May 24, 1938. H. G. RICHTER 2,118,267

RHEOSTAT

Filed Feb. 23, 1935

Fig. 1.

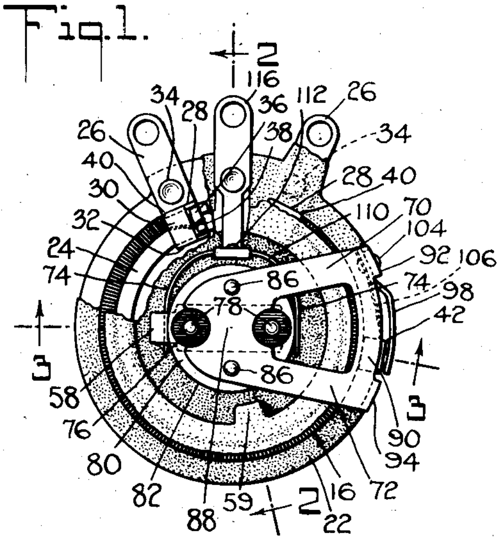


Fig. 2.

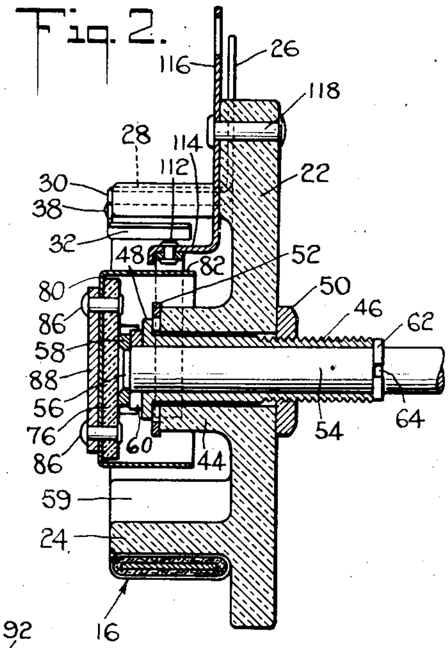


Fig. 3.

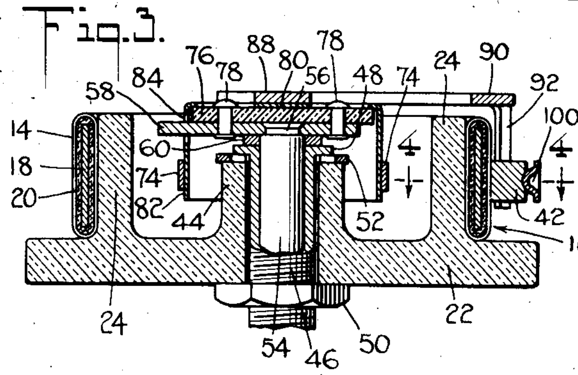


Fig. 4.

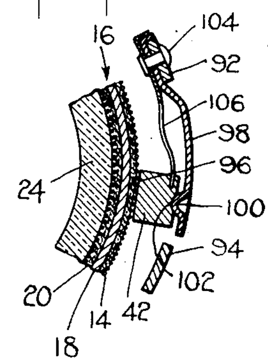


Fig. 5.

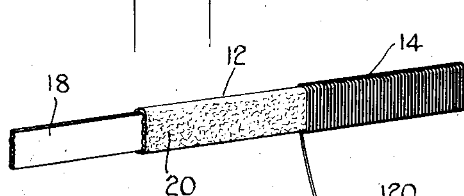
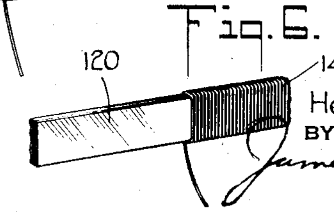


Fig. 6.



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UNITED STATES PATENT OFFICE

2,118,267

RHEOSTAT

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Application February 23, 1935, Serial No. 7,800

10 Claims. (Cl. 201—56)

This invention relates to variable resistors, and more particularly to power rheostats intended to operate at relatively high temperature.

