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C. J. CHRISTENSEN

2,419,537

RESISTOR

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FIG. 1

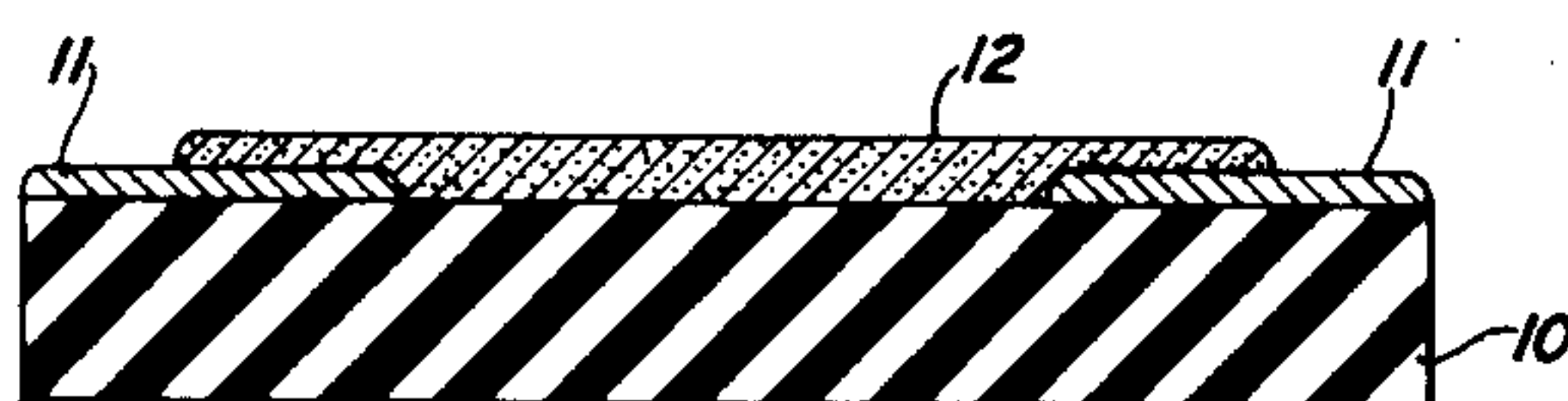


FIG. 2

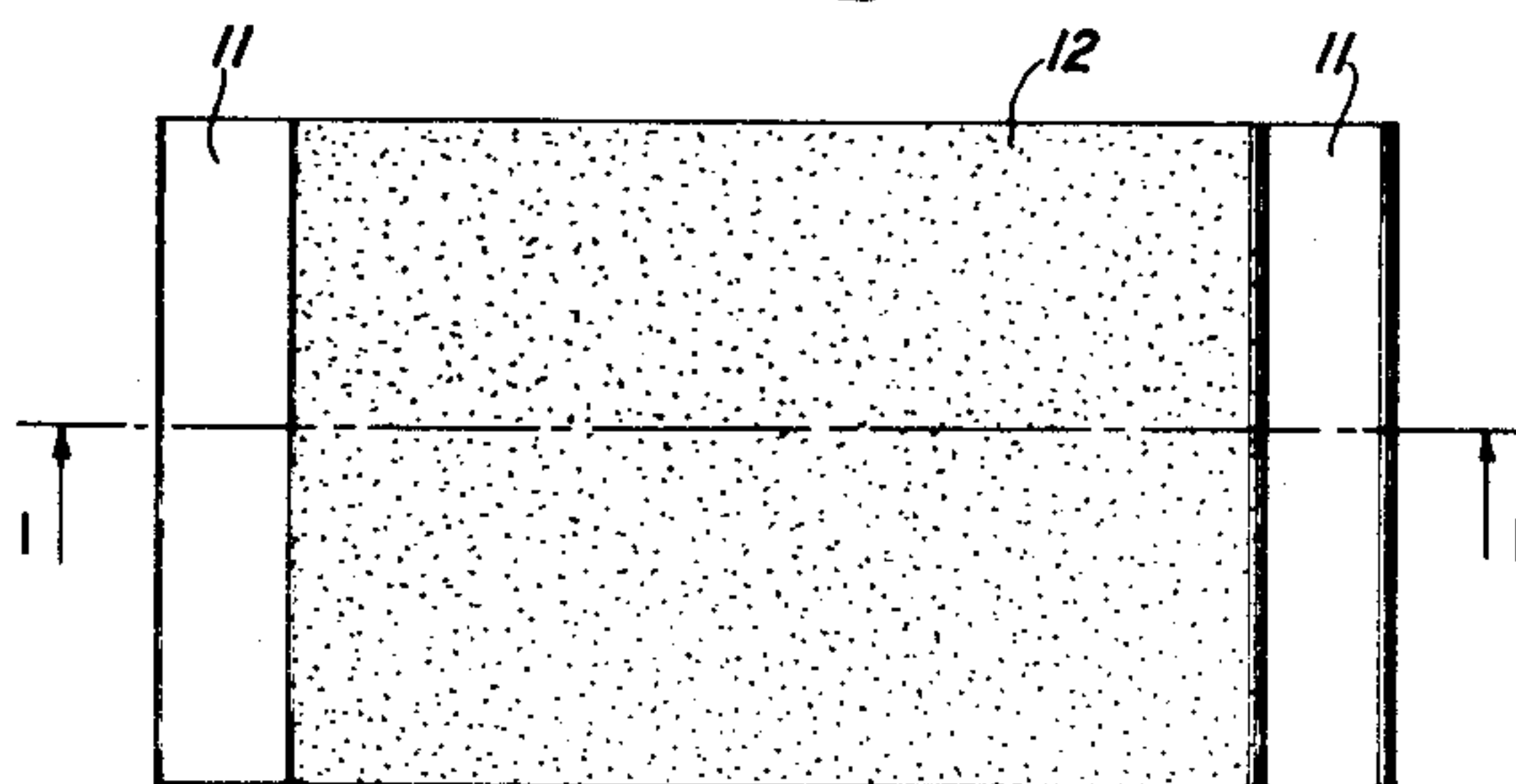


FIG. 3

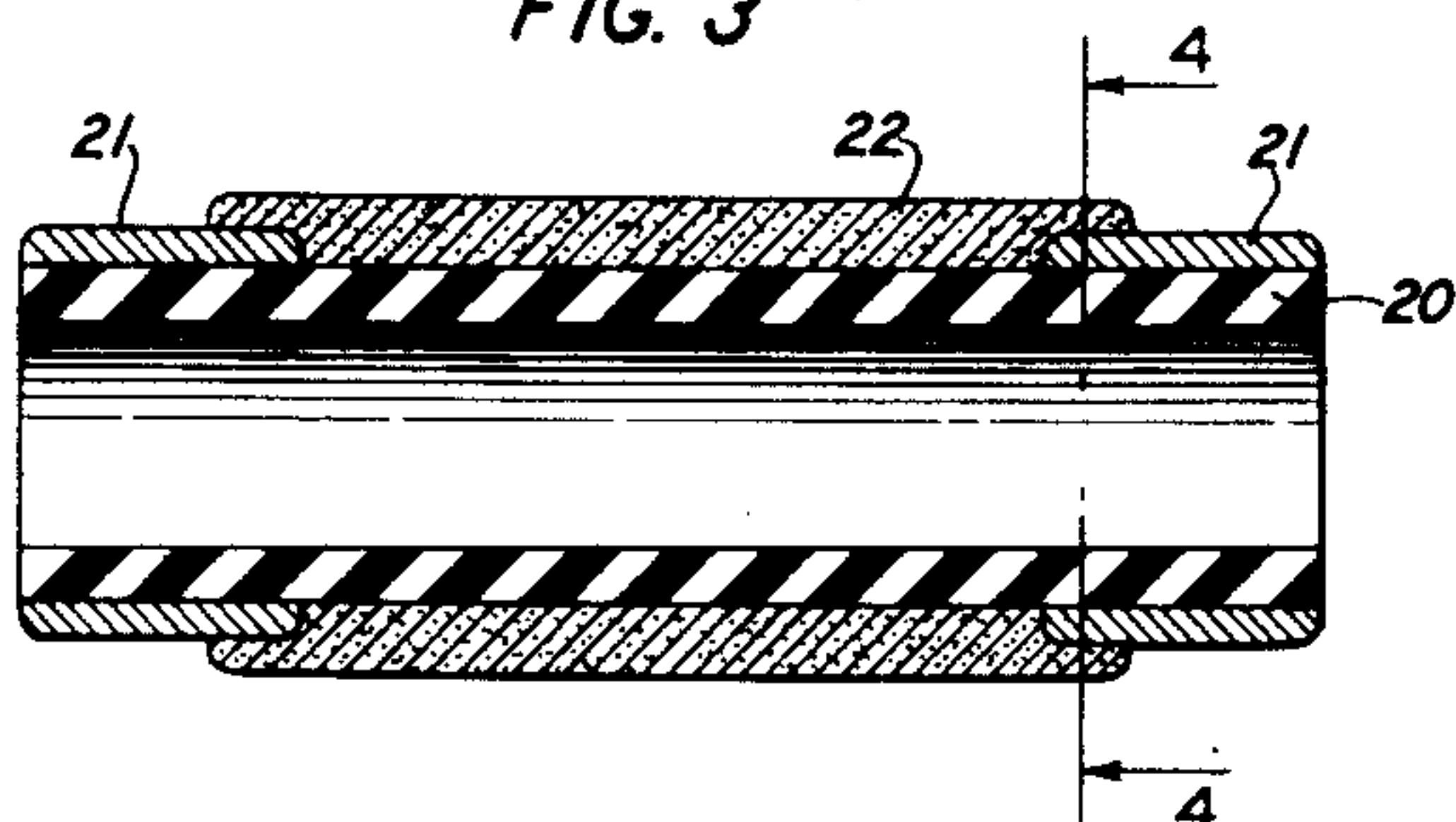
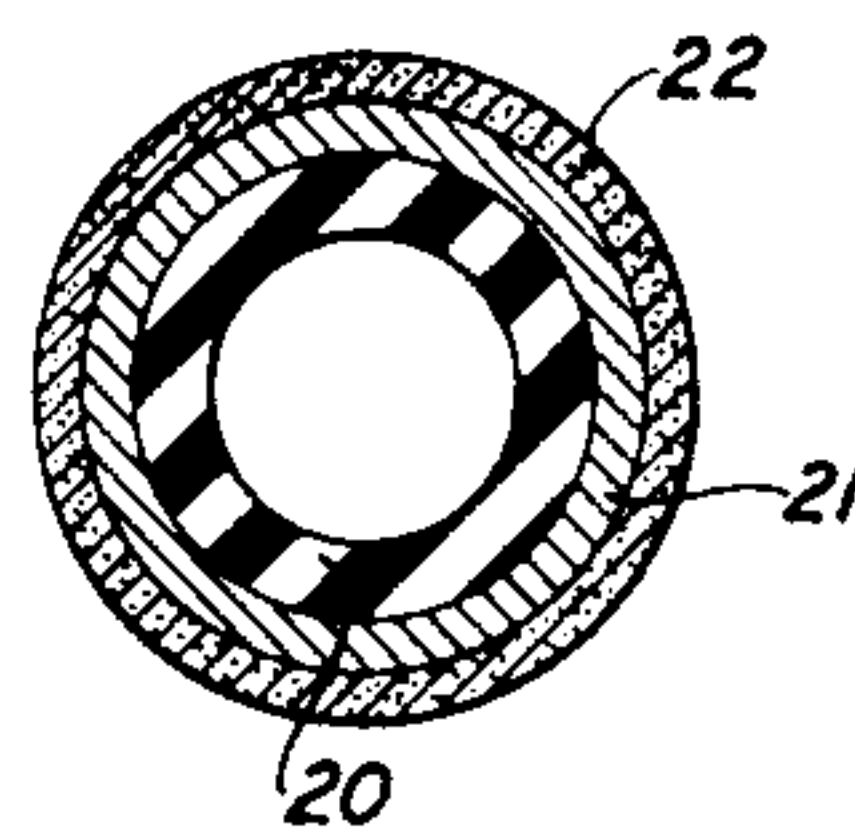


FIG. 4



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RESISTOR

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2 Claims. (Cl. 201—76)

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This invention relates to resistors and more particularly to resistors comprising a film of resistance material, and to a method of making such resistors.

One way of making resistors in the form of thin films is to mix finely divided resistance material with a suitable binder and thinning agent and to paint or spray the mixture on a suitable backing member. Difficulties in the finished product and in the making of such devices are often encountered due to certain characteristics of the binding material. Some binders, which might be otherwise suitable, cannot be used because they react unfavorably with the resistance material. Other binders are not stable under temperature variations and tend to flow plastically. Many binders require a relatively high temperature for "curing" and their use is therefore limited to backing material, which can stand this high temperature. In some cases films made with certain bonding agents show electrical polarization, which is undesirable. In cases where the resistor is made of a semiconductive material having a relatively high variation of resistance with temperature, it may be desirable to increase the specific resistivity of the bonded material without materially affecting the temperature dependence factor.

An object of this invention is to produce a thin film resistor free from the above-noted difficulties and having the indicated desirable characteristics.

A feature of this invention resides in the use, as a binding material for thin film resistors, of a silica medium resulting from the drying of silica sol, which is a colloidal solution of silica. The dried sol, although consisting of the same elements as a silicon oxide, is not like ordinary crystalline silica, such as quartz, but is of a more amorphous nature.

