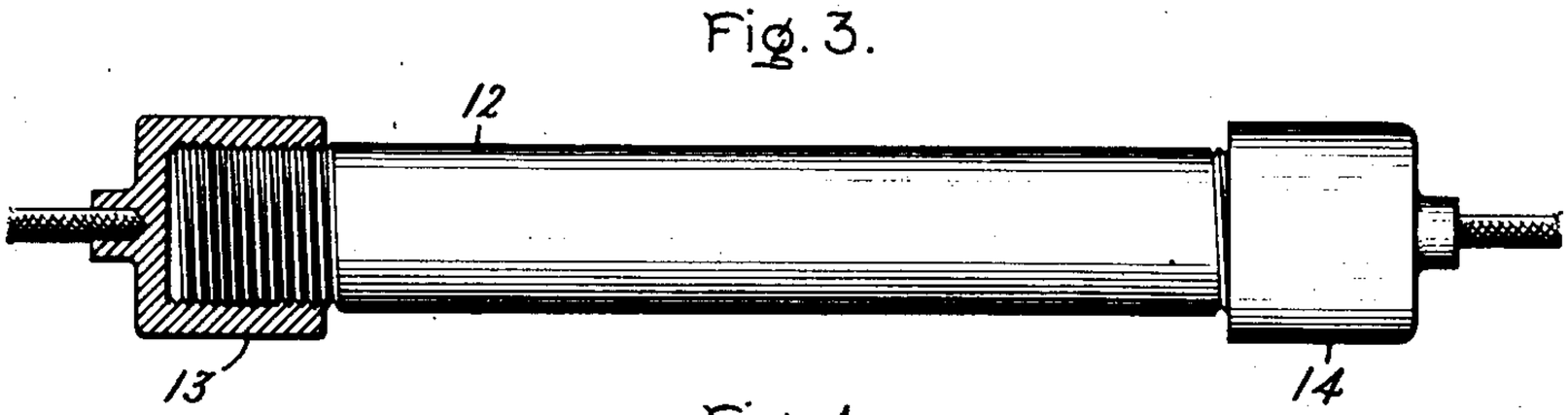


Fig. 4.

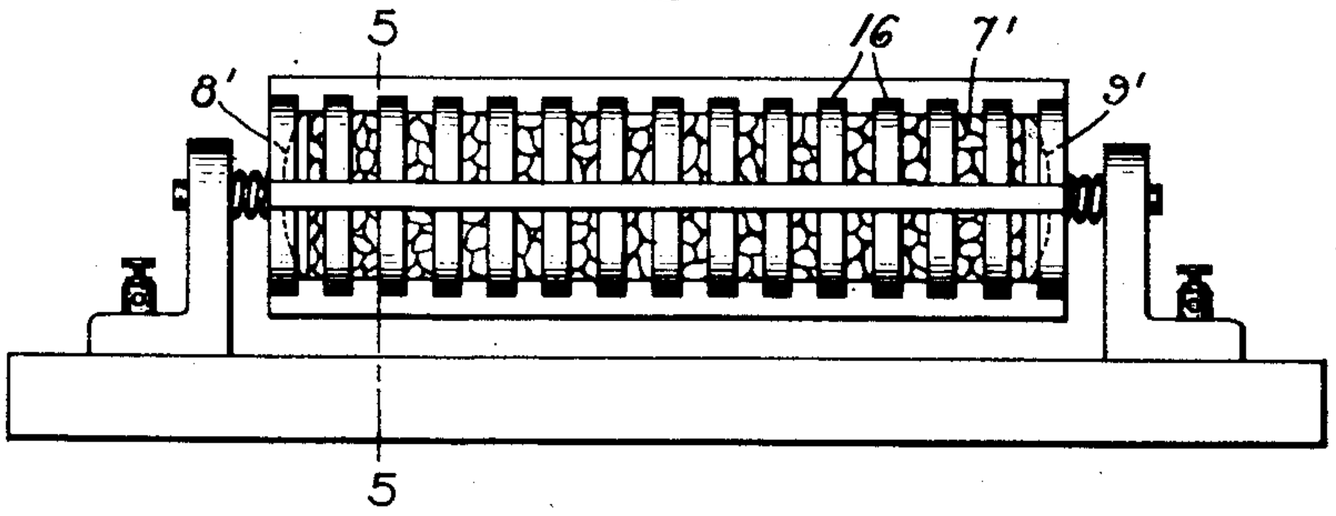
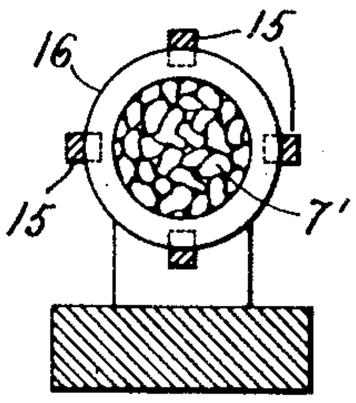


Fig. 5.



Witnesses:

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Att'y.

UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

RESISTANCE UNIT.