The primary object of my invention is to generally improve variable resistors, especially low resistance units commonly called power rheostats. Such rheostats dissipate substantial power and operate at relatively high temperatures. The insulation core on which the resistance wire is wound must therefore be made of a refractory material. In the past, a core made of porcelain or the like has been used, and inasmuch as the core is commonly made circular or arcuate in configuration, it has been necessary to employ a bobbin machine to wind the resistance wire on the circular core. However, such a machine is costly and slow in operation.

A more particular object of my invention is to overcome the foregoing difficulty and to provide a power rheostat the resistance element of which may be wound straight and thereafter bent to arcuate configuration even though using a refractory insulation core. This object I fulfil preferably by using a Rockbestos core comprising a strip of copper sheathed in asbestos. Such a core is flexible and heat-resistant. Because of the high thermal conductivity of the copper strip, excellent heat dissipation is obtained even when only a small part of the resistance element is in use. The finished element is permanent and durable because the resistance winding itself operates to hold the asbestos covering on the copper strip. For these reasons I prefer to use Rockbestos as the bendable refractory insulation core, but other materials may be used, for example laminated mica the laminations of which are secured together by both low temperature and high temperature cements.

Further objects of my invention center about the mechanical construction of the rheostat and are to provide a stop arm the stopping force of which is applied directly to the control shaft without affecting the contact arm; to locate the stop arm within the contact arm for cooperation with a stop molded directly on the base of the unit; to provide a collector ring or cup advantageously located inside the stop arm yet connected directly to the contact arm at the outside of the unit; to provide two spaced contact arms with a wiper shoe protectedly located therebetween; to make the wiper shoe wear-resistant and self-lubricating; and to utilize the soldering lugs of the unit for holding the resistance element in place and to act as short-circuiting terminals therefor.

To the accomplishment of the foregoing and other objects which will hereinafter appear, my invention consists in the rheostat elements and their relation one to the other as are hereinafter more particularly described in the specification and sought to be defined in the claims. The specification is accompanied by drawing in which:

Fig. 1 is a rear elevation of a rheostat embodying features of my invention;

Fig. 2 is a section taken in elevation in the plane of the line 2—2 of Fig. 1;

Fig. 3 is a section taken in the plane of the line 3—3 of Fig. 1;

Fig. 4 is a section through the wiper shoe taken in the plane of the line 4—4 of Fig. 3;

Fig. 5 shows a step product or part of the rheostat and is explanatory of the invention; and

Fig. 6 is a modification.

Referring to the drawing and more particularly to Fig. 5, I employ a core strip 12 made of refractory insulation material. This strip is preferably straight and is wound while in straight condition with a resistance wire winding, as is indicated at 14. The strip may then be severed into appropriate lengths which are bent to the circular or arcuate shape indicated at 16 in Fig. 1, in order to form individual resistance elements.

Because rheostats of the character here illustrated, commonly termed power rheostats, have a low resistance, say 5 to 50 ohms, and dissipate substantial power, they must be capable of operating at elevated temperatures, and the core 12 must therefore be made of refractory material. So far as I am aware, no one has heretofore employed a satisfactory refractory material which is also bendable. It has therefore been the practice to mold the core in circular configuration and to thereafter apply the resistance wire winding thereto. In accordance with my invention it is possible and desirable to rapidly wind long strips of insulation core, say, 6 feet in length.

The core 12 preferably comprises a metallic strip 18 sheathed with asbestos 20. Strip 18 may be made of copper which is pliable and an excellent conductor of heat. The asbestos may be temporarily held in place by cotton thread or the like, and even if such thread is later burned away, no harm results because the asbestos is then securely held in place by the resistance wire winding 14. If desired, the core 12 may be purchased in finished form under the commercial name "Rockbestos".

Referring now to Figs. 1 through 4 of the drawing, the rheostat comprises a refractory insulation base 22 molded, for example, from porcelain. This base has an annular flange 24 which acts as a supporting wall for the resistance element 16. The resistance element is placed around flange 24 and is held in place by soldering lugs 26 the inner ends of which are reversely bent to U shape and slipped over the resistance element and flange. More specifically, the lugs are bent to provide an outer wall 28, a back wall 30, and an inner wall 32, as is best shown in Figs. 1 and 2. Lugs 26 are secured to base 22 by rivets 34 passing therethrough. The end of the resistance wire winding is electrically connected to the soldering lug, preferably by the use of hard or silver solder. The back wall 30 may be slit to form a T 36, and the end 38 of the resistance wire winding may be passed beneath wall 30 and anchored about the neck of T 36, as is best shown in Fig. 1, preparatory for the soldering operation. It should be understood that the two lugs 26 are alike and similarly connected to the adjacent ends of the resistance element, although only one of the lugs is exposed in Fig. 1 by supposed removal of the enamel coating applied to the finished unit.

