(No Model.)

H. E. WERLINE.

ELECTRICAL RESISTANCE.

No. 549,470. Patented Nov. 5, 1895.

Fig. 3.

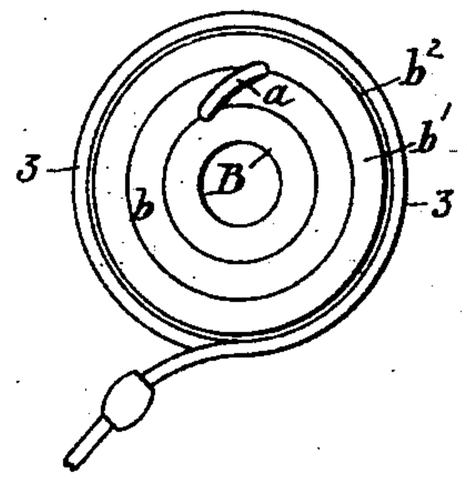


Fig. 1.

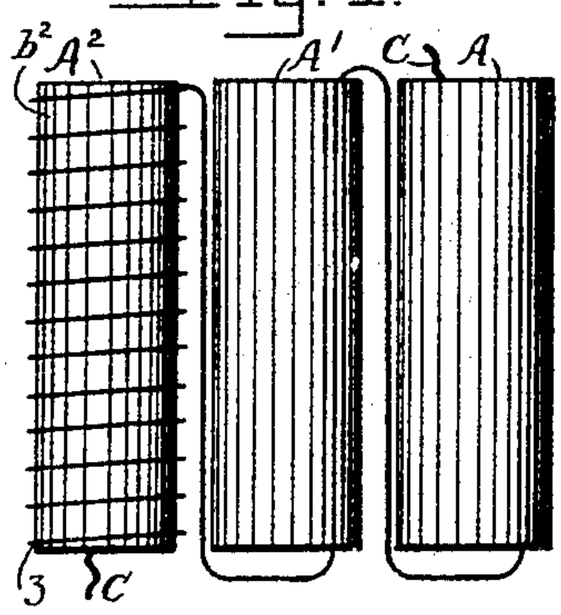
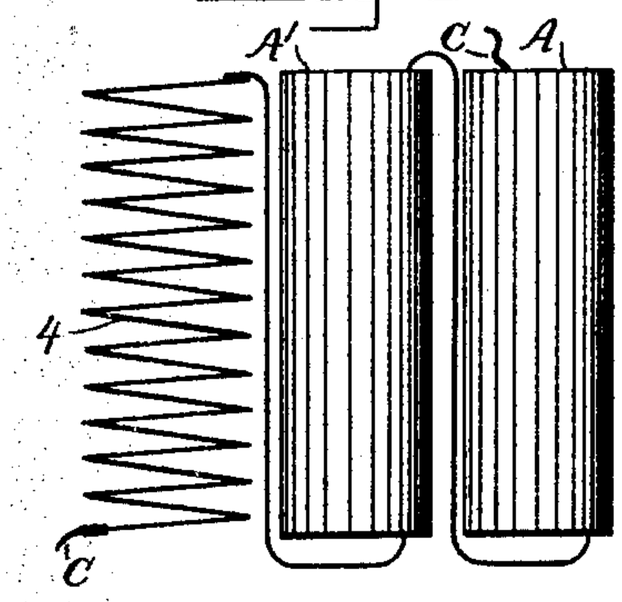


Fig. 2.