945,993. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed December 2, 1904. Serial No. 235,161.

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Resistance Units, of which the following is a specification.

This invention relates to an improved form of resistance unit. While this unit may be used in a great variety of ways it is believed to be particularly valuable when used for automatic current control or when used in connection with circuits subjected to sudden and heavy rushes of current, as for instance lightning arrester and similar circuits.

In the drawing, Figure 1 is a cross-section of one form of my improved resistance unit showing the granulated resistance material retained in the refractory tube; Fig. 2 is a plan view of the same; Fig. 3 is a resistance unit of cast silicon provided with suitable conducting terminals; Fig. 4 shows a refractory cage for supporting the granulated resistance material in place; and Fig. 5 is a cross-section on the line 5 5 of Fig. 4.

In Figs. 1 and 2 the non-conducting base 1 of porcelain or other suitable non-conducting material has secured rigidly thereto the metallic terminal blocks 2 and 3, carrying the binding posts 4 and 5 by which the unit may be connected in circuit. The non-conducting cylinder 6 incloses the resistance material 7, and holds it in place. This tube 6 consists preferably of a rough quartz cylinder such as may be made by melting granulated quartz around a heated carbon tube or by other well known processes. A tube of this material has the advantage that it does not become a conductor, except very slightly, even at very high temperatures, and furthermore, does not deteriorate when exposed to the air at these high temperatures. The resistance material 7 may consist of uncombined silicon in granular form. This element has a high specific resistance, a high fusing point and a suitable temperature coefficient, and furthermore is not readily oxidized at high temperatures; all of which characteristics make it admirably adapted for use as a resistance material for carrying sudden and heavy discharges. The resistance material 7 is preferably packed in a tube 6, and held firmly in place by the two metallic electrodes 8 and 9 supported respectively in the terminal blocks 2 and 3 and pressed toward each other by the coil springs 10 and 11, or other suitable spring mechanism.

At very high temperatures the element silicon may be fused and cast in the form of a prismatic or cylindrical unit as shown in Fig. 3, in which 12 is a silicon cylinder screw-threaded at each end and provided with metallic caps 13 and 14 of good conducting material to which the circuit may be connected. If desired, the terminals 13 and 14 may be cast directly to the ends of the silicon rod instead of being screw-threaded thereto.

In Figs. 4 and 5 is shown a modified form of resistance unit, similar to the form shown in Fig. 1 except that the quartz tube is replaced by a cage of refractory material. This cage consists of longitudinal bars 15 transversely notched to receive the rings 16, thus forming a cylindrical cage within which the resistance material 7′ is securely held under pressure by the metal electrodes 8′ and 9′.

The resistance of the units shown in Figs. 1 and 4 may be readily controlled by varying the size of the granulated particles, as well as by increasing the length and cross-section of the unit. As the specific resistance of the element silicon is nearly twice that of ordinary carbon, and furthermore as silicon unlike carbon is able to stand a red heat without oxidation, the units herein described are particularly valuable for use in connection with lightning arresters in place of the ordinary cylindrical resistance units or carbon or graphite.

Aside from the superiority of these resistance units for controlling sudden and heavy rushes of current they possess certain other valuable characteristics because of the peculiar temperature-resistance coefficient of the element silicon. At normal temperatures cast silicon has a nearly constant resistance so that upon an increase in temperature up to a red heat the electrical resistance increases only slightly. This variation is very much less than is ordinarily found in the metallic elements and above a red heat the resistance increases somewhat with temperature showing a positive temperature coefficient. This temperature coefficient is not, however, a constant for all higher degrees of

heat and at a temperature approximating that of melting silver the temperature coefficient reverses in sign so that a further heating causes an actual and rather rapid reduction in the resistance of the unit. This negative temperature coefficient makes the resistance units herein described suitable for automatic motor starting rheostats and for other purposes where it is desirable that the resistance should automatically decrease as the impressed voltage or the current flow increases. The change in temperature coefficient from a slight or positive value to a high negative value thus successively increasing and decreasing the resistance makes the silicon resistance units available for automatic protectors and regulators for a great variety of purposes, such for instance as automatic cut-outs for mercury vapor lamps and other translating devices used in series circuits, or as a means for automatically grounding a circuit to static or other abnormal voltage.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. In a resistance unit, a resistance material consisting of granulated silicon, and means for retaining said material in place under pressure.

2. In a resistance unit, conducting terminals and a resistance material between said terminals, said resistance material consisting of granulated silicon.

3. A resistance unit comprising a quartz tube, a resistance material consisting of granulated silicon packed within said tube, conducting terminals in contact with said material, and means for retaining said resistance material under pressure.

4. A resistance unit comprising a non-conducting tube, a resistance material in granular form packed within said tube, said resistance material consisting of an incombustible substance having a negative temperature-resistance coefficient at certain temperatures, conducting terminals in contact with said material, and means for retaining said material under yielding pressure.

In witness whereof I have hereunto set my hand this 14th day of November, 1904.

ELIHU THOMSON.

Witnesses:

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DUGALD MCK. MCKILLOP.