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3,064,335

METHOD OF MANUFACTURING VARIABLE RESISTORS

Filed Feb. 24, 1959

FIG. 1.

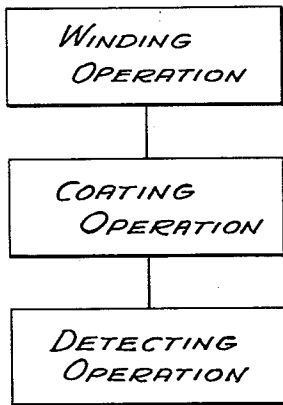


FIG. 2.

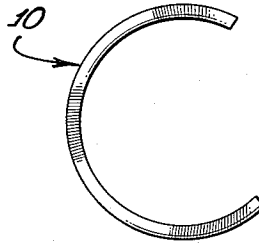


FIG. 3.

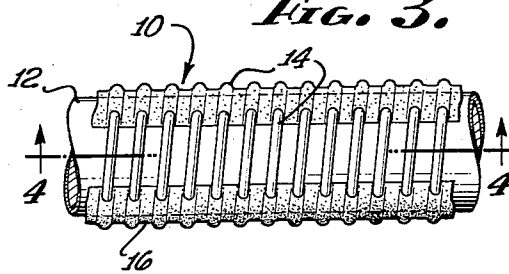


FIG. 4.

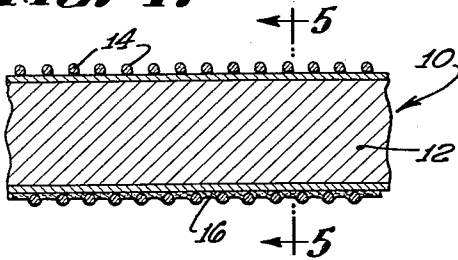


FIG. 5.

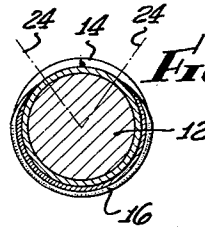


FIG. 6.

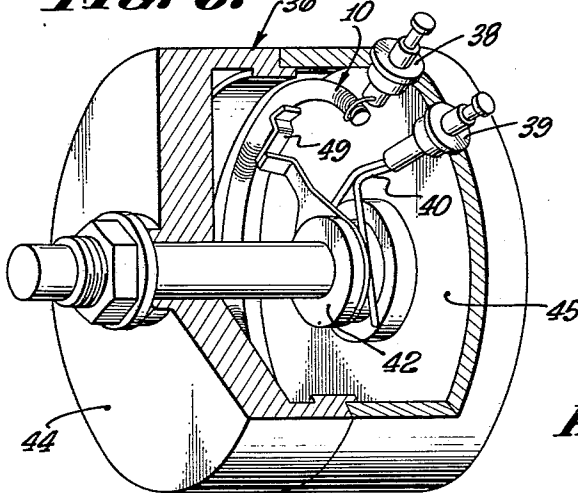
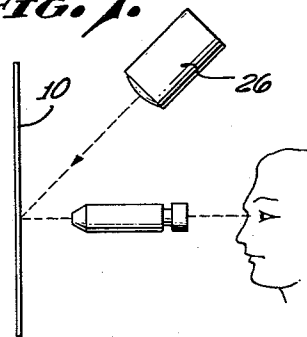


FIG. 7.



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METHOD OF MANUFACTURING VARIABLE RESISTORS

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This invention relates broadly to the manufacture of resistance elements of the kind employed in precision instruments such as potentiometers and rheostats. More particularly this invention relates to a method of assembling resistance elements for use in precision instruments.

Resistance elements of the type under consideration include a relatively fine wire spirally wound about the surface of a support member such as a wire of greater diameter and strength which serves as a mandrel. The fine wire is maintained in tight, intimate engagement with the larger support wire by applying a coating of bonding cement to a portion of the perimeter of the assembly including the fine wire and the support member. Subsequently, the assembly of the two members described above is formed into a coil of a single turn or a plurality of turns by a conventional coiling operation and positioned within a hollow casing. A rotor, supporting a contact member, is mounted in covers provided at the ends of the casing. The uncoated portion of the coiled resistance element is arranged on the inner surface of the coil to provide a path of travel for the contact member.