Other and further objects and features of this invention will be more clearly and fully understood from the following description of exemplary modifications of the invention taken in connection with the appended drawing in which:

Fig. 1 is a sectional view of one form of resistor made in accordance with this invention;

Fig. 2 is a plan view of the resistor shown in Fig. 1;

Fig. 3 is a sectional view of another form of resistor made in accordance with this invention; and

Fig. 4 is a section taken on line 4—4 of Fig. 3.

In the drawing the thickness of the films of

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metal and of resistance material have been exaggerated in the interest of clarity of illustration.

One way of making the silica sol used as a binder for the resistance material, is to place 20 cubic centimeters of .06 normal hydrochloric acid and 40 cubic centimeters of butyl Cellosolve in a receptacle and to stir the mixture vigorously while slowly adding 50 cubic centimeters of ethyl silicate. The mixture is continuously stirred while the hydrolysis reaction is going on, approximately 15 minutes. The resulting material is a colloidal solution of silica.

A mixture of resistance material and the bonding agent may be applied to a backing member by painting, spraying or other suitable method. A mixture for applying the resistance material to a backing member by painting may be prepared by grinding one gram of resistance material with a small amount of pure methyl alcohol and then adding 1 cubic centimeter of the silica sol, such as that above described. This mixture may be applied to a slab of insulation such as disclosed in Figs. 1 and 2 or to a cylinder such as is shown in Figs. 3 and 4.

To make a device like that shown in Figs. 1 and 2, a slab 10 of insulating material is provided adjacent the ends of one surface with films of metal 11. These films may be, for example, of silver or other suitable metal. A silver film may be formed by applying to the slab a silver bearing mixture capable of being "cured" by heating. After heating, the film is substantially metallic silver. A film 12 of the resistance mixture may then be applied to the slab and to portions of the metallic films 11. The resistance film or coating may then be "cured," that is, dried and baked at any temperature from 100° C. to a temperature below that detrimental to any other part of the assembly.

A resistor device such as is shown in Figs. 3 and 4 may be made by applying bands of metallic material 21 to the ends of a tube 20 of insulating material, for example, glass, ceramic, or other suitable material. The resistance mixture is applied in a film or coating 22 around the tube 20 overlapping the metallic films 21 in the same manner as the film or coating 12 in the device of Figs. 1 and 2. The metallic and resistor films of this device may be processed in the same manner as those of the previously described resistor shown in Figs. 1 and 2.

If the insulating base, such as 10 or 20, is of a material having a very smooth surface, it may be advantageous to roughen this surface before applying either of the films.

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The atmosphere in which the resistance film or coating is baked should be suited to the nature of the resistance material. For example, if the resistance material is a semiconductive mixture of the oxides of manganese and nickel, the heat treating atmosphere will ordinarily be air.

After the baking, the resistance film consists only of the resistance material dispersed in a silica medium resulting from the drying of silica sol. As previously indicated, this medium is a form of silica differing in physical characteristics from ordinary crystalline silica such as quartz, the dried silica sol being more in the nature of an amorphous material. The film is rigid and stable, making it a very favorable type of film for many uses. The dried silica sol binder of this film is stable with variations in temperature and there is no tendency towards plastic flow. Because of the relatively low "curing" temperature of this binder (approximately 100° C.) the backing member may be made of any of several materials that would be adversely affected by the high temperature necessary to cure many existing binders.

By the use of this cured silica sol binding material and a semiconductive material, a resistance film can be made having a factor of resistance dependence upon temperature substantially the same as that of the pure semiconductor; but with a resistivity many times greater than that of the semiconductor alone.

Although this invention has been disclosed by means of illustrative embodiments thereof, it should be understood that it is not limited thereby, but by the scope of the appended claims only.

What is claimed is:

1. A resistor comprising a body of insulation, metallic films adhering to spaced portions of said body, and an electrically resistive coating cover-

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ing a portion of each of said films and extending over that portion of the body intermediate said films, said coating consisting of finely divided, metal oxide semiconductive, resistance material having a high variation of resistance with temperature dispersed in a silica medium consisting of dried silica sol, the factor of resistance dependence upon temperature of said coating being substantially the same as that of the pure semiconductive material.

2. A resistor comprising a tube of glass, a band of silver at each end of said tube, and a band of resistance material comprising a mixture of manganese and nickel oxides on that portion of the tube intermediate said silver bands and in electrical contact with each band, said resistance material being dispersed in a thin film of a silica medium consisting of dried silica sol, the factor of resistance dependence upon temperature of said band of resistance material being substantially the same as that of the oxides.

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