Dec. 19, 1950 B. B. SCOTT ET AL 2,534,994

PRECISION ELECTRICAL RESISTANCE DEVICE AND METHOD OF MAKING IT

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Fig. 1.

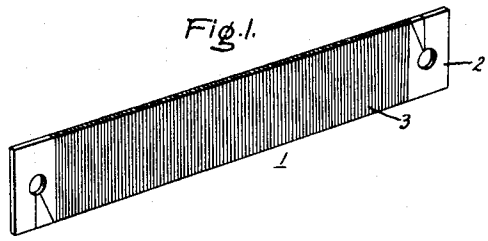


Fig. 2.

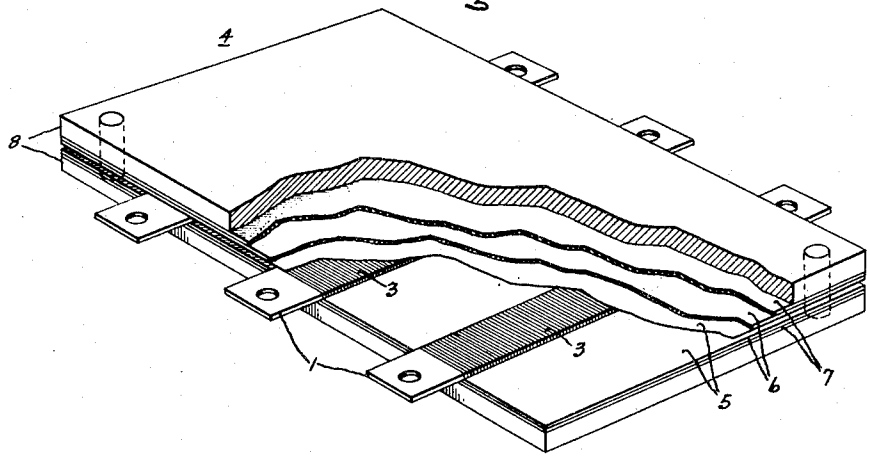


Fig. 3.

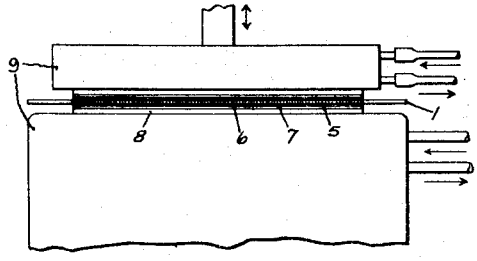


Fig. 4.

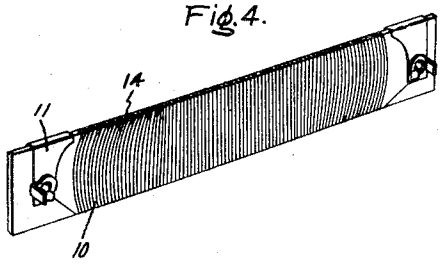
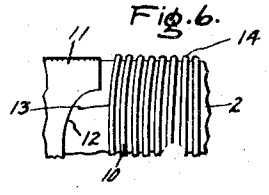


Fig. 5.



Fig. 6.



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PRECISION ELECTRICAL RESISTANCE DEVICE AND METHOD OF MAKING IT

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Application December 27, 1948, Serial No. 67,472

9 Claims. (Cl. 201—64)

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Our invention relates to precision wound electric resistances and to a method of making precision resistances.

An object of our invention is to provide a precision wire wound resistance for use in electrical computers, and the like, whose fine wire turns will remain in place to insure long brush life and which will be free from turn to turn short circuiting in spite of non-regular spacing of turns and the tendency to clearance between the wire and its supporting card due to column bending of said resistances during winding.

The brush life of resistances is largely determined by the effectiveness of the bonding between wire turns and cards. Where the resistance wire is firmly fastened at the brushing edges true wire wear from brush contact only occurs, but where turns are loose on the card, movement and flexing of the wire occurs resulting in short brushing life making a difference of a hundred to a thousand fold in the life expectancy of the resistance.

Former methods of manufacturing accurate resistances were not adequate for making the precision resistances required for computers and the like. Existing varnishes had neither the required strength nor the necessary adhesive qualities to hold the wire in place on the card used for such an application. Soft card material to anchor the wire cannot be used since such material is electrically unsatisfactory when impregnated with moisture. The small sizes of wire necessitated by the requirement of precision resistances, do not lend themselves to the use of notched cards, since any variations in the corresponding small notches would cause relatively uneven brushing characteristics. Also, variations in commercial wire diameter makes unequal spacing necessary to maintain the high turn resistance accuracy required, but no satisfactory method has heretofore been devised for producing resistors having unequally spaced turns, properly anchored to the card and separated and insulated from one another.