A major problem in the manufacture of the potentiometers described involves the presence of the bonding cement on the portion of the coiled resistance element forming the path for the travel of the contact member. The bonding material causes interruptions in the transmission of current through a circuit including the instrument.

The chief object of this invention is the provision of a method of manufacturing a variable resistor including a resistance element comprising a relatively fine resistance wire helically wound about a supporting mandrel, which includes a step for detecting, in a novel manner, the presence of bonding cement, employed to maintain a predetermined positioning of the two members, on the portion of the fine resistance wire serving as a path for the flow of current.

Another object of the invention is the provision of a method of manufacturing a variable resistor of the type under consideration which includes the step of supplying to the resistance element bonding cement a luminescent agent and subsequently subjecting the resistance element to luminescent excitation radiations to detect the presence of bonding cement on portions of the resistance element where disturbance to the flow of current may occur.

Other features and objects of the invention will be apparent upon a consideration of the ensuing specification and drawings wherein:

FIGURE 1 is a block diagram of the method of making a resistance element illustrating the invention;

FIGURE 2 is a side elevation of a resistance element formed as a single turn coil;

FIGURE 3 is an enlarged, front view of a portion of the resistance element prior to formation of the element in the single turn coil shown in FIGURE 2;

FIGURE 4 is a sectional view of the element illustrated in FIGURE 3 taken along lines 4—4 on FIGURE 3;

FIGURE 5 is a view in section, along lines 5—5 of

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FIGURE 4 illustrating the disposition of the bonding cement about resistance element;

FIGURE 6 is a perspective view, with parts cut away, of a variable resistor including the resistance element shown in FIGURE 2 as a component; and

FIGURE 7 is a view illustrating examination of the resistance element in linear form in the presence of radiation adapted to expose presence of bonding cement on undesired area of the resistance element.

In making a variable resistor of the type described above and illustrated as a potentiometer in FIGURE 6, it is necessary to form the resistance element 10 independently of the other components of the variable resistor. The resistance element 10 consists of an inner support 12, illustrated as a circular wire, having a relatively fine resistance wire 14 of a much smaller diameter helically wound about the outer surface thereof in the manner shown in FIGURES 3 and 4. Apparatus for winding the wire 14 about the support 12 when the latter is in linear form is well known in the art and a detailed description is deemed unnecessary for an understanding of this invention. Generally a metal working lathe equipped with a conventional headstock, tailstock and travelling carriage can be modified to include on the carriage a wire guide for guiding the relatively small resistance wire from a source such as a spool, over the surface of the support or mandrel wire connected to the headstock and tailstock. Rotational movement of the support wire in combination with the carriage travel causes the wire 14 to be helically wound about the support wire 12.

Prior to assembly of the fine resistance wire 14 about the supporting member 12 the latter is provided with a coating of material serving as insulation between the members 12 and 14. After assembly of the resistance wire 14 about the surface of the elongated support 12 a coating of bonding cement 16 is applied to the assembled members. Any suitable enamel may be employed as the bonding material for the resistance element. As an example of an enamel which has been found to be most satisfactory, there is one which is commercially available from General Electric Co. and known as "Formvar." It is composed of polyvinyl acetate and cresol formaldehyde resins in high-boiling naphtha cresol solvents having a viscosity at 30° C. of from 4000 to 4600 centipoises. It will harden within from 5 to 10 minutes under a baking temperature of 200° C., or from 20 to 30 minutes at 175° C., or from 1 to 2 hours at 150° C. A suitable thinner for the above example of a bonding enamel is ethylene dichloride. The cement 16 is applied to the members 12 and 14 in the pattern shown in FIGURES 3, 4, and 5. Thus, it is apparent that a portion of the periphery of the assembled members is devoid of bonding cement for a purpose to be later explained. Once the bonding cement has been applied separation of the two members is prevented.

