Aug. 26, 1958 C. J. ROACH 2,849,350

RESISTANCE ELEMENT METHOD OF MANUFACTURE

Filed March 25, 1955

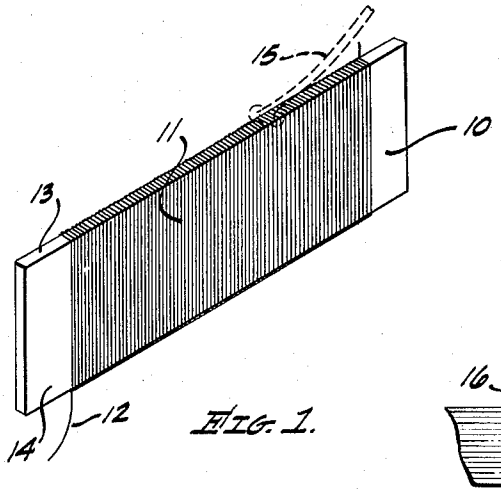


FIG. 1.

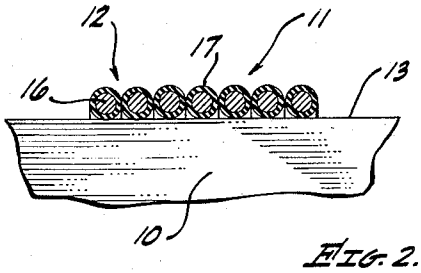


FIG. 2.

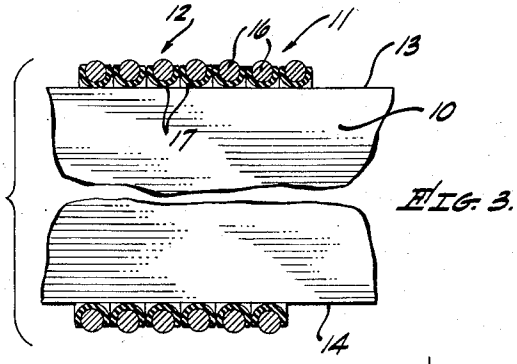


FIG. 3.

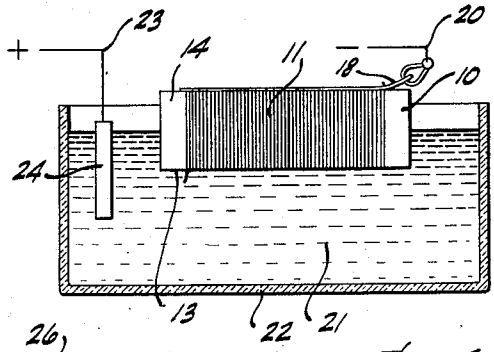
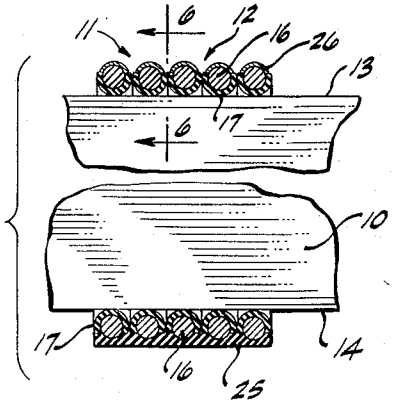


FIG. 4.

FIG. 5.



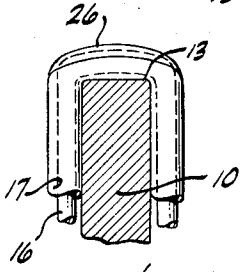


FIG. 6.

INVENTOR
CHARLES J. ROACH,
BY
Henry Hyman
ATTORNEY

United States Patent Office 2,849,350 Patented Aug. 26, 1958

2,849,350

RESISTANCE ELEMENT METHOD OF MANUFACTURE

Charles J. Roach, Los Angeles, Calif., assignor to Hughes Aircraft Company, a corporation of Delaware

Application March 25, 1955, Serial No. 496,681

1 Claim. (Cl. 204—15)

The present invention relates generally to a method for producing electrical resistance elements and the like, and relates more particularly to a method for producing non-corrosive wire wound electrical resistance elements.

