

[72] Inventor **Lester E. Burgess**
Roslyn, Pa.
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 [73] Assignee **Gulf & Western Industrial Products**
Company
Grand Rapids, Mich.

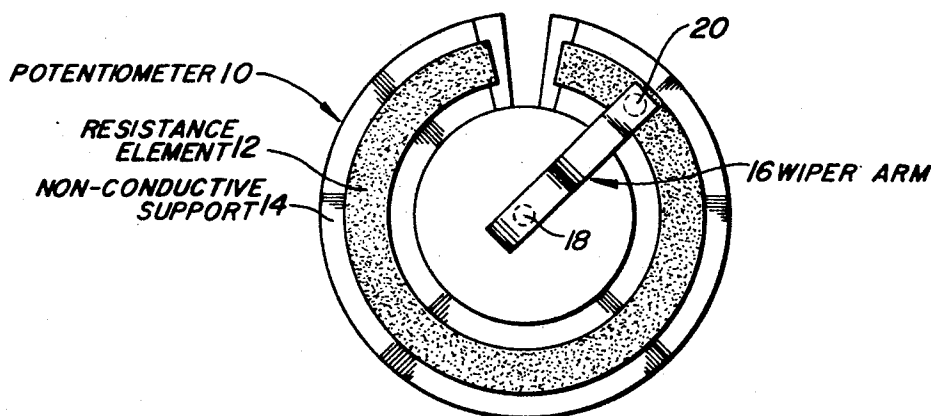
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Primary Examiner—Lewis H. Myers
Assistant Examiner—D. A. Tone
Attorney—Meyer, Tilberry and Body

[54] **WIPER ARM AND POTENTIOMETER**
COMPRISING THE SAME
10 Claims, 3 Drawing Figs.

[52] U.S. Cl..... **338/202,**
117/226
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 [50] Field of Search..... **338/202,**
308; 117/226, 227; 252/503; 310/253

ABSTRACT: An improved wiper arm for a potentiometer having bonded at least to the wiping end thereof, an electrically conductive, synthetic, resinous polymerizate, formed in situ by curing with an epoxy curing agent, a composition containing about 25 to 40 weight percent of an epoxy resin, about 40 to 70 weight percent finely divided silver, and about 5 to 20 weight percent finely divided carbon.