Outer wall 28 of lug 26 is preferably further used as a short-circuiting terminal for the resistance element. For this purpose, the edge 40 of wall 28 is struck inwardly or beveled, thereby facilitating movement of the wiper or contact shoe 42 from the resistance wire to the terminal.

The base 22 with applied resistance element 16 is next dipped in a protective enamel which not only coats the unit but fills in the interstices between the resistance wire windings and between the resistance element and flange 24. The enamel is wiped away on the outside of the resistance element, thereby exposing the windings for contact with wiper shoe 42. The unit is then air-dried and finally baked or fused at a suitable high temperature, say, 1200° Fahrenheit.

Coming now to the control mechanism of the rheostat, base 22 is provided with a central tubular support 44. A threaded metallic bushing 46 is passed through support 44 and locked in place between flanged head 48 and a nut 50. A lock washer 52 may be inserted between head 48 and support 44 in order to prevent rotation of bushing 46.

Bushing 46 receives a control shaft 54 the inner end 56 of which may be squared and is securely riveted directly to an appropriate stop arm 58. This stop arm cooperates with a stationary stop 59 preferably molded integrally with base 22 within flange 24. Control shaft 54 is axially located by means of a thrust washer 60 beneath stop arm 58, and a split washer 62 received in a mating groove 64 on control shaft 54.

Control shaft 54 has insulatedly mounted thereon contact arms 70 and 72 which cooperate with wiper shoe 42. The contact arms are preferably located outside stop arm 58 and at the outside or back of the unit. Electrical connection is obtained to contact arm 70 through collector brushes 74 located inside stop arm 58 and within the unit. To this end I secure a disc of insulation 76 on the outside of stop arm 58 by means of rivets 78, and then mount a metal cup 80 over insulation disc 76. The side wall 82 of cup 80 acts as a collector ring against which brushes 74 bear. As is shown in Fig. 3, side wall 82 is cut away at 84 to receive stop arm 58 but without contacting the stop arm. Cup 80 is secured to insulation disc 76 by means of rivets 86, and these rivets may also be used to lock contact arms 70, 72 in physical and electrical engagement with cup 80. In fact, because arms 70, 72 are preferably struck from a single piece of relatively heavy gauge sheet metal, it may be said that cup 80 is riveted in place between insulation disc 76 and the junction or common portion 88 of arms 70, 72, as is best shown in Fig. 2. Both the cup 80 and junction 88 are cut away to clear the rivets 78 which hold insulation disc 76 to stop arm 58, as indicated in Fig. 1.

Arms 70 and 72 may, if desired, be connected near their outer extremity by a web 90, and the projecting ends 92 and 94 are bent forwardly or at right angles outside the resistance element. While I have referred to the arms 70 and 72 as though two spaced arms are used, it should be understood that the construction may equally well be described as including a single broad arm the outer extremity of which is cut away between the parts 92 and 94.

The wiper shoe 42 is located in the space between the ends 92 and 94. This shoe is preferably made of a block of copper graphite alloy because the said alloy is self-lubricating and is capable of substantially indefinite wear. The bottom face 96 of the block (see Fig. 4) is preferably made straight so that it contacts with only one or two of the resistance wire windings 14 at any one time. The block is self-adjustably seated against the windings by means of a leaf spring 98 having a rounded projection 100 bearing against a mating seat 102 on the outside of the block. Leaf spring 98 is secured to the end 92 of contact arm 70 by means of a rivet 104. To insure good electrical connection, a thin flexible strap 106 is connected at one end to shoe 42 and at its other end to contact arm 70, as by the use of aforesaid rivet 104.

In the particular form here shown, the end 94 of arm 72 is not connected to shoe 42 and acts only as a protective guard for said shoe during operation of the rheostat. It should be understood, however, that if desired the leaf spring 98 may be connected to both ends 92 and 94, or the leaf spring may be connected to end 92 and electrical conductor 106 connected to the end 94, and so on.