In accordance with our invention, the wound resistance is coated with a thermosetting resin bonding material and, when desired, an impregnated protective strip is stuck to each side of the resistance. The resistance is air dried and then oven dried to remove solvent, after which it is pressed under heat and cooled. The wire ends are fastened to relieved terminal strips riveted to each end of the cards to provide an over run for the contacting brush. A felt wheel impregnated with an abrasive removes the insulating material covering the brushing edge of the resistance.

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For a more complete understanding, reference is directed to the accompanying drawing of one embodiment of our invention, in which Fig. 1 is a view of the resistance as it leaves the winding machine, Fig. 2 is a cut away view of three resistances held in a press fixture, Fig. 3 is a view of that fixture as held in a hydraulic press; Fig. 4 is a view of the finished resistance with the relieved terminal strips attached; Fig. 5 is a view of a relieved terminal strip and Fig. 6 is an enlarged sectional view of a terminal strip in relation to adjacent end turns.

Referring to the drawing, in the resistance 1, the support or card 2 upon which the resistance wire 3 is wound, is composed of varnish impregnated glass fabric. This material is used because its temperature coefficient of expansion approximates that of the wire wound upon it and it is not adversely affected by moisture.

After the resistance has been wound as shown in Fig. 1, it is immersed in thermo-setting resin solution, diluted by solvent to such a consistency as will cause it to flow around the wires and the card, until such time as air-bubbles no longer appear. Following a slow removal from the solution the resistance is placed upon wrapping paper with its brushing edge upwards, until excess solution has drained off, after which a strip of plastic material or varnish impregnated material such as electrical-grade paper, woven Nylon or Rayon of a thickness of substantially 0.0005'' or less is stuck along each of the resistance sides. The resistance then is dried in air from two to twenty-four hours and in a drying oven at 75 deg. centigrade for final solvent removal. The purpose of these strips is to form continuous skin-like surfaces attached to the outside of the wire turns so that particles of metal cannot become lodged between wire turns to cause turn to turn short circuits and also to prevent the movement of individual turns thereby materially increasing brushing life of the resistance.

In the next step sufficient resistances 1 are placed in a pressing fixture 4 to constitute a load. Within the fixture in addition to the resistances, are the cellophane sheets 5 to prevent sticking, polished steel plates 6 to provide a smooth surface finish and silicone rubber sheets 7 between the steel plates and the fixture to insure pressure equalization in spite of the usual non-uniformity of card thickness. Silicone rubber is used since it can withstand the high heat used. The cover plates 8 of the fixture 4 are constructed of quarter inch aluminum plates dowelled to prevent relative slipping. This fixture can readily be in-

serted and removed from between the steam heated platens 9 of a suitable hydraulic press.

The heat-pressing process causes the turns of wire to be pressed flat to the card. Under this pressure excess plastic flows from the card centers toward the edges and towards both ends. From zero at the center the excess accumulates towards the ends until at the end turns enough force is exerted by this flow of excess plastic to stretch the wire beyond the elastic limit in arcs bending towards the card ends.

Computer resistances require that a continuous circuit be maintained when the brush travels beyond the limits of the wire turns so that terminal strips 11 are riveted to the resistance card at each end to accommodate this over-run. These terminals are approximately of the same thickness as the wire and spaced from the end turns the same distance as the spacing between two wires so that the brush cannot fall between the terminal and the end turn to exert a dislodging force on that turn.

To accommodate the distortion of the end turns mentioned above, the contour of the terminal band is relieved by having portions of each side adjacent the turns cut away as indicated by the curved edge 12 so that when riveted to the supporting member there is clearance between the terminal band 11 and the distorted end turn portion 13. The terminal band 11 is U-shaped with equal sides, having a length substantially equal to one-half of the width of the card so that the ends of the resistance wire can be attached to either side of the terminal band allowing an accuracy of attachment of wire ends to within the length of one-half turn.

In the final operation the insulation is removed from the brushing edge 14 of the resistance by an abrasive impregnated felt butting wheel.