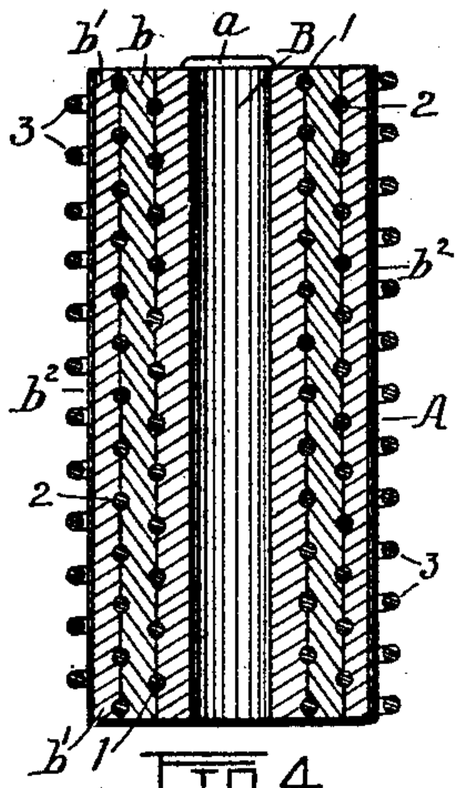


Fig. 4.

Fig. 6.

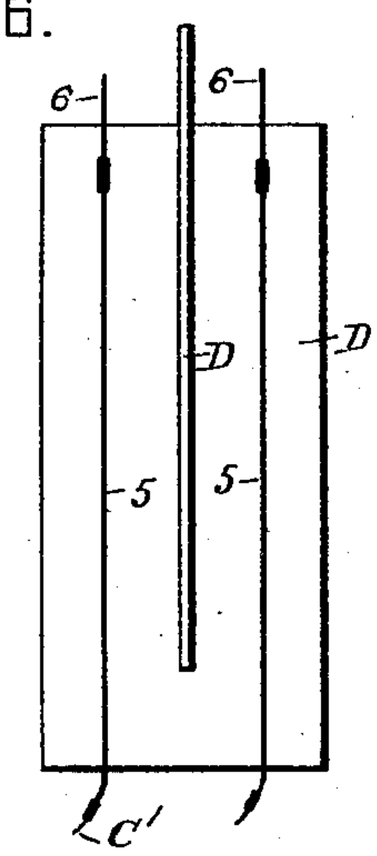
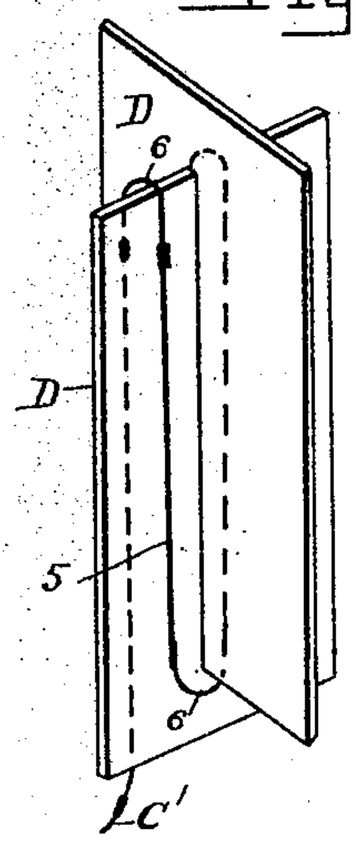


Fig. 5.



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UNITED STATES PATENT OFFICE.

HENRY ELMER WERLINE, OF LANCASTER, PENNSYLVANIA, ASSIGNOR OF THREE-FOURTHS TO FRANK S. BARR, OF SAME PLACE, AND EDWIN L. REINHOLD AND HENRY BURD CASSEL, OF MARIETTA, PENNSYLVANIA.

ELECTRICAL RESISTANCE.

SPECIFICATION forming part of Letters Patent No. 549,470, dated November 5, 1895.

Application filed December 23, 1895. Serial No. 494,539. (No model.)

To all whom it may concern:

Be it known that I, HENRY ELMER WERLINE, a citizen of the United States, residing in Lancaster, in the county of Lancaster and State of Pennsylvania, have invented certain Improvements in Electrical Resistances, of which the following is a specification.

This invention relates to improvements in that class of devices designed to retard the flow of an electric current through a circuit; and the objects of the improvements are, first, to concentrate the resistance-filaments; second, to prevent contact between the lapping portions of resistance-filaments; third, to facilitate the escape of heat from said lapping filaments; fourth, to maintain a uniform flow of the electric current through said filaments, and, fifth, to maintain the resistance-filaments and the parts connected therewith in their relative positions.

