Oct. 19, 1954 W. M. HICKS 2,692,321

RESISTOR

Filed Dec. 15, 1950

Fig. 1.

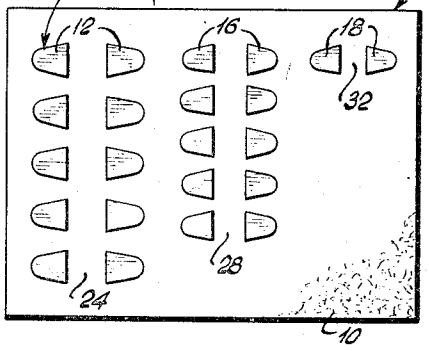


Fig. 2.

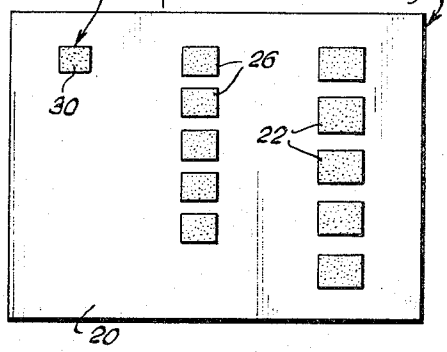


Fig. 3.

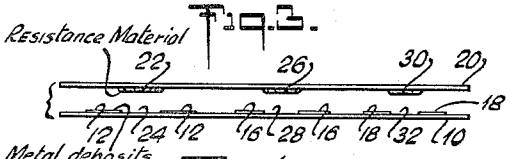


Fig. 4.

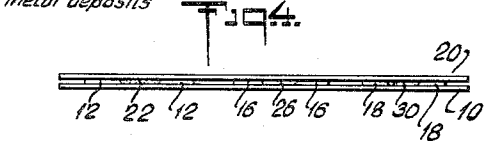


Fig. 5.

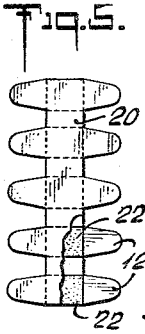


Fig. 6.

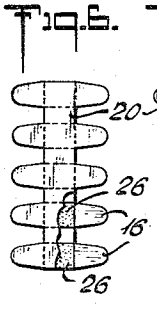


Fig. 7.

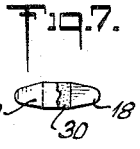


Fig. 8.

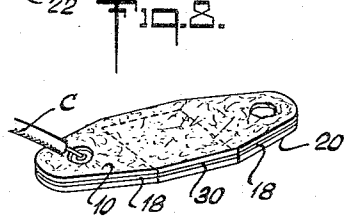


Fig. 8.

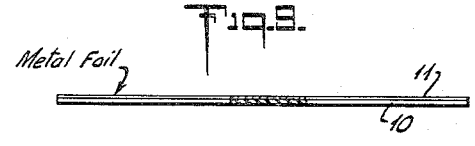


Fig. 10.

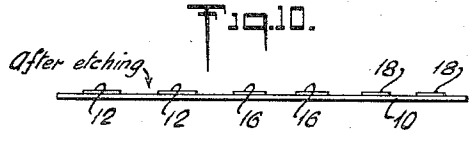


Fig. 11.

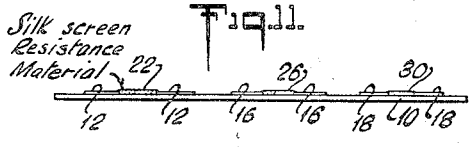


Fig. 12.

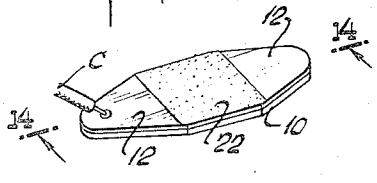


Fig. 13.

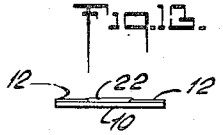
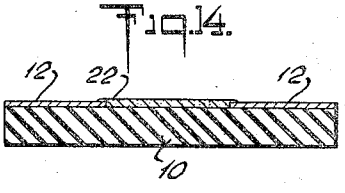


Fig. 14.



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RESISTOR

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Application December 15, 1950, Serial No. 200,889

8 Claims. (Cl. 201—73)

1

This invention relates to electrical resistances.

