June 18, 1940. S. RUBEN 2,204,623

VARIABLE RESISTOR

Filed July 17, 1936

FIG.1.

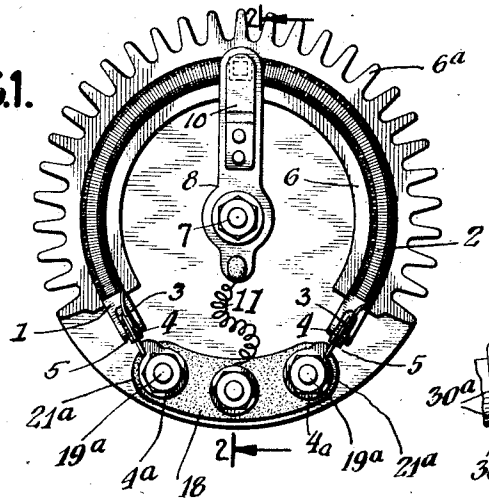


FIG.6.

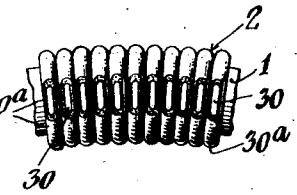


FIG.5.

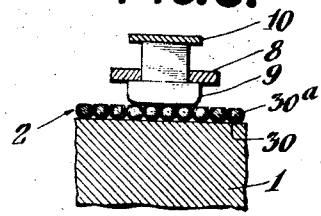


FIG.2.

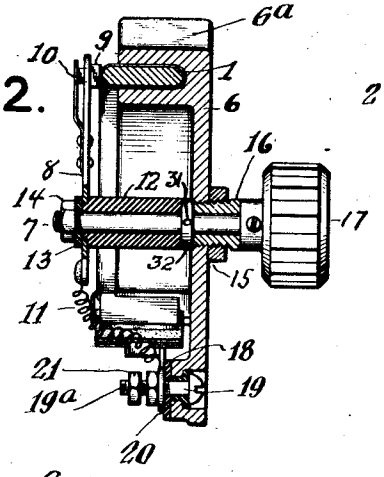
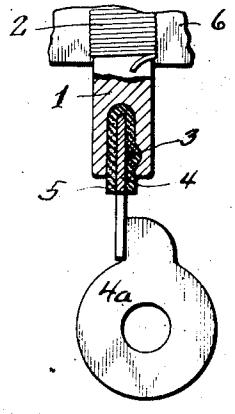


FIG.3.



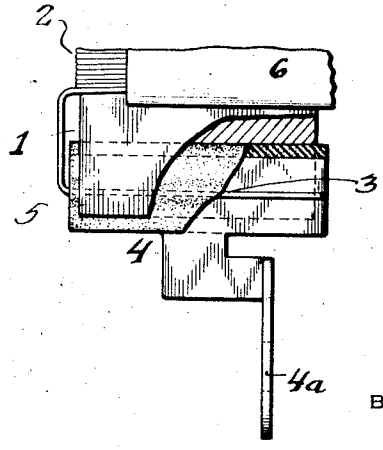


FIG.4.

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VARIABLE RESISTOR

Samuel Ruben, New Rochelle, N. Y.

Application July 17, 1936, Serial No. 91,027

4 Claims. (Cl. 201—56)

This invention relates to variable resistors.

An object of the invention is the provision of an improved variable resistor having a large current-carrying capacity within a small area, which is compact, attractive, highly durable and which may be economically produced.

Another object is the provision of such a device in which the resistor element is in insulated wire form and wound directly upon a metal base.

A further object is the provision of a wire wound variable resistor in which no spacing is required between the turns of the wire.

Another object is the provision of a variable resistor device of the wire-wound type in which a sheath of metal is directly cast upon the resistor element to afford a rapid heat transference.

A further object is the provision of a variable resistor device of the wire-wound type in which the wire is integrally coated with a thin, comparatively flexible inorganic insulating coating thermally bonded to the wire and which has a supporting housing of metal cast directly upon and around the insulated wire.

Another object is to provide a variable resistance element having a high rate of heat dissipation and a negligible temperature gradient between the active resistor and a surrounding intimately-contacting metal body.

