

Sept. 3, 1963

K. F. MILLER ET AL
VARIABLE RESISTOR CONTACT

3,102,990

Filed Dec. 11, 1961

Fig. 1.

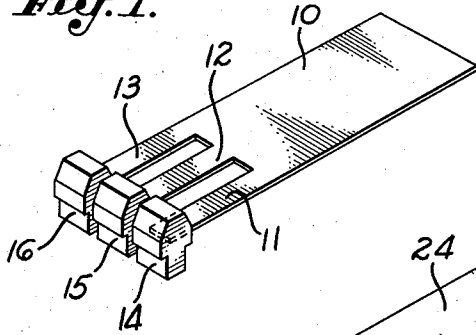


Fig. 2.

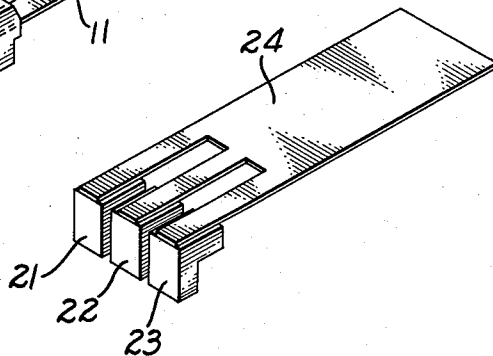


Fig. 3.

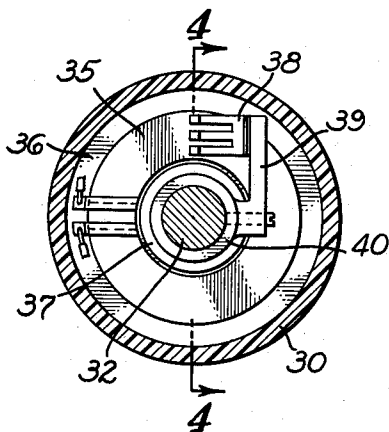
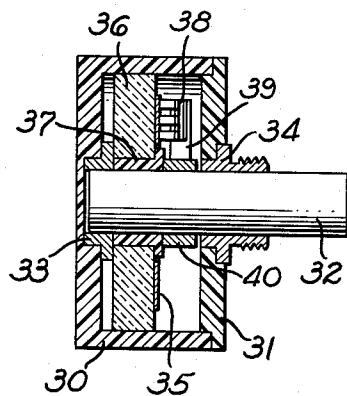


Fig. 4.



INVENTORS.

KENNETH F. MILLER
THOMAS M. PLACE, SR.

BY THEIR ATTORNEYS.

HARRIS, KIECH, RUSSELL & KERN

1

3,102,990

VARIABLE RESISTOR CONTACT

Kenneth F. Miller, Costa Mesa, and Thomas M. Place, Sr., Newport Beach, Calif., assignors to Beckman Instruments, Inc., a corporation of California
Filed Dec. 11, 1961, Ser. No. 158,318
12 Claims. (Cl. 338—162)

This invention relates to sliding contacts for variable resistors which are known as rheostats, potentiometers, voltage dividers, and the like. The contact of the invention is particularly adapted for use with resistors having a fused glass and metal resistance element, which material is ordinarily referred to as a "cermet" resistance material. Typically cermet resistance materials are described in U.S. Patents Nos. 2,950,995 and 2,950,996.

A good sliding contact for a resistance element such as a cermet resistance material, should generate little or no electrical noise when moving over the surface of the resistance element and should not produce any significant wear on the surface of the resistance material. A wide range of materials have been used for sliding contacts, including carbon, various metals, and a number of alloys such as silver-copper, silver-graphite, gold-copper-silver, and platinum-gold-copper. These prior art contact materials exhibit one or more of the major deficiencies such as high electrical noise, short life due to wear of the resistance material, and smearing of the film of resistance material. It is an object of the present invention to provide a new sliding contact material and method of making same, which contact is unique in composition, provides low electrical noise and substantially increased life, particularly when used with cermet resistance elements.

It has been found that a superior contact can be produced using a plastic mixed with a metal and a lubricant in finely divided form. The lubricant may also be a conductor, such as graphite, and the metal omitted from the mixture. It has been found that certain plastics exhibit lubricating qualities suitable for use in contacts and, as another alternative, the contact can be produced using a metal mixed with such a plastic.

Accordingly, it is an object of the invention to provide a molded variable resistor contact for use with a cermet resistance material or the like, comprising a thermosetting plastic and electrical conductor in finely divided form dispersed throughout the set plastic. A further object is to provide such a contact incorporating a thermosetting plastic, metal powder, and solid lubricant, with the metal and lubricant dispersed throughout the set plastic. A specific object of the invention is to provide such a contact in which the plastic is a diallyl phthalate resin.

It is an object of the invention to provide a molded variable resistor contact for use with a cermet resistance material or the like which may incorporate various thermosetting plastics, various metals and/or various lubricants in finely divided form with the metal, lubricant and plastic thoroughly mixed to produce a homogeneous molded unit.

It is an object of the invention to provide a potentiometer or variable resistor incorporating a cermet resistance element and the aforesaid molded contact. Another object is to provide a method of making the contact of the invention.