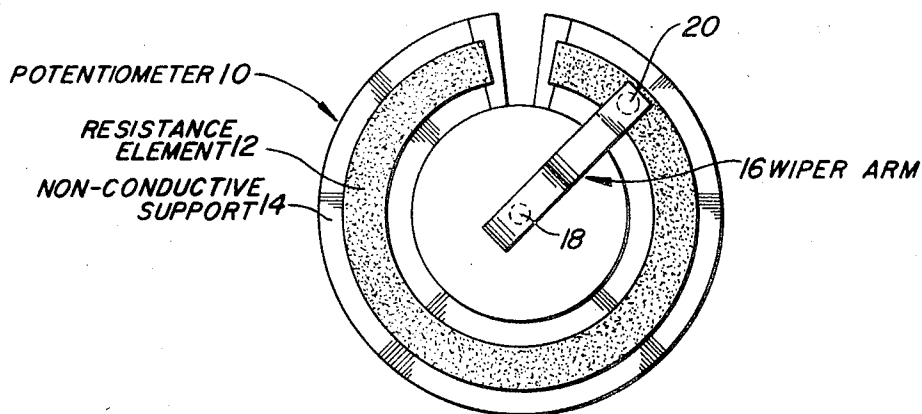


Fig. 1

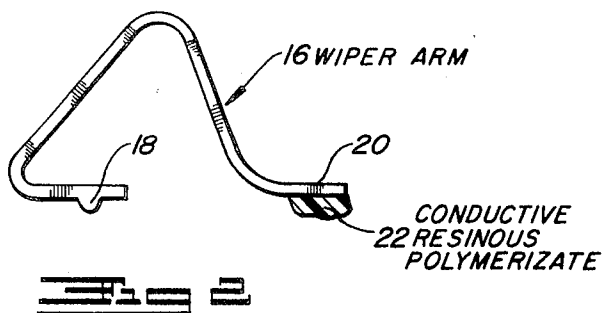


Fig. 2

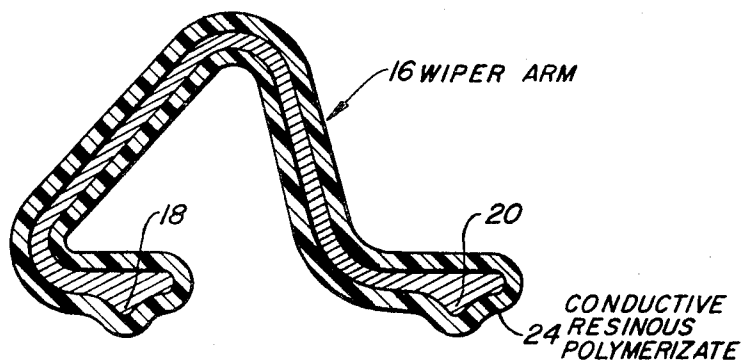


Fig. 3

INVENTOR.
LESTER E. BURGESS

BY

Meyer, Tilberry & Body
ATTORNEYS

WIPER ARM AND POTENTIOMETER COMPRISING THE SAME

This invention relates to the potentiometer art, and more particularly to an improved wiper arm and a potentiometer comprising the same.

The present invention is particularly applicable to potentiometers in which the electrical resistance element is a thick film of electrically semiconductive material, such as a "cermet"; however, it will be appreciated that the invention has broader applications and may be used with potentiometers in which the electrical resistance element is formed of other materials.

In one conventional form of potentiometer to which the invention is particularly applicable, the electrical resistance element is deposited in an annular configuration about the central axis of a circular supporting member of nonconductive material.

The wiper arm has a fixed end adapted for connection to a terminal and a free end adapted to contact selectable portions of the resistance element, the arm being operative to provide an electron-conducting path between its fixed and free ends. The wiper arm is mounted for pivotal movement about its fixed end, with the axis of rotation being the central axis of the nonconductive supporting member.

One of the important functions of the wiper arm is to provide a good electrical contact with the electrical resistance element, without damaging the latter. Since wiper arms are conventionally formed of metal wire or metal ribbon which would normally damage a cermet-type electrical resistance element, it has been the practice of the prior art to cement a carbon "button" to the free end of the wiper arm so that the electrical resistance element is swept by carbon and not metal.

This arrangement has proved to be generally satisfactory in potentiometers which are designed to be preset, and then reset only infrequently. However, the carbon button has proved unsatisfactory in potentiometers designed to be reset frequently in the course of its operation. Under these circumstances the relatively poor wear properties of carbon provide an uneconomically limited service life for the wiper arm.

Even when used in potentiometers adjusted only infrequently, the carbon button suffers a number of disadvantages. The button itself, and the process of mounting it to the wiper arm are both expensive and time consuming. Moreover, it is frequently difficult to develop a cement which will provide satisfactory electrical conductivity, be compatible with carbon and the metal portion of the wiper arm in terms of adhesivity and thermal coefficient, and at the same time survive the varying environmental conditions to which potentiometers are exposed.

Finally, it has been found that for many applications the carbon button yields an equivalent noise resistance (ENR) which is unsatisfactorily high.

These and other disadvantages of the prior art practices have created a need for an improved wiper arm for potentiometers. The present invention is addressed to filling this need.

It has now been discovered that the disadvantages of the prior art practices are obviated by bonding to at least the free end of a wiper arm, a electrically conductive synthetic resinous polymerizate, formed in situ by curing with an epoxy curing agent, a composition containing about 25—40 weight percent of an epoxy resin, about 40—70 weight percent finely divided silver, and about 5—20 weight percent finely divided carbon.

In accordance with one aspect of the invention, the conductive polymerizate is bonded to substantially the entire surface of the wiper arm, whereby the electron-conducting path between the fixed and free ends of the arm is provided at least in part by the polymerizate.

In accordance with another aspect of the invention the polymerizate is bonded only to that localized portion of the free end of the wiper arm which is adapted to contact selectable portions of the resistance element of the potentiometer.

It is, therefore an object of the invention to provide an improved wiper arm for potentiometers.

A further object of the invention is to provide a potentiometer having an improved wiper arm.

A further object of the invention is to provide an improved wiper arm and potentiometer comprising the same which overcomes the disadvantages of prior art wiper arms formed with a cemented carbon button for contact with the electrical resistance element of a potentiometer.