Heretofore, considerable difficulty has been encountered due to corrosion of bare wire portions of resistance elements. It is customary practice to employ a strip of support material or card that is generally rectangular in cross-section, and to wind a plurality of convolutions of an insulated wire about this card. The card thereafter may be curved into a generally semi-circular configuration or may be used flat. In any event, it is also a customary practice to remove the insulatory coating, such as enamel, for example, from the windings and along a line overlying one edge of the card. A contact member or wiper arm is designed to travel along this exposed strip portion of the wire, with electrical connections being made with one end of the wire convolutions and with the contact member. In devices of this type, it is essential that the exposed portions of the convolutions be extremely clean and free from any undue roughness, in order, partially, that the contact member may freely and easily move along this exposed portion of the wire convolutions.

In resistance elements of the class described, it is necessary that the wire utilized therein have a relatively low temperature coefficient of expansion, a relatively high tensile strength and a high electrical resistivity relative to the ohms per circular mil foot. In order to fulfill such requirements, it is common practice to employ wires made from various nickel alloys or nickel-chromium alloys; however, such alloys are frequently susceptible to corrosive action due to particular surrounding atmospheric media, thus creating surface contamination and associated roughness on exposed portions of the convolutions. Surface roughness on the exposed portions of the wire convolutions causes considerable electrical or electronic "noise" in devices incorporating potentiometers or the like in which such resistance elements are used. Such "noise" creates undesirable disturbances in the function and efficiency of these units and must accordingly be eliminated.

This problem has been recognized for a considerable period of time; however, the solutions offered by the prior art have had several disadvantages. For example, it has been proposed that various precious metals be utilized in the manufacture of the wire; however, the necessary and desirable factors set forth hereinbefore, relative to the wire used in resistance elements, cannot be met by precious or several other types of metals. In another instance, it has been proposed that wire used in such resistance elements be plated overall and then have a layer of insulating material applied thereto prior to winding upon a supporting card. This alleged solution to the problem presents certain disadvantages relative to the changed resistivity of the wire in accordance with the diameter thereof and accordingly, such overall plated wire is unsatisfactory for the present purpose. In addition, overall plating of wire is extremely difficult to accomplish while still maintaining a uniform plating thickness in order that the end product may be linear in function throughout the length thereof.

A still further proposed solution to the present problem has been that of the disposition of the electrical resistance element in a liquid such as, for example, oil or various types of silicon liquids. While such immersion will prevent most corrosive action on exposed portions of the wire convolutions, the presence of the liquid naturally increases the torque or other force required to move the contact member over the surface of the exposed wire portions. In the present instance, it is necessary that the torque required for movement of the contact member be in the nature of .01 to .03 inch/ounces of torque input.

Accordingly, it is one important object of the present invention to provide a novel method for producing resistance elements having low corrosive characteristics.

Another important object of the present invention is to provide a novel method for producing electrical resistance elements wherein exposed portions of wire convolutions therein are rendered non-corrosive by plating with a precious metal.

A further important object of the present invention is to provide a method for producing non-corrosive resistance elements wherein the wire utilized therewith has a low coefficient of expansion, high tensile strength and high electrical resistivity as compared with normally corrosive components of electrical resistance elements.

Still another important object of the present invention is to provide a novel method for plating portions of wire utilized in electrical resistance elements.

A still further important object of the present invention is to provide a novel method for producing electrical resistance elements wherein such elements have low electrical or electronic "noise" creating characteristics.

Another object of the invention is to provide a method for producing electrical resistance elements wherein portions of wire convolutions are protected against corrosion by plating with precious metal and wherein a consistent foot to foot electrical resistance accurately is maintained.

A further important object of the present invention is to provide a method of producing electrical resistance elements wherein the resulting end product is efficient, effective and reliable in operation and use.

Other and further important objects of the present invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawing, wherein:

Figure 1 is an isometric view showing one form of electrical resistance element that may be manufactured by means of the process of the present invention;

Fig. 2 is a greatly enlarged fragmentary sectional view through a portion of the wound wire convolutions immediately after being applied to a supporting material;

Fig. 3 is a view similar to Fig. 2 showing the wire convolutions substantially as they will appear in the next step in the process;

Fig. 4 is a generally diagrammatic view showing the method of plating exposed portions of the wire convolutions employed in the present process;

Fig. 5 is an enlarged fragmentary sectional view similar to Fig. 3 showing the general appearance of the wire, plating and insulation following completion of the various steps in the present process; and

Fig. 6 is a transverse sectional view taken as indicated by line 6—6, Fig. 5.

