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VARIABLE RESISTOR

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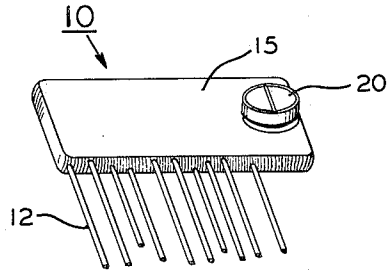

FIG. 1

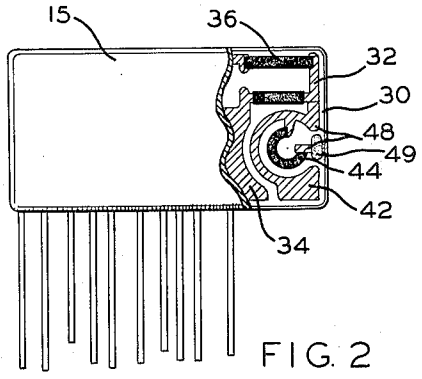

FIG. 2

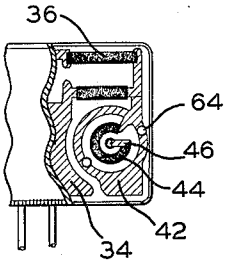

FIG. 3

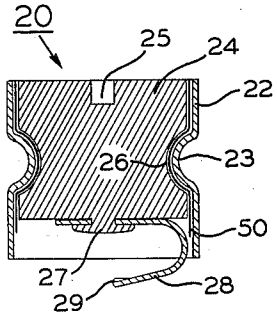

FIG. 4

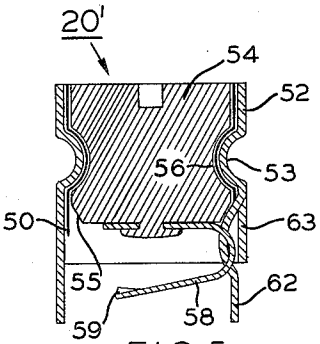

FIG. 5

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VARIABLE RESISTOR

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5 Claims. (Cl. 317—101)

This invention relates to a variable resistor and more particularly to a variable resistor for printed circuit application.

The variable resistors of the present invention are capable of being utilized as resistors, potentiometers, rheostats, or any other application of a resistance and movable contact.

The resistors are of the type having a resistive material applied to an insulating base and an external movable contact member capable of making selective contact with the resistive material.

In the evolution of printed circuitry the self-contained potted unit plays a great role. First came the multiple capacitor, the first to use the active dielectric as the supporting base for printed wiring, with its overall coating of an insulating material which provided a hermetically sealed unit from which only the lead wires protrude. Then as the natural outgrowth of the multiple capacitor came the printed resistance-capacitance circuits (R-C), which combined the use of printed resistors with the printed capacitors, and in a like fashion, presented a compact fully encased unit of extreme miniaturization capable of many and diverse electronic applications. The next logical development would be the inclusion of a variable resistance in the printed R-C circuits. However, in spite of the market for such units, prior attempts at the inclusion of variable resistances have not met with success, principally because the movable contact member failed to provide rugged, sure, easy, and leakproof construction.

It is an object of this invention to provide a moisture resistant sealed unit having a variable resistance included in the circuit, and which is not exposed to atmospheric conditions.

It is a further object of this invention to provide a movable contact member for the resistance of an encased printed circuit which will be rugged, easy to operate, and capable of economical mass production.

These and other objects of the invention as will become apparent during the course of the description, will be best understood by reference to the appended drawing which forms a part of this application, and in which:

Fig. 1 is a perspective view of the preferred embodiment of this invention;

Fig. 2 is a breakaway front view with the coating composition partly removed and with the contact member removed to show the resistive coating and its relationship with its conductive coating and the rest of the circuit;

Fig. 3 is a similar view of another modification of resistive and conductive coating arrangement;

Fig. 4 is an expanded section view of the movable contact member of this invention; and

Fig. 5 is an expanded section view of another embodiment of the movable contact member which provides indexing and stop means.

Generally the invention relates to the provision of a resistance coating and conducting coating on an insulating

base (which also serves as the support for the other parts of a printed electronic circuit) and to a contact member comprising a sleeve mounted on the conducting coating, and a barrel mounted within the sleeve and having a wiper arm contacting the resistance coating, so as to provide an electronic circuit having a variable resistance element.

In Fig. 1 the finished unit is designated by 10, and shows a unit of a generally flat rectangular construction with rounded corners. However, it should be understood that the invention could as well be applied to a unit of any other shape, and that the shape shown is merely to illustrate an extremely convenient expression of the invention. The primary importance of Fig. 1 is to show in a perspective of a finished product, the general relationship of the contact member 20 to unit 10, as well as to show cover coating 15 preferably of a thermosetting plastic, and its sealing relationship with the leads 12 and the member 20.