Brushes 74 are the ends of a resilient U-shaped strip of metal 110 the center portion of which is riveted at 112 to the rearwardly bent inner end 114 of a third or center soldering lug 116 which passes from the inside to the outside of the unit between the ends of the resistance element and through an opening or passageway in annular flange 24 of the base. Center lug 116 is riveted in place by a rivet 118. It will be understood that the three soldering lugs shown make it possible to vary the resistance in either direction or to use the unit as a potentiometer.

While the bendable refractory core 12 of the resistance element is preferably made as before described, it is possible to use other materials, and a core made of laminated mica is illustrated in Fig. 6. The core 120 consists of a large number of thin laminations of mica which are preferably secured together by two kinds of cement one effective at low temperatures, and the other effective at high temperatures. I am informed and believe that the low temperature cement is an organic cement, which is volatilized and driven off at the final high baking temperature, while the high temperature cement is an inorganic cement, which first fluxes and becomes effective at the high baking temperature. A suitable product is made by the New England Mica Company under the trade number "16". In using this material I find it desirable to heat the same to a temperature of, say, 400° Fahrenheit before bending the resistance element from the straight to the arcuate configuration.

It is believed that the construction of my improved rheostat, as well as the many advantages thereof, will be apparent from the foregoing detailed description. In addition to advantages heretofore pointed out, I may mention that the finished unit is rugged and sturdy in construction and appearance; it is open, thereby dispensing with the cost of a casing and increasing the heat radiation from the unit; the supporting flange or wall holds the otherwise bendable resistance element rigidly in truly circular configuration; while the impregnation and coating with enamel not only protects the structure but gives the same the appearance of being made in one piece.

It will be apparent that while I have shown and described my invention in preferred forms, many changes and modifications may be made in the structures disclosed, without departing from the spirit of the invention, defined in the following claims.

I claim:

1. A variable resistor comprising a control shaft, a stop arm mounted on the end of said shaft, an insulation disc secured to said stop arm, a metallic cup mounted over said insulation disc, the side wall of said cup being cut away to receive said stop arm, a contact arm conductively secured to said cup, a stationary brush slidably contacting said cup, and a stationary stop cooperating with said stop arm.

2. A variable resistor adapted for high temperature operation, comprising a refractory insulation base, an arcuate approximately cylindrical wire-wound resistance element mounted on said base, at least the exterior of the core of said element being made of refractory insulation, the windings extending transversely of said core, fused enamel securing said windings to said core and securing the wound core to the base, the windings being exposed at the outer cylindrical periphery of the resistance element, a contact arm movable around said resistance element, a contact shoe made of a block of copper graphite alloy and having a contact face of substantial dimension in two directions, and resilient means secured to said arm and self-adjustably supporting the contact shoe in engagement with the exposed windings at the outer cylindrical periphery of the resistance element.

3. A variable resistor comprising an arcuate approximately cylindrical wire-wound resistance element the windings of which are exposed at the outer cylindrical periphery thereof, a control shaft for the resistor, two spaced metallic contact arms extending divergently from the shaft and movable around the outside periphery of said resistance element, a contact shoe made of a block of copper graphite alloy having a relatively large flat bottom face bearing against the exposed windings, a leaf spring secured at one end to one of said arms and extending toward the other arm and having a rounded protuberance bearing against the aforesaid contact shoe, and a flexible connector strip extending from said contact shoe to said arm, said shoe being located between the two spaced arms.

4. A variable resistor adapted for high temperature operation and comprising a refractory insulation base having an annular flange projecting therefrom, an arcuate wire-wound resistance element mounted on said base around the outside of said flange, the core of said element being a thin bendable strip at least the exterior of which is made of refractory insulation, soldering lugs riveted to said base and having their inner ends bent to U shape around the resistance element and flange in order to hold the resistance element on the base and against the flange, means connecting the ends of the resistance wire to said soldering lugs, and fused vitreous enamel filling all of the space between and bonding together the resistance element and base and flange into a unitary heat-dissipating structure.