With reference to the drawing, as shown in Fig. 1, a strip of support material 10 is adapted to be wound with a plurality of convolutions 11 of a composite insulatory coated wire 12. As shown, in this particular form of the invention, the card or support material 10 is generally

rectangular in cross-section and has longitudinally extending edges 13 and 14. The convolutions of the wire overlying one of the edges, as, for example, edge 13 are adapted to be treated by means of the process to be hereinafter more fully described, and a contact member or wiper arm 15 is adapted for cooperation therewith.

The base wire utilized in the present process may be of any suitable type having the desired characteristics in regard to a low coefficient of expansion, tensile strength and electrical resistivity, as hereinbefore described, such as the characteristics presented by various types of nickel-chromium alloys. As shown in Fig. 2, the composite wire 12 includes the main wire portion 16 having an insulatory coating of enamel or the like applied thereto as at 17. With the coated wire wound in the manner shown in Fig. 2, is it common practice to employ either an abrasive or solvent to remove the insulatory coating from the curved portions of the convolutions overlying one of the edges of the card 10. In carrying forth the process of the present invention, the coating 17 on the wire is removed from both rounded edges of the wire overlying both of the support material edges 13 and 14, so that the wire will appear generally as shown in Fig. 3.

After removal of the wire insulatory coating 17, as shown in Fig. 3, a shorting strip of material 18 is positioned to overlie and interconnect the various convolutions along one of the exposed edges thereof, in the particular illustration, edge 14. The shorting strip 18 may be of any desired material such as, for example, a continuous metallic strip, metallic wool or the like. This shorting strip 18 may then be connected to one side of a suitable source of current by means of a lead 20. The card may thereafter be inverted, as shown in Fig. 4, and immersed a portion of its width into an electroplating solution 21 that may be retained in a suitable container 22. The other side of the circuit is completed through a lead 23 and a plate 24 disposed in the solution 21. The electroplating solution 21 is derived from a precious metal such as, for example, rhodium, gold, platinum or indium, with such precious metal being plated upon the exposed portions of the wire convolutions overlying the edge 13 of the support material 10. The coating 17 protects other portions of the wire convolutions from being effected by the plating action. It is to be understood, in this connection, that while the present invention is described to include electroplating specifically, other forms of plating may be employed without departing from the spirit and scope hereof.

In certain prior art situations, it has been proposed that the plating of certain portions of wire convolutions may be accomplished by applying one of the electroplating leads to one or both of the ends of the wire wound about the support material. While the plating may be accomplished in this manner, the inherent resistance of the wire prevents even application of the plating to all

of the various convolutions thereof, i. e. the convolutions adjacent the ends of the support material would be more heavily plated than the convolutions in the central area thereof. Such uneven plating would result in non-linear characteristics in the resultant electrical resistance element. As set forth hereinbefore, in the present method, any uneven plating is avoided through use of the shorting strip 18 and the general application of current in a like manner to all of the wire convolutions.

After the electroplating step in the process has been completed, the metallic shorting strip 18 is removed from its position overlying the exposed portions of the winding about the edge 14 of the support material 10. The portion of the wire convolutions formerly in contact with the shorting strip 18 is thereafter reinsulated by application of a continuous insulatory coating, as indicated at 25 in Fig. 5. The completed resistance element will thereafter appear as shown in Fig. 5 with a plated layer of precious metal being disposed on the exposed portions of the wire as indicated at 26. Thus, the plating 26 is applied to the wire over a very short distance and only as shown with reference to Figs. 5 and 6, so that no appreciable change will be experienced in the resistivity of the wire, and that a smooth non-corrosive surface will be presented along which a contact member may operate.

Having thus described the invention and the present embodiment thereof, it is desired to emphasize the fact that many modifications may be resorted to in a manner limited only by a just interpretation of the following claim.

What is claimed is:

A method of manufacturing electrical resistance elements comprising, in combination, the steps of: winding a plurality of convolutions of an insulated non-precious wire about an elongated rectangular support; removing insulation from said wire along entire transverse opposite edges of said support; electrically connecting all of said convolutions along one edge of said support; electroplating a precious metal on exposed portions of said wire along the other edge of said support; eliminating said electrical connecting; and reinsulating said convolutions along said one edge of said support.

References Cited in the file of this patent

UNITED STATES PATENTS

1,563,731	Ducas	Dec. 1, 1925
1,939,902	Kaul	Dec. 19, 1933
1,987,118	Lodge	Jan. 8, 1935
2,023,603	Lodge	Dec. 10, 1935
2,204,623	Ruben	June 18, 1940
2,479,302	Bondley	Aug. 16, 1949
2,682,501	Teal	June 29, 1954
2,694,040	Davis et al.	Nov. 9, 1954