

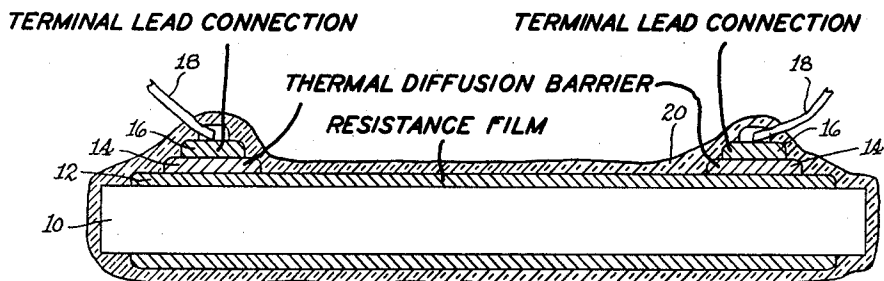
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METAL FILM RESISTOR

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METAL FILM RESISTOR

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The present invention relates to new and improved metallic film resistance components.

For some time it has been known to create resistance units having this metallic film by depositing a metal organic compound or a metal salt composition upon an inert base, and subsequently firing the so-coated base, for predetermined periods.

Satisfactory resistance coatings, per se, can be obtained by the broad process described, but difficulty has arisen in maintaining predetermined characteristics in the resistance film when such is covered with a high temperature vitreous enamel protective surface coating. Such vitreous enamel compositions are normally applied from an aqueous suspension, and are fired at a temperature of about 1000 to 1300° F. for a period of 1 to 5 minutes. During the firing the metallic resistors undergo changes in resistance values, and may become unsatisfactory with a complete absence of any stability in the operational characteristics. Repeated investigations into the nature of this trouble indicates that it results primarily because the ends of the resistance films adjacent to the terminal elements break down prematurely producing undesirable and uncontrollable discontinuities in the resistance. This is particularly severe when silver is used as terminal lead connections.

One object of the present invention is to prevent instability and break down in vitreous enamel coated resistors employing a metallic resistance layer. Another object of the invention is to provide simple, satisfactory processes for manufacturing metallic film type resistors. Other objects of the invention, as well as the advantages, will become apparent from the specification and claims which follow. In the accompanying drawing the single figure is a sectional view of a resistor pursuant to the present invention.

The generic aspect of the invention may be broadly defined as comprising a process for forming metallic resistance films on non-conductive cores, including the step of associating with such resistance film an element, compound, or composition having at least one constituent of low thermal mobility at or adjacent to its terminal connections. In accordance with the present invention, the above disadvantage is substantially prevented by placing a narrow ring of a second material of low diffusion constant adjacent to the terminal elements prior to firing so as to counteract the diffusion tendency of the first terminal metal.

This feature of the invention is perhaps best illustrated with reference to a specific example. Quarter inch diameter cylinders of steatite, coated with a 40% silver and 60% palladium resistance layer, were in accordance with one form of the invention provided with a narrow palladium ring overlay adjacent to its ends at about the approximate locations of the silver deposit applied over it in connecting the resistance film with the terminal lead elements, and the unit fired at 700° F. for fifteen minutes. Thereafter, the resistor was coated with a vitreous enamel of the type mentioned above and again fired

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at a temperature of 1200° F. for about 2 minutes. During the subsequent firing, there was no substantial migration or diffusion of any major portion of the end silver deposits into the resistance layer. It was particularly noted that the resistance film, after the initial firing, did not have silver rich alloy areas near the terminal connections as had the units prepared by prior known processes.

The above construction is illustrated in the figure where the steatite base is shown at 10, the silver palladium alloy coating at 12, the thermal diffusion barrier at 14, the silver terminal lead sites at 16, the leads themselves at 18, and the enveloping vitreous enamel coating at 20.