Yet another object of the invention is to provide a wiper arm and potentiometer comprising the same, which when compared with the prior art is more economical to manufacture, has better wear characteristics, and yields better ENR values.

Still another object of the invention is to provide a wiper arm and a potentiometer comprising the same, wherein the arm has bonded to at least its free end, an electrically conductive polymerizate formed in situ by curing with an epoxy curing agent, a composition containing an epoxy resin, finely divided silver, and finely divided carbon.

These and other objects and advantages of the invention will become apparent from the following detailed discussion thereof, when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic plan view of the potentiometer embodying the improved wiper arm of the present invention;

FIG. 2 is a schematic elevation view of a wiper arm conforming to one aspect of the present invention; and

FIG. 3 is a schematic sectional view of a wiper arm conforming to a second embodiment of the present invention.

Referring now to the drawings, wherein the showings are for purposes of illustrating preferred embodiments of the invention only, and not for the purpose of limiting the same, FIG. 1 depicts a potentiometer, designated generally as 10, comprising electrical resistance element 12, deposited on nonconducting support 14. Useful materials which may be formed into the electrical resistance element are notoriously well known in the art, as are their methods of preparation and deposition. Since these aspects of the potentiometer art form no part of the present invention, they will not be detailed here. However, reference may be had to copending application Ser. No. 768,877 for a disclosure of commercially available resistance materials as well as a novel resistance material and method of making the same all of which are useful for purposes of practicing the present invention.

Potentiometer 10 is provided with a wiper arm designated generally as 16, having fixed end 18 and free end 20. Wiper arm 16 is positioned coaxially with the central axis of nonconducting support 14. In this manner, free end 18 of the wiper arm is adapted to contact selectable portions of resistance element 12.

In the embodiment illustrated in FIG. 1, wiper arm 16 is adapted to move relative to the nonconductive support. However, it is to be appreciated that the invention is equally applicable to potentiometers in which the wiper arm is held in a fixed position, and the electrical resistance element is adapted for movement relative to it.

FIG. 2 illustrates a first embodiment of wiper arm in accordance with the present invention wherein electrically conductive, synthetic, resinous polymerizate 22 is bonded only to a localized portion of free end 20 of the wiper arm. In this embodiment, the wiper arm is preferably formed of a wire or ribbon of precious metal, for example silver, but may be formed of a base metal, for example stainless steel. A series 400 stainless steel is particularly suitable for this purpose.

FIG. 3 illustrates a second embodiment of the invention wherein polymerizate 24 is bonded to substantially the entire surface of wiper arm 16. In this embodiment, the supporting structure to which the polymerizate is applied may be a precious or a base metal, but may also be a nonconductive material such as a thermoplastic or thermosetting resin. Where the wiper arm is formed of an electrically nonconductive material, polymerizate 24 alone provides the electron conducting path between the fixed and free ends of the wiper

arm. Where the supporting structure is formed of an electrically conductive material, the entire cross section of the wiper arm serves as an electron-conducting path.

A particularly suitably polymerizable is one formed in situ on the wiper arm by curing, with an epoxy curing agent, composition containing about 25—40 weight percent of an epoxy resin, about 40—70 weight percent finely divided silver, and about 5—20 weight percent finely divided carbon.

For purposes of this disclosure, the term "epoxy resin" refers to polyether materials having terminal reactive epoxy groups. The polyethers are formed by the reaction of a chlorohydrin with a phenol or alcohol. The most widely available epoxy resins are prepared by reacting epichlorohydrin and bisphenol A. In this reaction, the bisphenol A can be substituted by ethylene glycol, glycerol and related hydroxyl-containing compounds. Likewise, dichlorodihydrin and butadiene dioxide can be used as the epoxy-containing starting materials replacing epichlorohydrin.

Although the epoxy resins may be cured into a thermoset condition by direct linkage between epoxy groups, or linkage of epoxy groups with aromatic or aliphatic hydroxyls as may be present in the resin, it is preferred to effect a cure with a curing agent such as an aliphatic or aromatic amine.

A preferred group of epoxy resins are those formed by reacting diglycidyl ether with bisphenol A and having an epoxy equivalent weight within the range of about 175 to about 200. A commercially available material of this type having an epoxy equivalent weight of about 190 is sold by Shell Chemical Company under the name Epon 828.

While any of the conventional aliphatic and aromatic amine-curing agents may be used, it is preferred to use 2-ethyl-4-methyl imidazole since this material provides a very adequate pot life at ambient temperatures.