Fig. 2 shows the unit of Fig. 1 with part of covering 15 broken away and the contact member removed to reveal the inventive subject matter and enough of the circuit to a show a typical hookup for applicants' variable resistor.

The base 30 is of an insulating material having a dielectric constant in the range of 1 to 6000 and preferably in excess of 1000. Suitable base materials are steatite and barium strontium titanate. The circuit depicted comprises conducting coatings 32, capacitor sections 34, and resistors 36, all of which may be formed in accordance with the teachings set forth in Letters Patent 2,694,185 to George T. Kodama, and which are also shown only by way of environment for applicants' inventive contribution of making possible the addition of a variable resistance in a cover coated printed circuit.

The variable resistance comprises a conductive outer arcuate section 42 of conductive material, preferably the same material as conductive coating 32. Within section 42 is an arcuate section 44 of resistive material, preferably the material of resistor 36. Suitable printed conductors 48 which may be of the same material as coating 32, join sections 42 and 44 with the rest of the circuit.

The contact member 20, best shown in Fig. 4, comprises a sleeve 22 and a barrel 24 of brass or other suitable material. The sleeve 22 is of thin wall construction, in the order of 0.02 inch, and has an inside diameter of the order of 0.28 inch. The dimensions are only illustrative and it is within the scope of applicants' inventive concept to utilize other dimensions, it being preferred that sleeve 22 have a relatively great inside diameter, so as to provide a member capable of a high degree of self-support and able to withstand forces tending to collapse the wall. Sleeve 22 is made with the same inside diameter as the conductive coating section 42 so that the sleeve may be mounted thereon.

The barrel 24 is so dimensioned as to turn within sleeve 22 with a slight drag. In applicants' preferred embodiment barrel 24 is of steel which provides a surface having desirable characteristics of smoothness into which the brass sleeve may be accurately rolled to provide the desired drag resistance when the barrel is rotated within the sleeve. However, barrel 24 may be made of the same material as sleeve 22 so as to avoid any possibility of corrosion. Suitable depressions, such as screw driver kerf 25, are provided to receive a tool for rotating barrel 24 within sleeve 22. A circumferential groove 26 is provided in barrel 24 as an index means for positioning the barrel for rotation within sleeve 22 and above the lower end of the sleeve. A mating indexing depression 23 is provided in sleeve 22, as by rolling the sleeve material into groove 26 of the barrel. The rolling of sleeve 22

into groove 26 in barrel 24 produces the tight fit necessary for maintaining a friction fit of barrel 24 in sleeve 22, so that barrel 24 will not be free to rotate without the application of external force. The rolling of the sleeve also produces a virtually leakproof fitting and has been found satisfactory for all usual conditions of use. However, a layer of conducting grease 50, e.g. a grease having a high graphite content, may be utilized to ensure waterproof sealing, as well as to lubricate the fitting.

The lower end of barrel 24, which by virtue of the indexing effect of groove means 23, 26 is above the lower end of the sleeve 22, has secured thereto a wiper arm 28 of spring brass, Phosphor bronze, beryllium, copper, or other spring material, by means of beading 27. Wiper arm 28 is so constructed and arranged that it extends beyond the lower end of sleeve 22, so as to be resiliently urged into contact with the resistive coating 44 by virtue of positioning the unit 20 on conductive coating 42 on base 30. Wiper arm 28 is provided with an upwardly dished end 29 to ensure against the end digging into the resistance coating 44 and thereby against greatly reducing the life of the unit.

In constructing unit 10, the contact member 20 is secured to base 30 in such a manner that sleeve 22 is positioned on arcuate conductive coating 42 and is secured thereon by solder. Preferably all points where sleeve 22 contacts conductive coating 42 are soldered to obtain highest electrical contact and to obtain maximum sealing. A thick lacquer (not shown) may be positioned on base 30 to complete the arcuate conductive coating 42 so as to afford, by engagement with sleeve 22, a sealing barrier preventing entry of cover coating 15 within the limits of coating 42, and thereby prevenitng fouling of the resistor. A protective coating 49 is provided over the conducting lead from the resistance coating to prevent shorting out the resistor through the sleeve.

In Fig. 3 a modified embodiment of the invention shows another arrangement which may be utilized when it is desired to join the variable resistance with circuitry deposited on the reverse of the insulating base 30. In this embodiment conductive coating 42 completely encircles resistive coating 44. Connection to the reverse of base 30 is made by providing printed conductor 46 with a passage through base 30, rather than utilizing the Fig. 2 arrangement of path 48 which extends over the edge of base 30. The Fig. 3 embodiment is provided with passages 64 through plate 30 for receiving legs 62 of the Fig. 5 embodiment of the contact member. The arrangement greatly facilitates assembly of unit 10 in that accurate placement of contact member 20 on the conducting coating is assured. Other advantages obtained by the use of holes 64 include greater stability and strength of contact member 20. The use of legs 62 and passages 64 has the additional advantage of permitting securing solder to be applied on the rear of plate 30. Then the sleeve may be completely circumferentially soldered to circular coating 42 to produce a rigidly mounted completely sealed unit.