Although the precise mechanism involved is not completely understood, it is believed the enriching of the alloy deposit near the terminal boundaries with silver permits an alloy of low melting point and high internal mobility to be formed during the firing. The amount of palladium applied did not appear to be critical as long as the thickness of palladium was about ten times thicker than the thickness of the resistance layer. In any event, no difficulty was experienced with excessive diffusion of the silver into either the resistance layer or the ceramic body, and the resistance film so formed can be satisfactorily coated with common commercial vitreous enamel compositions in a conventional manner.

Alternatively, the terminal rings may constitute additional bands of the original alloy, although the resistor so formed is slightly more susceptible to oxidation in the terminal region.

One specific process in which metallic film resistors having exceptional predetermined characteristics were produced was formulated as follows: A metal organic resinate solution was diluted with acetophenone until it contained about .66% metal. The solution containing .66% metal was then applied by brush or spraying to a ceramic base. The dried film was then partially decomposed at about 400° F. In this fashion re-dissolution of the metal organosol by the second coat was avoided and independent multiple coats were applied. In this manner local variations in the thickness of the metal film were also avoided as much as possible. After sufficient coats to give the desired resistance were applied, the organosol was burned off at 750° F. Good, distinct metallic films having exceptioned stability and low temperature characteristics were thus obtained.

To each end of the steatite core is applied a terminal. This terminal consists of silver flake bonded to the steatite by material such as powdered glass. It is to be pointed out that it is preferable that the terminals are immediately adjacent to the resistance film but do not actually contact said film.

The critical feature of the inventive process is the application of the metallic bands which physically and electrically connect the resistance film to the terminals. For a band material of low thermal mobility palladium is preferred with platinum and other noble high melting point metals also being satisfactory.

This band is formed by painting a 5% solution of organic palladium compound of resinous character and thereafter firing at 800° F. for 15 minutes. This cycle was repeated until a band having a thickness of about ten times the resistance film was formed.

The resistance unit was then sprayed with a suspension of a commercial vitreous enamel and fired at a temperature of 1000° F. for 3 minutes.

Although the above examples describe silver-palladium resistors only, it will be realized by those skilled in the art that the broad teachings apply to other metallic resistance materials, as for example, gold-palladium, gold-platinum, and silver-platinum alloys. The teachings also apply where the resistance layer consists solely of one

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element and where the terminal contact is attached by means of a second, more mobile metal. It will further be apparent that other type core materials may be used, as for example, quartz, boro-silicate glass, lead glass, and the like.

Also, the terminal rings for prevention of diffusion, migration and oxidation of the constituent having the greater thermal mobility may be applied to the core either before or after the application of the main resistance film and terminal contact, or alternatively, between the application of the main resistance film and the terminals.

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

What is claimed is:

1. An electrical resistance comprising a vitreous base, a metallic alloy resistance film on said base, electrical terminals attached to spaced portions of said film, a narrow band of a metal which counteracts thermal diffusion interposed between said terminals and the portions of the film to which they are attached and a vitreous coating over the metal portions.

2. A metal film resistor comprising a vitreous base, an electrically resistive film of a metal alloy upon said base, terminals connected to said base by means of fired-on silver layers, narrow bands of a metal selected from the class consisting of platinum and palladium connect-

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ing said silver layers with the film so as to counteract any tendencies of said silver layers to diffuse into said resistance film and a vitreous coating over the metal portions.

3. An electrical resistor comprising a vitreous base, an electrically resistive silver alloy film on said base, thermal diffusion barrier coatings of a metal selected from the class consisting of platinum and palladium on spaced portions of said film, silver terminal connection layers on said barrier coatings, and a vitreous layer covering the metal portions.

4. The invention of claim 3 in which the barrier coatings are at least about ten times as thick as the resistive film.

5. A metal film resistor comprising a vitreous base, an electrically resistive film of a metal alloy upon said base, terminals connected to said base by means of fired-on silver layers, and narrow bands of a metal selected from the class consisting of platinum and palladium connecting said silver layers with the film so as to counteract any tendencies of said silver layers to diffuse into said resistance film.

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