Other objects will be apparent from the disclosure and the drawing in which—

Fig. 1 represents a plan view of a variable resistor constructed according to the invention;

Fig. 2 is a cross-section taken on the line 2—2 of Fig. 1;

Figs. 3 and 4 show detailed views at the ends of the resistor coil; and

Figs. 5 and 6 are magnified views of portions of the resistance winding.

This application is a continuation in part of my co-pending applications Ser. No. 67,599, filed March 7, 1936, and Ser. No. 71,365, filed March 28, 1936.

Broadly the present invention may be said to comprise a variable resistor of the wire-wound type in which the resistance wire has an insulation of inorganic material integral with its surface, part of said insulation being cut away to permit contact with the wire by a movable contact element, the insulated portion of the wire being embedded in a metal support which is directly cast upon the insulation, thus providing an immediate heat transference from the resistance element to the exterior.

The inorganic insulating coating is best applied to the resistance wire by the electro-deposition method described in my co-pending application Ser. No. 67,599. The wire passes through a solution in which finely-divided insulating material, such as colloidal kaolinite is suspended in an organic silicate such as ethyl silicate. The resistance wire is positively charged and the container in which the solution is held is negatively charged. As the wire is pulled through the solution a thin coating of kaolin and silicate is electrolytically deposited upon the wire which is then passed through an oven which bakes and hardens the insulation. A continuous process is used, the wire preferably passing through the solution a number of times at a temperature of about 160° C., being baked after each immersion to insure a non-porous coating. The repeated passes effect a self-healing action inasmuch as any weak or porous areas remaining from the previous pass will be covered up. In the electro-deposition process the potential between the wire and the metal container in which the solution is held may be about 6 volts, depending upon the speed of wire travel through the solution, the concentration of the colloid, the size of the wire, etc.

The following formula and procedure for coating nickel-chromium wire of small diameter has given excellent results:

500 g. of ethyl silicate are mixed with 100 g. of alcohol and 9 g. of water. After standing for 24 hours 80 g. of water and 130 g. of colloidal kaolin (kaolinite) are added and the entire mixture ball-milled. Should the solution tend to gel, an organic inhibitor in an amount up to 10% of the weight of the kaolin may be added.

Instead of the mixture described above, I may coat the wire with a solution as described in my co-pending application Serial No. 71,365, as follows:

200 g. of Garnett shellac is dissolved and combined with 1,000 c.c. of a 10% ammonia solution which is stirred and heated to 90° C. to completely dissolve the shellac and eliminate any excess of free ammonia. This solution is then diluted with 3500 c.c. of water and 1125 g. of kaolinite added. The mixture is then ball-milled for 10 hours.

The coated wire is flexible, resistant to alkalies and acids and can be heated to high temperatures without leakage. If desirable, a top coat of ethyl silicate may be applied to the coated wire in order to increase its abrasion resistance.

In order that a flexible coating may be obtained it is practically necessary to limit the thickness of the coating to not more than 3 mils.

For most purposes a coating of from 1 to 2 mils is amply sufficient. The wire so coated, considering its inorganic nature, is remarkably flexible and may be wound upon small or irregularly-shaped metal mandrels or supports without cracking.

Other suitable finely-divided suspendable inorganic insulating materials may be substituted for the kaolinite, for instance titanium oxide. The metal housing cast around the insulated wire should have a melting point lower than that of the coating used. In general application, I prefer a zinc alloy casting containing aluminum and copper.

The resistance wire used in the device of this invention can be of unusually small diameter because of the immediate and intimate contact between the coated wire and the metal cast or compressed about it. Due to the absence of heat-insulating substances such as enamel, asbestos or other materials commonly used in the prior art, the variable resistor of this invention is capable of much higher power dissipation than the devices previously used.