Fig. 5 shows another embodiment 20' of the contact member of this invention. Barrel 54 is indexed and secured within sleeve 52 by mating members 53 and 56 and may be provided with a lubricating and sealing layer 50, in the same manner as contact member 20 of Fig. 4. Sleeve 52 is provided with spaced legs 62 which extend below the lower edge of the sleeve. Legs 62 may be merely straight line extensions of sleeve body 52 as shown by the left hand leg of Fig. 5, or may be curved in from the sleeve body to provide stop means to limit the travel of wiper arm 28, as shown by the right hand leg of Fig. 5. If two straight legs are provided there need be no change in the shape of the lower edge of the barrel from the shape shown in Fig. 4. However, if at least one curved stop leg is utilized, the barrel should be provided with bevel means 55 to permit the inward bending of the leg and to permit rotation of the barrel around the leg. Although the curved leg may be produced by an indenting pressure action, it is proposed that two spaced slits 63 be made in sleeve 52 and leg 62 bent in at the slits so as to eliminate any binding action which might result from pressure formation. Leg 62 is curved to the extent that it contacts and provides a positive stop means for wiper 58, and is then curved back to the vertical either directly in line with the sleeve wall, or offset inwardly or outwardly with respect to the sleeve wall so as to provide indexing means.

Fig. 5 also shows another embodiment of the wiper arm which can also be used on the Fig. 4 contact member. Wiper arm 58 is of such length as to extend past the beading which secures the arm to the barrel so as to provide a very resiliently mounted wiper arm. A dished outer end 59, similar to dish 29, is provided to prevent injury to the resistance coating, and to ensure smooth sliding contact.

Cooperative securing and positioning means for offset leg 62 may be provided for locating and indexing the sleeve 52 on conductive coating 42 by utilizing passages 64 which are not centered (Fig. 3), so that sleeve 52 may be located in only one position.

It should be understood, however, that the Fig. 5 contact member 20' may be utilized on the Fig. 2 coatings by provision of suitable holes 64; and that the Fig. 4 contact member 20 may be utilized on the Fig. 3 coatings without modification.

The thermoplastic compound 15, as best shown in Fig. 1, may be used to provide still additional stabilizing means for the contact member, in that the plastic may be of such thickness as to extend into groove 23 or 53 in the sleeve of the contact member.

As many apparently different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments hereof, except as defined in the appended claims.

We claim:

1. A variable resistor for a printed circuit comprising a base of dielectric material, a first arcuate coating of conductive material positioned on said base, a second arcuate coating of resistive material positioned on said base within said first arcuate coating, said first and second coatings being electrically connected to other printed circuit elements positioned on said base, a squat cylindrical sleeve mounted on said first coating and conductively connected thereto, a barrel rotatably secured within said sleeve, a wiper arm attached to said barrel and so constructed and arranged as to contact said resistive coating, means for rotating said barrel and said wiper arm so as to vary the amount of said resistive coating that is included in said printed circuit.

2. A movable contact member as in claim 1 wherein said sleeve has a large internal diameter with respect to the wall thickness, and said barrel is of such size as to provide a close tolerance fit within said sleeve.

3. A movable contact member as in claim 1 wherein said means include a groove in said barrel, and a mating interengaging indentation on the wall of said sleeve.

4. A variable resistor comprising a base of dielectric material, a first arcuate coating of conductive material on said base, a second arcuate coating of resistive material on said base and within said first arcuate coating, an upstanding conductive sleeve mounted on said first coating in conductive relation thereto, a conductive barrel rotatably mounted within said sleeve, resilient wiper means secured to said barrel and depending therefrom, said wiper means contacting a portion of said resistive coating, and a conductive grease sealing the space between the barrel and sleeve.

5. A variable resistor for a printed circuit comprising an insulating base, a conductive coating on said base, a resistive coating on said base within an area bounded by said conductive coating, a sleeve, a barrel rotatably mounted within said sleeve, a wiper arm secured to the

bottom of said barrel, indexing means positioning said sleeve on said conductive coating and said wiper arm on said resistive coating, and stop means on said sleeve limiting the travel of said wiper arm.

References Cited in the file of this patent

UNITED STATES PATENTS

2,178,283	Lodge	Oct. 31, 1939
2,358,991	Miller	Sept. 26, 1944
2,616,994	Luhn	Nov. 4, 1952
2,650,270	Mucher	Aug. 25, 1953
2,676,226	Mucher	Apr. 20, 1954
2,682,018	Phillips	June 22, 1954
2,683,767	Cunningham	July 13, 1954
2,703,377	Hings	Mar. 1, 1955
2,740,025	Polye	Mar. 27, 1956
2,883,499	Kilby	Apr. 21, 1959

OTHER REFERENCES

Tele-Tech, December 1953; pp. 136 and 137.