With these objects in view the invention consists in the construction and combination of the various parts, as hereinafter fully described, and then pointed out in the claims.

In the accompanying drawings, forming part of this specification, Figure 1 is a side elevation of two nests of wire coils and a nest of combined wire and carbon coils, all of said coils being connected to form parts of the same circuit. Fig. 2 is a similar view of two nests of wire coils and of a single carbon coil, all connected to form parts of the same current. Fig. 3 is an enlarged top view of the nest of combined wire and carbon coils shown in Fig. 1, and Fig. 4 a similar vertical section through the same. Fig. 5 is a perspective view of a group of separate carbons connected by loops, and Fig. 6 a view of that side of said group on which the terminals of the carbons are united with the line-wires.

Similar numerals and letters indicate like parts throughout the several views.

For the purposes of this specification when spoken of generally the resistance mediums are termed "filaments," and the assemblage of coils of filaments in one body "nests." Nests may contain only resistances of wire coils, as in nests A A′, Figs. 1 and 2, or they may combine inner wire coils with an outer surrounding coil of carbon 3, as shown in nest A^2.

In the nests shown, B indicates a tubular core of asbestos, around which is wrapped a wire, constituting an inner coil 1. This wire is so wrapped around the core as to be partially embedded in the asbestos, the convolutions of the coils being wound as close together as can be done without danger of bringing them into contact with each other. When the coil has been carried to the top of the core, an annular wall or jacket *b*, of asbestos, is placed around it and the continuation of said wire is then carried across the upper edge of jacket *b*, as shown at *a*, and wound down and around the same to the bottom of the nest, when another annular wall or jacket *b′* of asbestos is also placed around the second coil 2, about which jacket *b′* the wire is again wound upward and constitutes the outer coil.

The number of coils in the nests may be varied in proportion to the amount of resistance required in each case; but it is preferable that that number be so regulated that the inner coil may be connected with a line-wire at one end of the nest and the outer coil with a line-wire at the other end. The core need not necessarily be tubular; but it is preferably so to facilitate the escape of heat from the center of the nest. It will be observed that in this construction the coils themselves are separated by the walls of asbestos, and that the convolutions of each coil are also separated from each other by being embedded in the asbestos, so that all parts of the resistance medium are rigidly retained in their relative positions, and accidental contact of those parts is positively prevented. In addition to the walls or jackets of asbestos mentioned, the outer coil of wire is also protected by an outer wall or jacket of the same material, and this again is covered by a coating b^2 of cement or other similar material, which, after hardening, binds the parts of the nest together and prevents any displacement thereof.

With the wire coils I combine coils of carbon when necessary. As shown in Figs. 1 and 3, there is an outer coil 3 of carbon, embracing one of the nests of wire coils, the free end

of the outer wire coil of said nest being connected with the adjacent end of the carbon coil, the other end of which is connected with a line-wire C. In Fig. 2 is shown an independent carbon coil 4, which is connected with the outer coil of the adjacent nest and with a line-wire.

In the nest combining the wire and the carbon coils (shown in Fig. 1, 3, and 4) the coil 1 is formed about core B and protected by jacket *b*. The extension of the wire-forming coil 1 is then wound around jacket *b* to form coil 2 and is protected by asbestos jacket *b'* and a coat of cement b^2. After the cement has set the nest protected thereby is inserted through the center of carbon coil 3, which is then connected with the outer wire coil 2. The carbon coil has such inner diameter as to permit the other portion of the nest to be freely inserted therein. Should another wire coil be used instead of the carbon, it is formed and covered as before described.

With the increase of temperature caused in the wire coils by the flow of the electric current through them the resistance of the wire to such flow increases, while the increase of the temperature of the carbon coils decreases the resistance thereof to the flow of said current. In this combination of the wire and carbon in an electric resistance to the same current the increase and decrease, respectively, in the two mediums counteract each other and a uniform resistance is maintained.