In order to more particularly describe the invention reference is made to the drawing in which the insulated wire 2 comprising a metal core 30 having a thin integral kaolinite deposit thermally bonded thereto, as hereinabove described, is wound upon arc-shaped aluminum form 1. The ends 3 of the resistance wire are brought out and held in contact with bronze terminals 4 by folded mica sheets 5 which insulate terminals 4 from the extensions of the aluminum form 1 in which they are held. The bronze terminals 4 are bent to provide a contact washer at 4a for securing to binding posts 19a. A flat base-metal alloy frame 6 is case around and in direct contact with the coated wire winding 2, said frame having integral flanges 6a to aid in the heat dissipation. Extending through and at right angles to the base of the frame 6 is metal control shaft 7 held within bushings 12 and 16 and carrying a metal control arm 8, insulated therefrom by insulating bushing 12 and insulating washer 13. Contact 9, carried by arm 8, makes direct surface contact with the top of resistance wire winding 2, the coating 30a of which has been removed over the area of contact so as to expose metal core 30 as seen more particularly in Figures 5 and 6. Flat spring 10 serves to hold contact 9 under pressure against the wire surface. Nut 15 secures bushing 16 in the frame 6. Sleeve 32, secured to the shaft by pin 31, holds insulating bushing 12 onto shaft 7 and nut 14 holds insulating washer 13 in place. The shaft 7 carries a knob 17, preferably of insulating material. Arm 8 at its end opposite the contact is soldered or welded to a pigtail conducting wire 11, the other end of which is secured by center binding post 19a comprising the threaded end of screw 19 which is insulated by insulating washer 18 and insulating sleeve 20 from the frame 6. Screw 19 carries nuts 21 for securing the terminals of the circuit.

The resistant wire winding connects with terminal posts 19a which are designed for having connected therewith terminals for the circuit to be controlled. On posts 19a are mounted bronze washers 4a and nuts 21a.

I claim:

1. A resistance element for a variable resistor adapted to operate at high temperatures comprising a coil of resistance wire having over substantially its entire surface and bonded thereto by a silicate binder, a thin, hard, uniform, non-softening adherent coating comprising a plurality of layers of extremely finely divided high heat resistant particles of inorganic insulating materials of the group comprising high heat resistant silicates and oxides, said resistance element coil being closely wound and the turns thereof being unseparated other than by the insulating coating on the wire, a portion of the insulation being cut away so as to leave a bare section across said coil whereon a movable conductor may make electrical contact with said coil, and a cast metal housing in direct contact with said coil and covering a substantial part thereof.

2. A resistance element for a variable resistor adapted to operate at high temperatures comprising a coil of resistance wire having over substantially its entire surface and bonded thereto, a thin, hard, uniform, non-softening adherent coating comprising a plurality of layers of extremely finely divided high heat resistant particles of inorganic insulating materials of the group comprising high heat resistant silicates and oxides, said resistance element coil being closely wound and the turns thereof being unseparated other than by the insulating coating on the wire, a portion of the insulation being cut away so as to leave a bare section across said coil whereon a movable conductor may make electrical contact with said coil, and a cast metal housing in direct contact with said coil and covering a substantial part thereof.

3. A resistance element for a variable resistor adapted to operate at high temperatures comprising a coil of resistance wire having over substantially its entire surface and bonded thereto, a thin, hard, uniform, non-softening adherent coating comprising a plurality of layers of extremely finely divided high heat resistant particles of inorganic insulating materials of the group comprising high heat resistant silicates and oxides, said resistance element coil being closely wound and the turns thereof being unseparated other than by the insulating coating on the wire, a portion of the insulation being cut away so as to leave a bare section across said coil whereon a movable conductor may make electrical contact with said coil, and an aluminum metal housing cast directly in contact with said coil and covering a substantial portion of the coated section thereof.

4. A resistance element for a variable resistor adapted to operate at high temperatures comprising a coil of resistance wire having over substantially its entire surface and bonded thereto, a thin, hard, uniform, non-softening adherent coating comprising a layer of extremely finely divided high heat resistant particles of inorganic insulating materials of the group comprising high heat resistant silicates and oxides, said resistance element coil being closely wound and the turns thereof being unseparated other than by the insulating coating on the wire, a portion of the insulation being cut away so as to leave a bare section across said coil whereon a movable conductor may make electrical contact with said coil, and a cast metal housing in direct contact with the insulated portion of said coil and covering a substantial part thereof.

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