The manufacture of resistances has heretofore been unsatisfactory because of the complicated processes employed requiring both substantial time and expense, and also due to the failure of the resistance material employed as the result of thermal shock received from the heat of soldering conductor ends to the resistor terminals.

It is an object of this invention to provide simple and efficient resistors.

Another object of the invention is to provide a method of manufacturing resistors whereby they may be made in multiple, in the form of a number of separate units, or as units comprising a multiple number of resistances, or both.

Another object of the invention is to provide a simplified process for the manufacture of resistors whereby the speed and cost of manufacture may both be reduced.

Another object of the invention is to provide a resistance material of improved quality.

Another object of the invention is to provide a resistor wherein two spaced electrical conductive areas are bridged by an area of controlled electrical conductivity.

Other objects of the invention will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be pointed out in the following description, and the scope of the application of which will be indicated in the following claims.

The invention will best be understood if the following description is read in connection with the drawings, in which,

Figure 1 is a plan view of a first sheet comprising a backing member having thereon deposits of electrically conductive material;

Figure 2 is a plan view of a second sheet comprising a backing member having thereon deposits of resistance material;

Figure 3 is an end view showing the sheet of Figure 2 inverted and being superimposed upon the sheet of Figure 1;

Figure 4 is a view similar to Figure 3 showing one sheet on the other with the deposits of resistance material bridging the pairs of spaced deposits of conductive material;

Figure 5 is a plan view of a multiple resistor unit blocked out from the assembly shown in Figure 4;

Figure 6 is a plan view of another multiple resister unit blanked out from the assembly shown in Figure 4 and comprising the column of deposits shown in the middle of Figure 1;

Figure 7 is a plan view of a single resistor unit blanked out from the assembly shown in Figure 4 and comprising the pair of deposits of conductive material shown in the upper right hand corner of Figure 1 as viewed by the reader;

Figure 8 is a view in perspective of the resistance unit shown in Figure 7, showing the asbestos, paper or other backing removed above the spaced conductive areas of the unit, and with a conductor end soldered to one of said areas;

Figure 9 is a side elevation of a backing sheet with a lamination of metal foil superimposed upon it;

Figure 10 is a side view showing the assembly of Figure 9 after portions of metal foil have been removed;

Figure 11 shows the assembly of Figure 10 with deposits of resistance composition bridging the spaces between pairs of deposits of conductive material;

Figure 12 is a perspective view of a resistance unit stamped from the assembly shown in Figure 11, with a conductor end soldered to one of the conductive areas of the unit;

Figure 13 is a side elevation of the resistance unit shown in Figure 12; and

Figure 14 is a side elevation of a longitudinal cross section through the resistor unit shown in Figure 12.

My method comprises broadly the steps of placing deposits of electrically conductive material, preferably deposits of metal, such for example as copper or silver, on a backing member able to withstand temperatures on the order of 350° F., in pairs of opposed, spaced deposits. In Figure 1 the pairs of spaced deposits 12 are shown arranged in a column and close together with the lateral margins of the deposits of one pair separated by only narrow portions of the insulating member 10. Also on the surface of member 10 are shown the pairs of opposed spaced deposits 16 which are smaller than the deposits 12 but otherwise similarly disposed with respect to one another; and also on member 10 are shown the two deposits 18 disposed in opposed spaced relation.

On backing member 20, which is also of insulating material able to withstand temperatures on the order of 350° F., are the deposits 22 of resistance material. These deposits are of a size, and disposed on member 20, so that when the surface of member 20 bearing the deposits 22 is placed over and against the face of member 10 bearing

the deposits 12, the deposits 22 will register with, and bridge, the spaces 24 between the pairs of deposits 12. Similar deposits 26 of resistance material are shown on member 20, of a size, and in position to register with, and bridge, the spaces 28 between the pairs of deposits 16 on member 10; and a single deposit of electrical resistance material 30 is shown on member 10 of a size and in a position to register with and bridge the space 32 between the deposits 18 on member 10.

After backing members 10 and 20 have been placed in face to face contact, with the resistance material deposits 22, 26 and 30 in register with, and bridging, the respective spaces 24, 28 and 32 on member 10, I prefer to cure the assembly thus formed preferably at a temperature of about 350° F., for a period of from thirty minutes to one hour. By this curing step the resistance material I employ is softened and flows into intimate contact with the spaced electrical conductive deposits which it bridges, and when it rehardens, following the curing step, it adheres firmly to said metal deposits thus providing a good contact and union between the spaced conductive deposits and the bridging resistance material.