It is an object of the invention to provide a contact which does not significantly wear the resistance element during the serviceable life of the variable resistor. A further object is to provide a contact which generates low noise when passed over the surface of a resistance element. Still another object of the invention is to provide

2

a contact which may be molded onto its associated contact spring or carrier or may be attached to the spring by means of an electrically conductive adhesive.

The invention also comprises novel details of construction and novel combinations and compositions, which will more fully appear in the course of the following description. The drawing merely shows and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

In the drawing:

FIG. 1 is an isometric view of a preferred form of the sliding contact of the invention;

FIG. 2 is an isometric view of an alternative form of the invention;

FIG. 3 is a sectional view through a potentiometer incorporating the invention; and

FIG. 4 is a sectional view along the line 4—4 of FIG. 3.

The structure of FIG. 1 includes a contact carrier or spring 10 which is split at one end to form a plurality of fingers 11, 12, 13. Contacts 14, 15, 16 are molded in place at the ends of the fingers. Of course, one or any number of contacts can be used as desired. Typically, the contact spring may be of beryllium copper, although any relatively resilient metal or alloy may be utilized.

A contact itself comprises a molded thermosetting plastic with electrical conductor in finely divided form uniformly dispersed therethrough. Typically, the composition may be a plastic, a metal and a lubricant, or a plastic and a conducting lubricant, or a plastic and a metal. Various plastics, such as epoxy resins, polytetrafluoroethylene, diallyl phthalate resin, phenolics and urea formaldehyde resins may be utilized. Various metals, such as silver, gold and aluminum and their alloys and copper may be utilized. Carbon or graphite may also be used as the conducting component. Graphite and molybdenum disulfide are suitable lubricants for use in the molded mixture.

In the production of cermet resistance elements, for which the contact of the invention is particularly intended, the composition of the resistance material is varied to obtain a variety of resistance values and to vary the temperature coefficient of the element. The constituents and the ratios of constituents used in forming the contact of the invention may be varied to obtain the greatest compatibility between the contact and the resistance element, with respect to electrical noise, wear of the contact and resistance material and smearing of material. It has been found that the preferred range for the thermosetting plastic in the contact is about 10–70 percent by weight. With compositions utilizing plastic, solid lubricant, and metal powder, it has been found that the preferred composition range in percent by weight is plastic about 10–70 and lubricant about 30, with the remainder metal powder.

Some specific examples of compositions in percent by weight are set out below.

Mixture No. 1:

Silver powder—200 mesh.....	51.0
Diallyl phthalate resin (Mesa Plastics Diall 1000)	36.7
Graphite—200 mesh.....	12.3

Mixture No. 2:

Copper—200 mesh.....	85
Epoxy resin (Miracle Adhesives—Adwell 185)	15

Mixture No. 3:

Acetylene black.....	60
Diallyl phthalate resin (Mesa Plastics Diall 1000)	40

Mixture No. 4:	
Silver powder—200 mesh-----	60
Polytetrafluoroethylene (du Pont Teflon 100)---	40
Mixture No. 5:	
Copper—200 mesh-----	60
Epoxy resin (Mesa Plastics Epoxy Resin 1592) -----	20
Graphite—200 mesh-----	20

It has been found that the diallyl phthalate resin has superior wear and lubricating properties when used as the binder in forming a sliding contact and this resin is the preferred plastic for use in making the contact of the invention. The diallyl phthalate-silver powder-graphite mixture set out as mixture No. 1 in the above chart is the preferred mixture for the contact, exhibiting the desired mechanical and electrical properties discussed previously to a superior degree.

An alternative form of the structure is shown in FIG. 2. Contacts 21, 22, 23 are formed by pressure molding and are then cemented to a contact carrier 24 using a conductive cement, such as a conductive epoxy resin.

FIGS. 3 and 4 illustrate the use of the contact of the invention in a rotary potentiometer. The potentiometer includes a housing 30 and cover 31 with a shaft 32 journaled in bushings 33, 34 carried in the housing and cover, respectively. A resistance element in the form of a film 35 of cermet resistance material fired to a ceramic base 36 is fitted in the housing 30. A bushing 37 may be provided in the base 36 for receiving the shaft 32. A contact carrier 38, which may be the carrier of FIGS. 1 or 2, is supported on an arm 39 projecting from a collar 40 carried on the shaft 32 for rotating the contacts with the shaft to traverse the resistance element. Suitable leads are applied to the resistance element and the contact carrier. Of course, the invention is equally suitable with other forms of variable resistors, including linear and helical.

The following is a specific example of one process for making the contact of the invention. Using the composition of mixture No. 1, the metal powder, resin binder and graphite are milled in a ball mill dry until the materials are thoroughly mixed and reduced to a fine particle size. A quantity of the mixture is then placed in a mold of appropriate shape and formed under pressure and heat. The time, temperature and pressure of molding are dependent upon the particular plastic used. For the composition of mixture No. 1 using diallyl phthalate resin, a molding pressure of 2,000 p.s.i. at 313° F. for three minutes was used.

