

Feb. 22, 1949.

H. CHRISTENSEN ET AL

2,462,162

METALLIC OXIDE RESISTOR

Filed July 3, 1944

FIG. 1

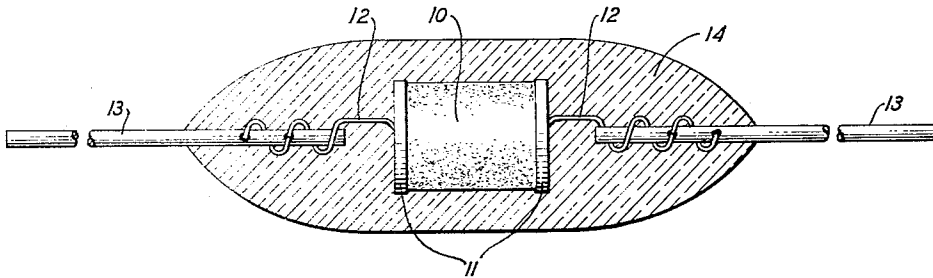
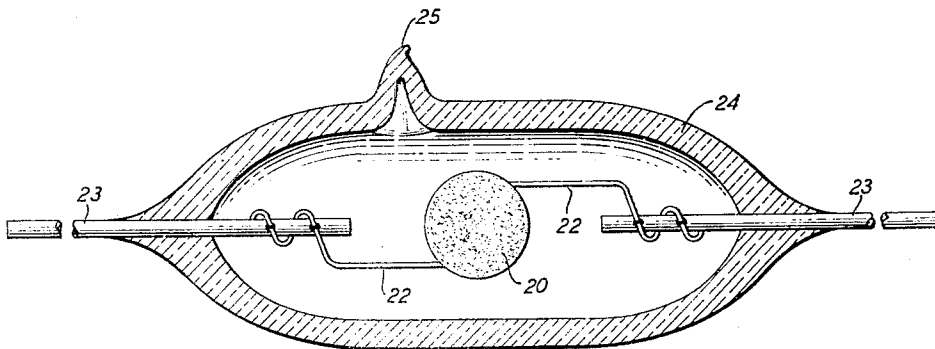


FIG. 2



INVENTORS H. CHRISTENSEN
J. J. KLEIMACK

BY Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

2,462,162

METALLIC OXIDE RESISTOR

Howard Christensen, Springfield, and Joseph J. Kleimack, Westfield, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application July 3, 1944, Serial No. 543,372

4 Claims. (Cl. 201-76)

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This invention relates to resistors and more particularly to resistors made from oxidic materials, the resistance of which is dependent upon the oxygen content.

Resistors may be made from oxidic semiconductors such as the oxides of various metals. For example, resistors, the resistance of which varies greatly with changes in temperature and which have been designated as "thermistors" may be made from the oxides of manganese, nickel, cobalt, copper, iron, or zinc, or of various selected combinations of these oxides. The resistance value of such resistors is dependent, among other things, upon the metal content and upon the oxygen content. For example, the oxides of manganese and nickel may be mixed together to make a resistor having a resistance that is less than that of manganese oxide or nickel oxide used alone. The resistance of such a resistor can further be varied by changing its oxygen content. The oxygen of oxidic semiconductors tends to come to equilibrium with that of the ambient atmosphere. The change in oxygen content is relatively slow at low temperatures and becomes more rapid as the temperature is increased. Thus the resistance of such a resistor may change as a function of the condition of its use or storage.

An object of this invention is to substantially fix the oxygen content of oxidic semiconductors at the time of manufacture so that there will be no later change of resistance due to variation of oxygen content.

One feature of this invention lies in heating the resistor element to a temperature higher than any temperature to which it will subsequently be exposed and allowing its resistance to stabilize at this high temperature.

Another feature of this invention resides in sealing the resistor element against further contact with the outside atmosphere after fixing the oxygen content at a desired value.

A further feature of this invention lies in selecting an insulating covering material having a given sealing temperature, selecting an oxidic resistance material that will have the required resistance for the size of resistance body employed when allowed to come to oxygen equilibrium with its surrounding atmosphere at said sealing temperature, then heat treating the resistor at said sealing temperature until it has attained oxygen equilibrium, and sealing the resistor within the insulating covering at that temperature.

Other and further objects and features of this invention will appear more fully and clearly from the following description of illustrative embodiments thereof taken in connection with the appended drawings, in which:

Fig. 1 shows in section a resistor device made in accordance with this invention; and

Fig. 2 shows also in section another resistor

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device also made in accordance with this invention.

The device shown in Fig. 1 comprises a pellet or cylinder 10 of oxidic resistance material having metallic coatings 11 adhering to opposite ends thereof. The coatings have been shown exaggerated as to thickness in the interest of clarity of illustration. Fine wire leads 12 may be secured to the coatings 11 in any suitable manner such as fusing into the coatings. The leads 12 may be secured to exterior conductors 13 by wrapping them around said conductors and spot-welding at suitable points. The assembly including the inner ends of the conductors 13 may be sealed into a glass body or mass of glass 14. Other suitable insulating materials may be employed for forming the body 14. The method of fixing the oxygen content and thus the resistance of a resistor device, such as illustrated in Fig. 1, may conveniently be described by outlining the process of making a particular resistor device.