Another mode of assembling the resistance-filaments is shown in Figs. 5 and 6. In this construction the nests are formed of a number of straight parallel rods or pencils 5 of carbon, lapping each other and having their adjacent ends connected by curved sections of wire 6, the carbon rods being separated by walls D, of mica or other non-conducting material, over the end edges of which the curved sections of wire 6 pass. The terminals of the end rods of the series are attached to line-wires C', which may be connected in the same manner as are the terminals of the coils, or a number of nests of these rods may be connected with each other. An assemblage of these resistance-nests may be connected with a switch—for instance, as shown and described in Letters Patent No. 478,149, issued to me July 5, 1892—or in any other suitable manner, whereby one or more of said resistance-nests may be cut out of the circuit to vary the flow of the current. No particular form or application of such a switch is shown, as it forms no part of this invention. Whether the filaments are grouped in coils or in straight sections, each coil and each section is separated from the other by some non-conducting material, asbestos being employed in preference, though I do not limit myself to its use.

I do not limit myself to the use of the materials herein mentioned in the construction of my resistance-filaments, as any material suitable for the purpose may be employed, nor to any special thickness or cross-section of the filaments; neither do I confine myself to any particular sequence in the combination of different materials adapted to counteract the variations in the flow of the electrical current through each other; neither do I restrict myself to the particular arrangement or form of assemblage of filaments herein shown and described.

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

1. The combination, in an electrical resistance, of lapping filaments connected to form a continuous conductor, the electrical resistance of a portion of said conductor varying in a direction opposite to that of another portion thereof under changes of temperature, and non-conducting walls interposed between the lapping filaments.

2. The combination, in an electrical resistance, of lapping filaments, non-conducting walls interposed between the filaments, and connections passing around the edges of the walls and uniting the ends of the filaments, to form a continuous conductor, the electrical resistance of a portion of said conductor varying in a direction opposite to that of another portion thereof under changes of temperature.

3. In an electrical resistance, the combination, with a non-conducting core, of a conductor-filament coiled around said core, a non-conducting wall surrounding said filament, a conductor-filament the electrical resistance of which varies in a direction opposite to that of the first filament under changes of temperature and coiled concentrically therewith around said wall, and an electrical connection between said filaments, substantially as and for the purpose specified.

4. In an electrical resistance, the combination, with a non-conducting core of impressible material, of a conductor-filament coiled around and impressed in said core, a non-conducting wall surrounding said filament, a conductor-filament the electrical resistance of which varies in a direction opposite to that of the first filament under changes of temperature and coiled concentrically therewith around said wall, and an electrical connection between said filaments, substantially as and for the purpose specified.

5. In an electrical resistance, the combination, with a non-conducting tubular core, of a conductor-filament coiled around said core, a non-conducting wall surrounding said filament, a conductor-filament the electrical resistance of which varies in a direction opposite to that of the first filament under changes of temperature and coiled concentrically therewith around said wall, and an electrical connection between said filaments, substantially as and for the purpose specified.

6. In an electrical resistance, the combination, with a non-conducting tubular core of

impressible material, of a conductor-filament coiled around and impressed in said core, a non-conducting wall surrounding said filament, a conductor-filament the electrical resistance of which varies in a direction opposite to that of the first filament under changes of temperature and coiled concentrically therewith around said wall, and an electrical connection between said filaments, substantially as and for the purpose specified.

7. In an electrical resistance, the combination, with a non-conducting core, of a series of conductor-filaments coiled concentrically, one over the other, around said core, non-conducting walls interposed between the coils of filaments, and electrical connections between said filaments, the electrical resistance of one of said filaments varying in a direction opposite to that of the other filaments under changes of temperature, substantially as and for the purpose specified.

8. In an electrical resistance, the combination, with a non-conducting core of impressible material, of a series of conductor-filaments coiled concentrically, one over the other, around said core, non-conducting impressible walls interposed between the coils of filaments, and electrical connections between said filaments, the electrical resistance of one of said filaments varying in a direction opposite to that of the other filaments under changes of temperature, substantially as and for the purpose specified.

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