5. A variable resistor comprising an insulation base having an annular insulation flange projecting therefrom, an arcuate wire-wound resistance element mounted on said base against said flange, the core of said element being a strip at least the exterior of which is refractory insulation, soldering lugs riveted to said base and bent around the resistance element and flange at points immediately adjacent the ends of the windings in order to hold the resistance element on the base, means connecting the ends of the resistance wire to said soldering lugs, the edges of said lugs bearing against said windings being inwardly bent to afford free sliding movement of a contact shoe from the windings to the lugs, whereby said lugs are adapted to act as metallic short-circuiting terminals for said resistor, and fused enamel bonding the resistance element and base into a unitary heat-dissipating structure.

6. A low resistance variable resistor adapted to operate at high temperature, said resistor comprising a refractory insulation base having a wide annular support wall, a thin wide bendable core strip at least the exterior of which is made of refractory material, said strip being bent to arcuate shape and mounted on said base outside of and against said support wall, a resistance wire winding on said core strip, soldering lugs mechanically secured to said base and bent to U shape around the resistance element and support wall in order to hold the resistance element on the base against the support wall, fused enamel additionally securing said wound core strip on said base against said support wall, all of the space between the wound core strip and base and support wall being solidly filled with vitreous enamel in order to obtain maximum thermal conductivity between the resistance wire and the base, whereby the base acts as an effective radiating surface for heat dissipation from the wire, and movable contact mechanism arranged for movement over the wide outside cylindrical surface of said resistance winding.

7. A low resistance variable resistor adapted for high temperature operation and comprising a refractory insulation base having an annular support wall, an arcuate approximately cylindrical wire-wound resistance element secured to said base against the outside of said support wall, whereby the windings thereof are exposed at the outer cylindrical periphery thereof, a control shaft rotatably mounted on said base, two spaced metallic arms extending divergently from the shaft and together movable with the shaft around the outside periphery of the resistance element, a contact shoe having a relatively large flat bottom face bearing against the exposed windings on the outer periphery of the resistance element, said contact shoe being located between and being protected by the aforesaid two spaced arms, and resilient connection means extending between

said contact shoe and at least one of said arms, said resistor being open and exposed at its outer periphery.

8. A low resistance variable resistor adapted to operate at high temperature, said resistor comprising a porcelain or refractory insulation base having a wide annular support wall, a wide bendable core strip bent to arcuate approximately cylindrical shape and mounted on said base outside of and against said support wall, a resistance wire winding on said core, and movable contact mechanism arranged for movement over the wide outside cylindrical surface of said resistance winding, said core being a relatively wide thin strip of highly heat-conductive metal surrounded by a sheath of refractory insulation such as asbestos, the resistor being coated with fused enamel which covers the base and resistance element except on the outside cylindrical surface where it is engaged by the movable contact, and which enamel fills the interstices between the resistance wire windings and between the resistance element and the base and support wall, thus forming a unitary heat-dissipating structure.

9. A low resistance variable resistor adapted to operate at high temperature, said resistor comprising a porcelain or refractory insulation base having an annular support wall, a bendable core strip bent to arcuate approximately cylindrical shape and mounted on said base outside of and against said support wall, a resistance wire winding on said core, and movable contact mechanism arranged for movement about said resistance winding, said core being a relatively wide thin strip of highly heat-conductive metal surrounded by a sheath of refractory insulation such as asbestos, the resistor being coated with fused vitreous enamel which covers the resistance element except where engaged by the movable contact, and which fills the interstices between the resistance wire windings and between the windings and the base and support wall, to form a unitary heat-dissipating structure.

10. In the manufacture of a variable resistor adapted to operate at high temperatures, the method which includes preliminarily sheathing a heat-conductive metallic strip of substantial width and length with asbestos, winding said sheathed strip with a resistance winding, bending said strip to arcuate approximately cylindrical shape, mounting said arcuately bent strip on a base made of refractory insulation, coating the structure with a protective enamel which coats the unit and fills in the interstices between the resistance wire windings and between the resistance element and the base, wiping away the enamel on one side of the resistance element to expose the windings for contact with a wiper shoe, air-drying the enameled unit, and baking the same at a suitable extremely high temperature, to form the windings, strip, and base into a sturdy integral structure of good heat-dissipating characteristic.

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