In accordance with this invention the bonding cement 16 is supplied with a luminescent agent prior to its application to the resistance element. The step of coating the resistance element may be accomplished by applying the bonding cement with a brush or similar applicator. However, if the bonding cement is permitted to flow over the area between lines 24, note FIGURE 5, on the resistance element distortion in circuit or circuits including the resistor may occur. To ensure absence of any of the cement in the area defined above, the resistance element is examined in the presence of luminescent excitation rays such as ultraviolet rays from a lamp 26 capable of rendering the luminous agent in the cement visible to visual inspection. Any suitable fluorescent material may, of course, be incorporated in the bonding cement to provide the desired properties under ultraviolet light. For

example, rhodamine B, activated zinc sulphide, a commercial compound known as "Zyglo," and other materials may be used with varying degrees of fluorescence and oil solubility, since it is generally preferred that the oil solubility be of an extremely low degree.

After it has been established that the area indicated by lines 24 on the resistance element is free of the bonding cement the resistance element is formed into the coil configuration illustrated in FIGURE 2. Once the resistance element has been shaped as illustrated in FIGURE 2 the portions of resistance element devoid of bonding cement define a circular path determined by the inner surface of the coil so formed.

The potentiometer shown in FIGURE 6 includes the housing 36 formed of a material possessing good electrical insulating properties. A single turn coil (resistance element 10) is secured within the housing by any convenient means. Openings are provided in the side wall of the housing to accommodate terminals 38 and 39 for the purpose of connecting conductor members to the coil and for the purpose of mounting a brush member 40.

A rotor 42 is rotatably mounted in cover members 44 and 45 of the housing. A slidable contact member 49 on the rotor provides a path for the flow of electrical current through the brush and the rotor to the surface of the resistance element. Rotation of the rotor causes movement of the slidable contact member 49 in the circular path defined by the surface of the resistance element devoid of bonding cement.

Variable resistors of the kind described are widely used in many applications requiring precision electrical measurements.

What I claim is:

1. In the method of manufacturing a resistance element having a relatively small resistance wire wound in a coil of a plurality of turns about a support, each turn being spaced in a direction axially of the support from its adjacent turn, the steps of coating a substantial portion of each turn of the coil and the surface areas of the support disposed between said portions of the turn with a hardenable bonding cement including a luminescent agent for securing the wire coil to the support to prevent relative movement between said coil and said support while leav-

ing a surface of the remainder of the coil and support uncoated and defining an axial section of said coil and wire, allowing the bonding material to acquire a set enabling it to be handled without loss or drainage thereof, subjecting the element to luminescent exciting radiations for the purpose of detecting the presence, if any, of bonding material on said uncoated surfaces and separating from the assembly of small wire, support and bonding cement forming the resistance element those sections revealing an undesirable amount of bonding cement in the uncoated portion of the assembly.

2. In the manufacture of a variable resistor including a resistance element formed by winding a relatively small resistance wire about a support wire, the steps of winding the relatively small resistance wire about the support wire to form axially spaced turns thereon, applying a coating of bonding material of hardenable cement having as a component an agent visible in the presence of luminescent excitation radiation to a first portion only of the perimeter of the assembled small wire and support wire to provide a second portion free of the bonding material and to prevent relative movement between the coil and the support, allowing the bonding material to acquire a set enabling it to be handled without loss or drainage thereof, subjecting the portion of the resistance element presumably free of the bonding material to luminescent excitation rays to detect the presence of bonding material thereon, separating from the assembly of small wire, support and bonding material the sections thereof revealing an undesirable amount of bonding material on the uncoated portion of the assembly, forming a predetermined amount of the remainder of the assembly into a desired configuration, positioning the formed resistance element into a housing with the uncoated portion of the resistance element providing a predetermined path and inserting a rotor supported contact member into the housing to engage the resistance element throughout the portion defining the path.

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