

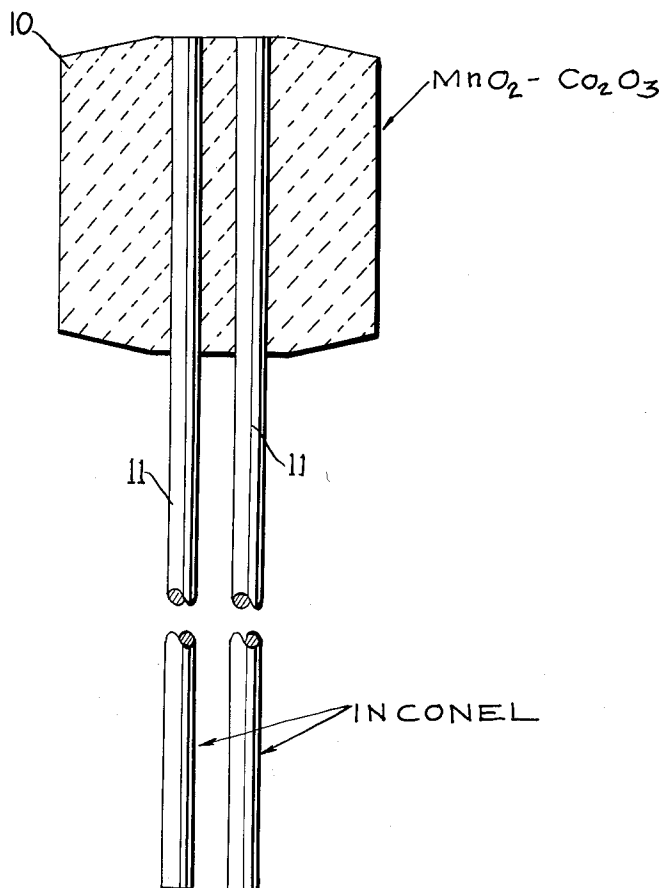
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SEMI-CONDUCTIVE ELEMENT

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3,016,506
SEMI-CONDUCTIVE ELEMENT

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1 Claim. (Cl. 338-22)

The present invention relates to semi-conductive elements such as thermistors, and, more particularly, to the composition of the body of resistance material and the terminal wires for the body.

Previously, it has been found that such elements having desirable voltage insensitivity characteristics can be reproduced with predictable resistance values by placing a resistance material on platinum terminal wires. With the increased demand and uses for thermistor elements, it is desirable to reduce the cost thereof as greatly as possible. While certain improvements have been made in that direction, the relatively high cost of platinum wires has hindered further reduction in costs.

In an attempt to use less expensive terminal wires, such as wires formed of an alloy sold by The International Nickel Company, Inc., under the trademark "Inconel" and consisting essentially of between about 6% and about 17% by weight of iron, between about 11% and about 18% by weight of chromium and the balance nickel at a minimum of 70% by weight, it was found that the resistance material became voltage sensitive to the extent that it did not provide a satisfactory thermistor elements where a change in its resistance in excess of about 20% could not be tolerated.

Accordingly, an object of the present invention is to provide a resistance material which is sufficiently voltage insensitive to enable the same to be used with wires much less expensive than platinum wires and produce a satisfactory thermistor element.

Another object is to accomplish the foregoing in a simple, practical and economical manner.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claim, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention, it has been found the foregoing objects can be accomplished by producing a semi-conductor such as a thermistor element comprising a body formed of a resistance material consisting essentially of between about 50% and about 80% by weight of manganese dioxide and between about 50% and about 20% by weight of cobaltic oxide; and spaced parallel conductive terminal wires formed of "Inconel."

In the drawing, the single figure is a greatly enlarged longitudinal sectional view of a semi-conductor such as a thermistor element embodying the present invention.

Referring to the drawing in detail, the element shown by way of example comprises a cylindrical body or bead 10 having a pair of spaced apart parallel terminal wires 11 embedded therein. This element has the following dimensions:

	In.
Body length-----	0.0625
Body diameter-----	0.0625
Wire diameter-----	0.0100
Space between wires-----	0.0100

Such elements are adapted to be used in networks with a potential of about one volt normally applied thereto.