For resistances treated with a solution of equal parts of a polyvinyl formal resin and permafil, pressure is supplied with the patents held at a temperature of 170 deg. centigrade for 15 minutes, when the steam is shut off and the platens cooled with water to room temperature in four minutes. The resin employed in the practice of this invention, comprises a mixture of ingredients containing (1) a polyvinyl formal resin obtained, for example, by the partial hydrolysis of polyvinyl acetate and the subsequent co-reaction of the partially hydrolyzed polyvinyl acetate with formaldehyde, and (2) a mixture of ingredients (known as permafil) comprising (*a*) an unsaturated alkyd resin comprising a polyhydric alcohol ester of alpha unsaturated, alpha, beta polycarboxylic acid, for instance, diethylene glycol maleate and (*b*) an unsaturated monohydric alcohol polyester of an organic polycarboxylic acid, for instance, diallyl phthalate. The resinous compositions employed in this invention are more particularly disclosed and described in the copending application of John A. Loritsch, Serial No. 601,591, filed June 26, 1945, now Patent 2,528,235, dated October 31, 1950, and assigned to the same assignee as the present invention.

It is to be understood that the scope of our invention is not to be restricted to the particular bonding material described above.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An electrical resistance comprising a supporting member having substantially smooth surfaces, resistance wire disposed in turns about said supporting member, a thermo-setting resinous material applied to said support member and to said turns of wire to provide insulation between said turns and to adherently bond said turns to said member to prevent relative movement therebetween, and terminal means for said resistance.

2. An electrical resistance comprising a supporting member having substantially smooth surfaces, resistance wire disposed in turns about said supporting member and forming a brushing surface of portions of said wire turns, a thermosetting resinous material applied to said support member and to said turns of wire to provide insulation between said turns and to adherently bond said turns to said member to prevent relative movement therebetween, and terminal means for said resistance.

3. An electrical resistance comprising a supporting member having substantially smooth surfaces, resistance wire disposed in turns about said supporting member and forming a brushing edge of portions of said wire turns, a thermosetting resinous material applied to said support member and to said turns of wire to provide insulation between said turns and to adherently bond said turns to said member to prevent relative movement therebetween, and terminal means for said resistance.

4. An electric resistance comprising a supporting member having substantially smooth surfaces, turns of resistance wire disposed about said supporting member in a desired unequal spaced relation depending upon variations in diameter of said wire and predetermined resistance characteristics required of said device, and a thermosetting resin material applied to said supporting member and said turns of resistance wire to adherently bond said wire to said supporting member to maintain said desired spaced relation of said turns of wire and to insulate said turns of wire from each other.

5. A precision resistance device comprising a supporting member, turns of wire wound on said supporting member, and a relieved contour terminal strip secured to said supporting member in spaced relation to said turns of wire to provide an over run brushing contact surface and to prevent engagement of a plurality of said turns of wire with said terminal strip with consequent short circuiting of said turns.

6. An electrical resistance comprising a supporting member having substantially smooth surfaces, resistance wire disposed in turns about said supporting member and forming a brushing surface of portions of said wire turns, a thermosetting resinous material applied to said support member and to said turns of wire to provide insulation between said turns of wire and to adherently bond said turns to said member to prevent relative movement therebetween, and a relieved contour terminal strip secured to said supporting member in spaced relation to said turns of wire to provide an over-run brushing contact surface and to prevent engagement of a plurality of said turns of wire with said terminal strip with consequent short circuiting of said turns.

7. The method of making an electric resistance comprising winding resistance wire in spaced turns on a supporting member to form a brushing edge of portions of said turns, applying a thermosetting resinous material to said supporting member and wire, compressing said material in the presence of heat to form an adherent bond between said turns and said support member to prevent relative movement therebetween, and

removing an excess of said material from said brushing edge to permit electrical contact with said wire along said brushing edge.

8. The method of making an electric resistance comprising winding resistance wire in spaced turns on a supporting member to form a brushing edge of portions of said turns, applying a thermosetting resinous material diluted by solvent to flow consistency, compressing said material and drying the solvent therefrom, compressing said material in the presence of heat to form an adherent bond between said turns and said support member to prevent relative movement therebetween, and removing an excess of said material from said brushing edge to permit electrical contact with said wire along said brushing edge.

9. The method of making an electric resistance comprising winding turns of resistance wire on a smooth surfaced supporting member in unequally spaced relation dependent upon the resistance and diameter of succeeding turns and on the desired resistance characteristics of the device to form a brushing surface of portions of said turns, immersing said wire and supporting member in a liquid solution of thermosetting resinous material until air bubbles no longer appear in the fluid, removing said support and wire slowly, placing said support and wire on a liquid absorbent material until excess liquid drains off, air drying said resistance, heating said resistance until solvent thereof is finally removed, simultaneously pressing and heating said resistance to effect curing of the resin, mounting terminal strips on said supporting member in spaced relation to said wire, attaching the ends of said wire to said terminal strips and removing an excess of said resinous material from said brushing surface to prevent electrical contact with said wire along said brushing surface.

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