The silver ingredient of the polymerizable composition may be in the form of flake or powder, and is preferably finely divided so as to facilitate uniform dispersion within the resin. Silver particles within the range of about 3 microns to about 20 microns are suitable for purposes of the invention. A -320 mesh silver powder is particularly suitable.

The carbon ingredient of the polymerizable composition should also be finely divided to facilitate uniform dispersion, and carbon particles within the range of about 0.1 to about 10 microns are suitable for this purpose. Electron grade powdered carbon is particularly suitable for purposes of the invention.

A resin composition of a consistency useful for local application, as illustrated in FIG. 2, may be prepared by admixing the epoxy resin, finely divided silver and finely divided carbon in suitable mixing equipment, for example a three roll paint mill. After the ingredients are uniformly dispersed, the curing agent is blended into the mixture. Where 2-ethyl-4-methyl imidazole is used as the curing agent, it may be added at the rate of one part by weight of curing agent to about 40 parts by weight of epoxy resin.

A resin composition suitable for overall application, as illustrated in FIG. 3 is preferably less viscous than the one described above, so that coating can be accomplished by a dipping operation. In this case the mixture of resin, silver and carbon is diluted, for example with a 50/50 mixture of methylethyl ketone and toluene and tumbled in a ball mill until a uniform dispersion is achieved.

It is generally preferred to clean the wiper arm before the resin composition is applied. In the case of a wiper arm formed from stainless steel, cleaning may be accomplished by immersion in warm hydrochloric acid, followed by a rinse in acetone.

Curing of the resin composition may be accomplished at room temperatures, but is preferably accomplished at elevated temperatures to reduce the cure time. Satisfactory curing can be accomplished in one hour at 150° C.

Potentiometer wiper arms produced in accordance with the present invention are inexpensive to manufacture and offer superior electromechanical properties, as compared with prior art wiper arms having carbon buttons.

The present invention has been described in conjunction with certain structural embodiments; however, it is to be appreciated that various structural changes may be made in the illustrated embodiments without departing from the intended scope and spirit of the invention.

Having described my invention thus, I claim:

1. In a wiper arm, for use with a potentiometer having an electrical resistance element, said arm having a fixed end adapted for connection to a terminal and a free end adapted to contact selectable portions of said resistance element, and said arm being operative to provide an electron-conducting path between said fixed and free ends: the improvement comprising an electron-conducting, synthetic resinous polymerizable bonded to at least the free end of said arm, said polymerizable being formed in situ by curing with an epoxy curing agent, a composition containing about 25—40 weight percent of epoxy resin, about 40—70 weight percent finely divided silver and about 5—20 weight percent finely divided carbon.
2. The wiper arm as defined in claim 1, wherein said polymerizable is bonded to substantially the entire surface of said arm.
3. The wiper arm as defined in claim 1, wherein said polymerizable is bonded only to a localized portion of the free end of said arm.
4. The wiper arm as defined in claim 1 in which said polymerizable is an epoxy resin cured with 2-ethyl-4-methyl imidazole and having an epoxy equivalent weight within the range of about 175 to about 200.
5. The wiper arm as defined in claim 1, formed of spring steel.
6. In a potentiometer having an electrical resistance element and a wiper arm having a fixed end connected to a terminal and a free end in contact with a selectable portion of said resistance element, said wiper arm being operative to provide an electron-conducting path between said fixed and free ends: the improvement comprising an electron conducting, synthetic resinous polymerizable bonded to at least the free end of said arm where it contact said resistance element, said polymerizable being formed in situ by curing, with an epoxy curing agent, a composition containing about 25—40 weight percent of an epoxy resin, about 40—70 weight percent finely divided silver and about 5—20 weight percent finely divided carbon.
7. The potentiometer as defined in claim 6 wherein said polymerizable is bonded to substantially the entire surface of said arm.
8. The potentiometer as defined in claim 6 wherein said polymerizable is bonded only to a localized portion of the free end of said arm, and is interposed between said arm and said resistance element.
9. The potentiometer as defined in claim 6 in which said polymerizable is an epoxy resin cured with 2-ethyl-4-methyl imidazole and having an epoxy equivalent weight within the range of about 175 to about 200.
10. The potentiometer as defined in claim 6 wherein said wiper arm is formed of spring steel.