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EXAMPLE I

An element having the foregoing dimensions was constructed by forming the body 10 of thoroughly admixed fine particles consisting essentially of 75% by weight of manganese dioxide and 25% by weight cobaltic oxide and by embedding wires 11 therein formed of an alloy consisting essentially of 75% by weight nickel, 15% by weight chromium and 10% by weight iron. The body was fired to adhere the same onto the wires.

The element was tested by applying measured potentials only for a short duration to prevent appreciable self-heating effects, and measuring the resistance of the element with a bridge or a null detector.

The following readings were taken:

Table I

Test No.	Potential In Volts	Percent Change In Potential	Resistance In K Ohms	Percent Change In Resistance
1-----	0.3	70	235	plus 3.2.
2-----	0.6	40	293	plus 2.5.
3-----	1.0	-----	286	-----
4-----	1.5	50	280	minus 2.1.
5-----	2.2	120	271	minus 5.2.
6-----	3.0	200	256	minus 10.5.
7-----	4.5	350	236	minus 17.5.
8-----	6.0	500	225	minus 21.2.

EXAMPLE II

For comparative purposes, an element was similarly constructed by forming the body of a mixture consisting essentially of 90% by weight of manganese oxide and 10% by weight of cupric oxide and embedding platinum wires therein. The element was similarly tested and the following readings were taken:

Table II

Test No.	Potential In Volts	Percent Change In Potential	Resistance In K Ohms	Percent Change In Resistance
1-----	0.3	70	29.5	plus 1.4.
2-----	0.6	40	29.3	plus 0.7.
3-----	1.0	-----	29.1	-----
4-----	1.5	50	29.0	minus 0.4.
5-----	2.2	120	28.8	minus 1.0.
6-----	3.0	200	28.5	minus 2.1.
7-----	4.5	350	27.9	minus 4.1.
8-----	6.0	500	27.5	minus 5.5.

These readings indicate that the element in accordance with the present invention compares favorably with a manganese dioxide-cupric oxide body on platinum wires where about a 20% change in resistance can be tolerated when the normal voltage increases about 500%.

EXAMPLE III

Another element was similarly constructed by forming the body of a mixture of the material used in Example II and embedding wires therein formed of the same alloy used in Example I. This element was similarly tested and the following readings were taken:

Table III

Test No.	Potential In Volts	Percent Change In Potential	Resistance In K Ohms	Percent Change In Resistance
1-----	0.3	70	41.4	plus 8.9.
2-----	0.6	40	40.0	plus 5.0.
3-----	1.0	-----	38.1	-----
4-----	1.5	50	35.6	minus 6.5.
5-----	2.2	120	33.0	minus 13.5.
6-----	3.0	200	30.0	minus 21.3.
7-----	4.5	350	26.2	minus 31.0.
8-----	6.0	500	23.4	minus 38.5.

These readings indicate that the element in accordance with Example III is so voltage sensitive that its resistance decreases about 20% when the normal voltage increases only 200%.

Further cursory tests were made with materials respectively consisting essentially of 50% by weight of manganese dioxide and 50% by weight of cobaltic oxide; and 80% by weight of manganese dioxide and 20% by weight of cobaltic oxide. It was found that elements having a body of such compositions and "Inconel" wire embedded therein were sufficiently voltage insensitive to enable the same to be used as thermistors.

It was further found that the compositions of the higher cobaltic oxide content exhibited greater voltage insensitivity than those of the lower cobaltic oxide content. However, the bodies formed of compositions having a 20% to 30% by weight cobaltic oxide content have better structural characteristics.

The expression "voltage insensitivity" and expressions of similar context mean that the resistance of the body material does not materially increase or decrease as the voltage applied across the terminal wires respectively decreases or increases. This effect is independent of changes in resistance due to the thermal coefficient of resistivity of the element.

From the foregoing description, it will be seen that the present invention provides a thermistor body com-

position which permits the use of low cost terminal wires without causing undue voltage sensitivity.

It will be understood that the details and examples hereinbefore set forth are illustrative only and that the invention as broadly described and claimed is in no way limited thereby.

We claim:

A semi-conductor comprising a body formed of a resistance material consisting essentially of between about 50% and about 80% by weight of manganese dioxide and between about 50% and about 20% by weight of cobaltic oxide; and spaced parallel conductive terminal wires for said body formed of an alloy consisting essentially of between about 6% and about 17% by weight of iron, between about 11% and about 18% by weight of chromium and the balance nickel at a minimum of 70% by weight.

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