After the curing step I pierce and blank out from the assembly shown in Figure 4 multiple or single resistance units comprising pairs of spaced electrically conductive areas and the bridging areas of resistance material, thus forming for example the multiple units shown in Figures 5 and 6, and the single resistor shown in Figure 7.

It is incidental to this invention how the deposits of conductive material are placed on member 10 and how the deposits of resistance material are placed upon the member 20. For the purpose of this invention these deposits may be made in any suitable way. For example they may be painted or printed on the respective members 10 and 20. If desired the whole surface of member 10 may be initially covered with conductive material and portions thereof thereafter removed in any suitable way as for example by a photo-etching process.

And, if desired, the deposits of resistance composition may be placed upon the surface of member 20 through a silk screen, which process is well known and need not be described here.

The members 10 and 20 which serve as backers for the deposits of conductive material and resistance material respectively may be of various compositions and of various thicknesses. Thus for example they may be sheets or boards of asbestos, or sheets or boards comprised by glass fiber with a resin binder, the resin selected being one capable of withstanding temperatures on the order of 350° F.

In order to attach the conductive end areas of a completed resistor to a conductor, as by soldering, I remove a portion of one of the backing members, as illustrated in Figure 8, and solder the exposed core of a conductor member C to the exposed conductive area. I have found that where asbestos paper is used as the backing it may be readily removed from over a portion of a conductive area by use of a wire brush.

It will also be understood that instead of making the deposits 12, 16 and 18 of resistance material on a separate backing, such as 20, they may be made directly on the backing 10, in any suitable way to fill the spaces 24, 28 and 32 respectively and somewhat overlap the said pairs of opposed conductive areas and thus to bridge the said opposed pairs of electrically conductive areas.

When this method is employed one surface of the conductive areas, 12, 16, and 18 will be exposed and ready for a conductor C to be soldered thereto, as illustrated in Figure 12. As shown in Figures 9 and 10 the pairs of opposed deposits 12, 16 and 18, are made by first superimposing on backing 10 a sheet 11 of metal foil and removing the sheet, as by photo-etching, leaving only said areas 12, 16, and 18 and the like, to provide pairs of spaced, opposed conductive deposits on backing 10.

It is, however, preferred to place the deposits 22, 26 and 30 initially on a second, separate backing member, such as 20. It will be observed that when this is done, in the assembly, as shown in Figures 3 and 4, the deposits 22, 26 and 30 will complement, and somewhat overlap, the deposits 12, 14 and 16, and form together with them a layer or lamination intermediate the members 10 and 20, and that the protection thus afforded to the deposits by members 10 and 20 continues after the units have been stamped out, and thus a finished product is provided in which both the electrically conductive material and resistance material is well protected from injury caused for example by inadvertent blows, scratches, etc.

For said resistance material, illustrated by the deposits 22, 26 and 30, I prefer to employ a composition comprising powdered carbon, an inert filler, such for example as sodium silicate, and a resin able to withstand temperatures of 360° F., or more, such, for example, as ethoxyline resin. Ethoxyline resin is the condensation product of epichlorhydrin with a bis-phenol (1950 Modern Plastics Encyclopedia and Engineer's Handbook, page 785, first column). This resin is described in an article entitled "Ethoxylines—a new group of triple-function resins," by Dr. Edward Preiswerk and Dr. Conrad Meyerhans, Plastics Research Department, Ciba, Ltd., which appeared in "Electrical Manufacturing," issue of July 1949. I have found that this composition satisfactorily withstands the thermal shock due to soldering the conductor ends to the resistor terminals, without breaking the bond between the electrically conductive material and the resistance material. Carbon and resin in the form of dry powder is readily mixed with sodium silicate, in liquid phase in its original state, forming a composition which I have found easy to apply by the silk screen method.

This mixture of ingredients gives a resistance composition of steady and controlled electrical conductivity. The ethoxyline resin forms a good bond with the conductive material deposits and its backing during the curing step, and, in combination with carbon and sodium silicate, forms a composition the conductivity of which does not vary substantially with time under a given load.

I have had very satisfactory results using backing members 10 and 20 comprising asbestos paper, and glass fiber coated with ethoxyline resin, respectively.

