

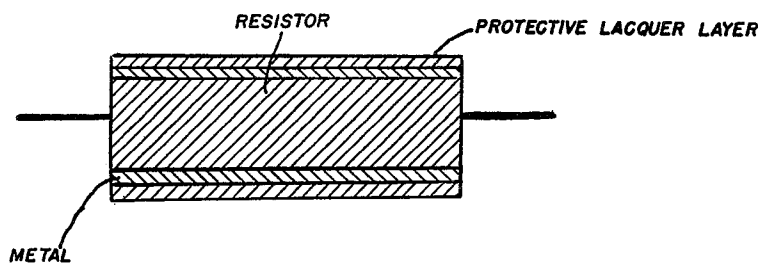
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RESISTOR

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INVENTOR.
THEO A. TIELENS &
JAN KUNNEN

BY
Frank R. Lufkin
AGENT

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3,109,754 RESISTOR

Theo Asmund Tielens and Jan Kunnen, Emmasingel, Eindhoven, Netherlands, assignors to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

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This invention relates to metal resistors, such as wire resistors, tape resistors or resistors having a metal layer deposited on a carrier from vapour, which metal consists of iron or a metal or alloy which is nobler than iron, such as chromium-nickel, nickel-copper, aluminium-chromium-nickel.

Such metal resistors, for example chromium-nickel wire resistors having a wire diameter which is smaller than 100 microns, tape resistors or resistors deposited from vapour having a layer thickness smaller than 10 microns, could so far not be protected easily against corrosion. The commonly used protective layers, for example consisting of lacquers, cements or glass enamels, gave no sufficient protection against corrosion when such a resistor is charged, at a high humidity, with a direct voltage causing a temperature rise such that the humidity in the immediate proximity of the resistor does not deviate noteworthy from that of the surroundings. This requirement corresponds to the test of the International Electric Committee, known as "tropical test under low D.C. tension." Under these conditions, such resistors of thin metal show interruption after a short time.

It is known that corrosion of metals can be counteracted in general by covering said metals with a layer of a less noble metal, for example Zn or Cd in order to protect steel. For this purpose, it is also known to use a metal-containing paint containing such a less noble metal in a fine distribution and a high concentration and which consists of a suspension of the metal powder in a solution of a binder. Such a zinc-containing paint frequently contains 90-95% by weight of zinc in the dry substance.

However the use of such a metal containing lacquer on metal resistors, in many cases causes high conductivity of this lacquer, a low breakdown voltage and danger of short-circuiting of part of the resistor by coarser metal particles. When such a lacquer layer is provided on a high-ohmic resistor, a considerable parallel conductivity with respect to the metal resistor appears to occur, which conductivity increases considerably as a result of the porosity of the lacquer layer when the lacquered resistor is subjected to a moist atmosphere having a high relative humidity. For example in the case of a wound wire resistor having a length of 40 mms. and a diameter of 6 mms., a minimum layer thickness may be chosen with which the corrosion protection is maintained, but then it is found that the lacquer layer in a moist atmosphere assumes an ultimate resistance value in the order of at most 10 K Ω . If, for example, the resistance change owing to the parallel resistance of the lacquer layer is to be kept below 1% of the total resistance, metal resistors of said proportions protected against corrosion, having a value of at most 1 K Ω only can be prepared by means of this known lacquer.

According to the invention, however, also resistors are possible having a higher resistance value, for example to 1 M Ω , which are provided with a zinc- or cadmium-containing lacquer for protection against corrosion, the resistance variation of which, owing to the parallel resistance of the moist lacquer layer in an atmosphere having a relative humidity of 10%, is smaller than, for example, 1% of the value of the total resistance.

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In that case, it is necessary to strongly increase the resistivity of a metal-containing lacquer. In addition to the choice of the content of metal powder, this is possible, for example, by suitable choice of the dispersion degree of the metal powder in the lacquer, of the particle size of the metal powder, and of the type of binder. It was surprisingly found that even with resistance values of the lacquer layer much higher than those occurring in the known metal-containing lacquer layers used as corrosion-resistant agents, the protective effect against electrochemical corrosion is maintained also when the resistor is charged with direct voltage under the conditions of the above-mentioned tropical test.

The use of a lacquer which contains large metal particles is to be avoided since otherwise parts of the resistor covered with such a lacquer are short-circuited. It has appeared that even in the case of wound wire resistors having the practically smallest possible pitch in connection with flash-over, a zinc- or cadmium-containing lacquer may be used subject to the particle size of the metal being smaller than 15 microns.

The binders that may be used are, for example, polystyrene, polybutylmethacrylate, chlorinated rubber etc.

If desired, a commonly used softener may be added, for example pentachlorodiphenyl in the case of polystyrene.

The zinc or cadmium content in the lacquer is preferably chosen from 70 to 85% by weight calculated on the dry substance. The exact dispersion degree of the lacquer may be adjusted by stirring for a reasonably short time, for example thirty minutes. The desired resistance value is then reached in a reproducible manner without the stirring time being especially critical.