Suppose, for example, the approximate resistance characteristics required in a given device may be obtained by employing a mixture of manganese and nickel oxides in which the atomic proportions of manganese and nickel are respectively 92 and 8. The pellets, such as pellet 10, may be made by extruding a mixture of 90 parts by weight of the mixed oxides, 10 parts by weight of a temporary binder such as isobutyl methacrylate, and sufficient volatile solvent to allow extrusion of the material through a round die of the order of .05 inch diameter. The extruded rod may be dried and then fired at a suitable temperature between 1,000 and 1450° C. For the above-noted material 1300° C. was found to be satisfactory. The resistance rod, which has been sintered by firing, may then be cut up into small sections and ground to a desired final length, say .05 inch.

The pellets are then heat treated at 860° C. to fix the resistance. This may be done by placing them in an oven and holding the temperature at 860° for a sufficient time to allow the oxygen of the resistance material to come to equilibrium with that of the ambient atmosphere. A time of about three minutes is sufficient for this size pellet at a temperature of 860° C. The pellet should be quickly removed to room temperature after the heat treatment.

Metallic coatings 11 may then be applied to the ends of the pellet or cylinder and wires 12, which may be for example of platinum, secured to the metallic layers. The leads 12 may then be secured to the conductors 13 as previously indicated.

A section of glass tubing may then be placed over a pellet, the length of the tubing being such that the conductors 13 protrude from each end. The assembly may then be heated to melt the glass down around the pellet, the leads and the

inner ends of the conductors 13. The sealing temperature for the glass used in this particular device was 860° C. On the basis of this temperature and the size of the pellet, which may be dictated, for example, by thermal mass requirements, the 92—8 manganese-nickel ratio was picked for the oxide mixture, because this material would have the proper value of resistance at a sealing temperature of 860° C. The metallic material for forming the layers 11, also was selected to accommodate this temperature, that is, a filming material that would not be adversely affected by the 860° C. temperature. The heat treatment for fixing the resistance was also made at this same temperature, as previously indicated. By previously heat treating the resistance elements at the same temperature as that to be used for sealing, further change, during sealing, of oxygen content and thus of resistance is inhibited.

The device shown in Fig. 2 comprises a bead or body 20 of semiconductive material having leads 22 embedded therein. The leads 22 may be attached to conductors 23 in a similar manner to the attachment of leads 12 to conductors 13 in the device of Fig. 1.

The bead 20 may be heat treated for fixing the resistance in a manner similar to that employed for the pellet 10. This heat treating temperature will be selected to fit the temperature at which the assembly is to be sealed into the envelope 24 which may be, for example, of glass. Since the envelope 24 does not come in direct contact with the resistor body 20, said body will probably not be raised to the sealing temperature of the glass. For this reason, the resistance fixing heat treatment might be done at a temperature lower than the treating temperature for the glass envelope 24 or at this sealing temperature.

One way of carrying out the process for a device of the type shown in Fig. 2 is to first seal the conductors 23 with the bead and leads attached, into the envelope 24 leaving a small opening in the envelope, then the assembly may be heated in an oxygen containing atmosphere at a temperature above the glass sealing temperature for sufficient time to stabilize the resistance of the bead 20. The envelope may then be evacuated or filled with an inert gas and the small opening sealed as at 25.

Various modifications of the foregoing exemplary processes may be employed. Bead resistors such as 20 may be provided with a glass coating such as used on the pellet 10 of Fig. 1. The pellet type of resistor may be sealed in to an envelope such as 24 without first coating it with glass or the like. A glass coated pellet or bead may be sealed into an envelope. In the latter case the resistance will be fixed before sealing on the glass coating and will not be affected by the elevated temperature of sealing into the envelope.

The temperature at which the resistor body is heat treated for fixing its resistance must always be as high as or higher than the temperature, which the resistor will attain during any phase of its processing or use subsequent to sintering. As indicated in connection with the description of the exemplary embodiments, the various factors of material and of treatment must be so correlated, that after the final treatment, the resistor has the proper resistance and is so conditioned that this resistance will not change with time during storage or use.

As has been previously indicated, the atmosphere in contact with the resistor during stabilization should contain oxygen. It may be atmospheric air or a mixture of oxygen with other gases in suitable proportions.

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

What is claimed is:

1. In a method of making a resistor from sintered metallic oxides wherein said resistor is brought to an elevated temperature, as a result of processing steps subsequent to sintering, the step of stabilizing the resistance of said resistor that comprises heating the resistor to said elevated temperature prior to said subsequent steps and maintaining it at this temperature until its oxygen comes to equilibrium with that of the ambient atmosphere, and then sealing a protective covering over the resistor at the same elevated temperature.

2. The method of making a resistor device and at the same time stabilizing its resistance, that comprises selecting an insulating covering material having a given sealing temperature, selecting an oxidic resistance material that will have the required resistance for the size of resistance body employed when allowed to come to oxygen equilibrium with its surrounding atmosphere at said sealing temperature, heat treating the resistor at said sealing temperature until it has attained an oxygen equilibrium with the surrounding atmosphere, and then sealing the resistor within the insulating covering material at the same temperature.

3. The method of inhibiting resistance variations of an oxidic resistor due to change in its oxygen content, that comprises maintaining the resistor at an elevated temperature in an atmosphere containing oxygen until an oxygen equilibrium between the resistor and the atmosphere is attained, said elevated temperature being a known temperature necessary for sealing an insulating protective covering over the resistor, and then sealing the resistor within said protective covering at the known temperature.

4. The method of stabilizing the resistance of an oxidic resistor that is to be protected by a glass covering having a sealing temperature of 860° C., that comprises maintaining said resistor at a temperature of 860° C. in an oxygen containing atmosphere until oxygen equilibrium between the resistor and the ambient atmosphere has been obtained, and then sealing the glass covering around the resistor at the sealing temperature.

HOWARD CHRISTENSEN.
JOSEPH J. KLEIMACK.

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