I have found that with a pair of metal deposits each approximately one-quarter inch in diameter and one-hundredth (.010") of an inch thick, and spaced apart approximately three-eighths (3/8") of an inch, and a bridging resistance composition comprising, by volume

	Per cent
Carbon	33
Ethoxyline resin	17
Sodium silicate	50

the total resistance obtained is 2500 ohms, and, keeping the other factors the same and changing

the resistance composition to the following, by volume

	Per cent
Carbon	27
Ethoxyline resin	25
Sodium silicate	50

the total resistance is increased to 500,000 ohms.

In each case a good bond was obtained between the metal deposits and the resistance composition.

Resistors embodying my invention are durable and dependable in use, and can be manufactured in large numbers simultaneously, in multiple or single units, speedily, and at low cost.

It will thus be seen that there has been provided by this invention a method and an article in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As various possible embodiments might be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. The method of forming resistors which comprises, forming deposits of electrically conductive material in spaced opposed pairs of deposits on a first backing member, forming on a second backing member deposits of a composition of controlled conductivity in sizes to bridge the spaces between said pairs of deposits on said first backing member, superimposing one of said backing members on the other with their deposit bearing faces in opposition and with said deposits of controlled electrical conductivity in bridging relation to said pairs of deposits of electrically conductive material respectively, and blanking out from said superimposed sheets the areas having deposits thereon.

2. The method of making electrical resistances which comprises, forming deposits of electrically conductive material in spaced opposed pairs of deposits on a first backing sheet able to withstand temperature on the order of 350° F., forming, on a second backing sheet able to withstand temperatures on the order of 350° F., deposits of a resistance composition in amounts sufficient to bridge the spaces between said pairs of deposits respectively on said first backing sheet, superimposing one of said sheets on the other in face to face relation thereby positioning the resistance composition deposits in bridging relation to said pairs of deposits of electrically conductive material respectively, binding the sheets together in superimposed position, and blanking out from said superimposed sheets the areas having said deposits thereon.

3. Forming deposits of electrically conductive material in spaced opposed pairs of deposits on a first backing sheet able to withstand temperatures on the order of 350° F., forming, on a second backing sheet able to withstand temperatures on the order of 350° F., deposits of a resistance composition in amounts sufficient to bridge the spaces between said pairs of deposits on said first backing sheet, superimposing one of said sheets on the other in face to face relation thereby positioning the resistance composition deposits in bridging relation to said pairs of deposits of electrically conductive material respectively, curing the superimposed sheets for a period of approximately thirty minutes to one hour at 350° F. to cause said resistance composition to flow and adhere to said conductive material, and blanking out from said superimposed sheets the areas having said deposits thereon.

4. The method claimed in claim 1 including the step of securing said sheets together in superimposed position prior to the stamping operation.

5. The method claimed in claim 1 including the step of treating the blanked out portions of said sheets to cause the opposed blanked out portions of said sheets to adhere together.

6. The article comprising a backing member adapted to withstand temperatures on the order of 350° F. and having on its face a plurality of electrically conductive areas, a second backing member adapted to withstand temperatures on the order of 350° F. having on its face an area of electrically controlled conductivity, said backing members being disposed in face to face relation with the said deposit on said second backing member positioned in bridging relation to said deposits on said first backing member.

7. A resistor comprising an insulating base, having thereon a plurality of deposits of electrically conductive material spaced apart on said base and bridged by a deposit of carbon, an inert filler, and ethoxyline resin obtained as the condensation product of epichlorhydrin with a bis-phenol.

8. A resistor comprising an insulating base, having thereon a plurality of deposits of electrically conductive material spaced apart on said base and bridged by a deposit comprising carbon, an inert filler, and resin in the form of dry powder obtained as the condensation product of epichlorhydrin with a bis-phenol.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,985,166	Haroldson	Dec. 18, 1934
2,005,922	Stoekle	June 25, 1935
2,206,780	Linton	July 2, 1940
2,441,960	Eisler	May 25, 1948
2,526,059	Zabel	Oct. 17, 1950

OTHER REFERENCES

"Ethoxylines, a New Group of Triple-Function Resins," Electrical Manufacturing, by Preiswerk et al., reprinted from Electrical Manufacturing of July 1949.

Brunnetti et al.: "Printed Circuit Technique," Nov. 15, 1947, Bureau of Standards Circular No. 468.