A second example of a process is given below, using mixture No. 5 having a liquid resin binder. The metal, lubricant and liquid resin with catalyst are thoroughly mixed forming a paste. A quantity of the paste is then placed in the mold for setting. For the epoxy resin, a pressure of 2,000 p.s.i. at 340° F. for six minutes was used.

Comparative wear tests between contacts of the type described herein and the best metal alloy contacts show that the life of the molded plastic contact is over three times that of the metal contact. Tests were conducted using an annular cermet resistance element $\frac{7}{8}$ of an inch in diameter and of the composition described in the aforesaid U.S. Patent No. 2,950,996, mixture No. 12. Two commercially available contact alloys were used, Palney #7 from J. M. Ney Co., and Baker alloy 503 from Englehard Industries, Inc. The plastic contacts were mixture No. 1 of this application. After 1,000,000 cycles (passage of the contact from one end of the resistance element to the other) both types of the metal contacts produced a substantial and noticeable amount of wear on the surface of the films. Alloy contacts previously tested have not exceeded this number of cycles. In contrast, the molded plastic contact of the present invention pro-

duced less wear after 3,574,800 cycles, at which time the test was terminated.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

We claim as our invention:

1. A molded variable resistor contact for use with a cermet resistance material or the like, consisting of in percent by weight, diallyl phthalate resin about 37, silver powder about 51, and graphite about 12, with the silver and graphite dispersed throughout the set resin.
2. A molded variable resistor contact for use with a cermet resistance material or the like, consisting of in percent by weight, epoxy resin about 15, and copper in finely divided form about 85, with the copper dispersed throughout the set resin.
3. A molded variable resistor contact for use with a cermet resistance material or the like, consisting of in percent by weight, diallyl phthalate resin about 40, and acetylene black carbon about 60, with the carbon dispersed throughout the set resin.
4. A molded variable resistor contact for use with a cermet resistance material or the like, consisting of in percent by weight, tetrafluoroethylene polymer plastic about 40, and silver powder about 60, with the silver dispersed throughout the set plastic.
5. A molded variable resistor contact for use with a cermet resistance material or the like, consisting of in percent by weight, a thermosetting plastic about 10-70, a solid lubricant in finely divided form up to about 30, and the remainder metal powder, with the lubricant and metal dispersed throughout the set plastic.
6. In a potentiometer, the combination of:
 - a housing;
 - a cermet resistance element mounted in said housing;
 - a movable contact carrier mounted in said housing for traversing said resistance element;
 - and a molded contact fixed to said carrier for contacting said element and consisting of a thermosetting plastic and electrical conductor in finely divided form dispersed throughout the set plastic.
7. In a potentiometer, the combination of:
 - a housing;
 - a cermet resistance element mounted in said housing;
 - a movable contact carrier mounted in said housing for traversing said resistance element;
 - and a contact molded about a portion of said carrier for support thereon in contact with said element, said contact consisting of a thermosetting plastic with electrical conductor in finely divided form dispersed therethrough
8. In a potentiometer, the combination of:
 - a housing;
 - a cermet resistance element mounted in said housing;
 - a movable contact carrier mounted in said housing for traversing said resistance element;
 - and a molded contact cemented to said carrier for support thereon in engagement with said element, said contact consisting of a thermosetting plastic and electrical conductor in finely divided form dispersed throughout the set plastic.
9. In a potentiometer, the combination of:
 - a housing;
 - a cermet resistance element mounted in said housing;
 - a movable contact carrier mounted in said housing for traversing said resistance element;
 - and a molded contact fixed to said carrier for contacting said element and consisting of a thermosetting plastic, metal powder and solid lubricant in finely divided form, with the metal and lubricant dispersed throughout the set plastic.

5

10. In a potentiometer, the combination of:
 a housing;
 a cermet resistance element mounted in said housing;
 a movable contact carrier mounted in said housing for
 traversing said resistance element;
 and a molded contact fixed to said carrier for con-
 tacting said element and consisting of in percent
 by weight, diallyl phthalate resin about 37, silver
 powder about 51, and graphite about 12.

11. A potentiometer comprising:
 a housing;
 a resistance element formed of a fused glass having
 metal particles dispersed therein mounted in said
 housing;
 a movable contact carrier mounted in said housing 15
 for traversing said resistance element;
 and a contact molded about a portion of said carrier
 for support thereon in contact with said element,
 said contact consisting of a thermosetting plastic

6

and a metal selected from the group consisting of
 silver, gold, aluminum and alloys thereof and
 copper, with the metal dispersed throughout the set
 plastic.

12. The potentiometer defined in claim 11 wherein
 said molded contact further consists of a lubricant select-
 ed from the group consisting of graphite and molybde-
 num disulfide.

References Cited in the file of this patent

UNITED STATES PATENTS

2,740,732	Peck et al. -----	Apr. 3, 1956
2,790,882	Siegel -----	Apr. 30, 1957
2,862,088	Mairs -----	Nov. 25, 1958
2,950,996	Place et al. -----	Aug. 30, 1960

FOREIGN PATENTS

1,186,513	France -----	Feb. 23, 1959
-----------	--------------	---------------