The use of metal-containing lacquers on a basis of silicon has the advantage that the variation of the value of the parallel resistance of the lacquer layer due to moisture occurs to even a far lesser degree.

The same result may also be obtained with a metal lacquer layer which is not composed on a basis of silicon by covering said layer with a metal-free known silicon lacquer.

In order to confer upon a lacquered resistor according to the invention an increased protection against mechanical damage and sufficient insulation and to embellish at the same time the appearance of the resistor, it may in addition be provided with an insulating lacquer layer, possibly coloured.

The sole FIGURE of the drawing is a cross-sectional view of the resistor constructed in accordance with the teachings of the present invention showing the metal layer and protective lacquer layer thereon.

Examples

I. 130 g. of zinc dust having an average particle size of 2.5 μ and of which 85% by weight has a particle size <5 μ and 100% a particle size of <15 μ , are added to a solution of the composition:

26 g. of polystyrene (average mol. weight approximately 200,000),

9 g. of pentachlorodiphenyl (technical),

86g. of xylene,

which mixture was then stirred for thirty minutes.

Wire-wound resistors having a value of approximately 30 K Ω , manufactured from Ni—Cr wire (composition 80% Ni, 20% Cr) of a thickness of 20 μ wound around a ceramic tube at a mutual distance of the wires of 30 μ , which tube has a diameter of 6 mm. and a length of 4 mm., were covered with the thus manufactured lacquer. After drying this lacquer layer, another insulating lacquer layer was provided, which lacquer had the following composition:

300 g. of monoethylglycoether,

50 g. of polyvinylbutyral and
25 g. of chromium trioxide.

The life of these resistors was tested while they were charged with a direct voltage of 5 v. and subjected to an atmosphere of a relative humidity of 100% at a temperature of 45° C.

After having been subjected to these conditions for 5000 hours, no interruption of the resistors had occurred and they showed a variation of only a few 0.1% of the resistance values. A number of resistors which otherwise were equal to those described above but which had not been covered with the zinc-containing lacquer layer according to the invention, were already interrupted all of them after 50 hours when they were subjected to the above described test.

Resistors having the same properties as described above were obtained when the zinc content in the above prescription was varied between 110 and 140 g.

Example II

II. 200 g. of cadmium powder were stirred with 100 g. of the polystyrene solution of the composition of Example I.

This lacquer was provided on a number of wire-wound resistors of 30,000Ω having a length of 40 mm. and a diameter of 6 mm. provided with nichrome wire 20μ thick (80% Ni, 20% Cr). After drying, an insulating lacquer layer was provided.

Of these resistors also the life was tested and, for comparison, also the life of a number of otherwise equal resistors, in which the insulating lacquer layer was provided on the resistor without the cadmium-containing intermediate layer according to the invention. After having been subjected for 50 hours to an atmosphere of a relative humidity of 100% at 45° C. under a charge with a direct voltage of 5 v., all of the latter resistors were interrupted by corrosion of the resistor wire. In the resistors provided with Cd-lacquer according to the invention, these interruptions did not occur even after 1000 hours under the same conditions.

III. 70 g. of zinc powder having an average particle size of 2.5μ were added to 40 g. of a solution of a thermo-hardening polysiloxane on a basis of dibutoxypolysiloxane and this mixture was intimately stirred for thirty minutes.

A number of resistors as described in Example I were covered with this lacquer layer and, after drying, an insulating layer of the composition as described in Example I was provided.

After having been subjected for 5000 hours to the tropical test described above, none of these resistors was

interrupted and they showed a variation in the resistance values of also only a few 0.1% of the value.

IV. A number of resistors as described in Example I were covered with the zinc-containing lacquer described in said example. After drying, these lacquered resistors were covered with a lacquer consisting of a solution of a thermo-hardening polysiloxane on a basis of methylphenylpolysiloxane, to which a red dye had been added. All of the resistors had an equal resistance with respect to the tropical test described in Example I compared with the resistors according to the invention described in said example.

Also other metal resistors, such as tape resistors and deposited from vapour, covered in the same manner with the zinc- or cadmium-containing lacquer according to the invention, could be protected against corrosion without annoying parallel conductivity occurring.

What is claimed is:

1. A resistor comprising an insulated support, a metallic resistor element on said support and a protective lacquer layer covering exterior surfaces of said metallic element, said lacquer layer containing a metal powder selected from the group consisting of zinc and cadmium powder.
2. A resistor comprising an insulated support, a metallic resistor element on said support and a protective lacquer layer covering exterior surfaces of said metallic element, said lacquer layer containing a metal powder selected from the group consisting of zinc and cadmium powder, said metal powder having a particle size of less than 15μ.
3. A resistor as claimed in claim 1 wherein said lacquer layer contains from 70% to 85% by weight of the selected metal powder.
4. A metal resistor comprising a protective lacquer layer covering exterior surfaces of said resistor, said lacquer layer being composed on a base of silicon and containing a metal powder selected from the group consisting of zinc and cadmium powder.
5. A metal resistor as claimed in claim 1 further comprising a metal-free lacquer layer covering the metal containing lacquer layer.

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