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G. L. PEARSON

2,391,506

RESISTANCE DEVICE

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FIG. 1

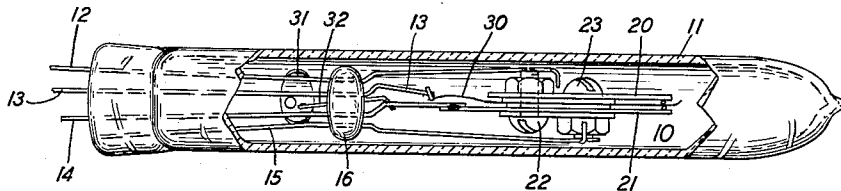


FIG. 2

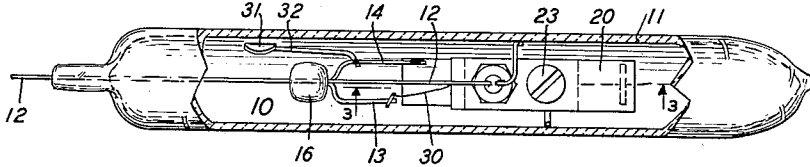


FIG. 3

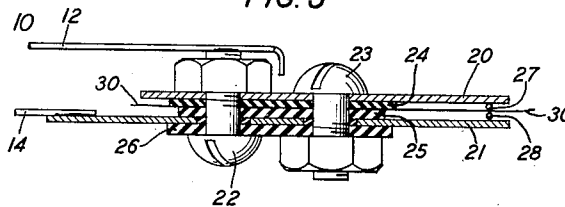
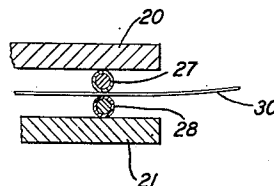


FIG. 4



INVENTOR
BY G. L. PEARSON

Walter C. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

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RESISTANCE DEVICE

Gerald L. Pearson, Millington, N. J., assignor to
Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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9 Claims. (Cl. 201—63)

This invention relates to resistors and more particularly to resistors having a relatively high temperature coefficient of resistance and low thermal inertia. Resistors, the resistance of which varies greatly with changes in temperature have for convenience been called "thermistors," the term being derived from the words "thermal" and "resistor." Wherever the word thermistor appears in this specification or the appended claims, it is intended to designate a resistor having the foregoing characteristics. Since most of the known materials exhibiting thermistor characteristics and at the same time having sufficient conductivity to render them useful as circuit elements, comprise the semiconductors having high negative resistance-temperature coefficients, exemplary descriptions and explanations in this specification may be made with reference to such materials. It should be understood, however, that such electrically conducting materials as may have a relatively high positive resistance-temperature coefficient, are not thereby excluded from the invention described and claimed.

It has been found that a thermistor may be made to exhibit a negative resistance characteristic. For example, the static voltage-current characteristic curve of a negative resistance-temperature coefficient resistor rises to a voltage maximum and then falls off. This declining voltage-current curve is an indication of the negative resistance characteristic. If a sufficient direct current voltage is applied to such a thermistor to bias it beyond the voltage maximum point, the device will react to an applied alternating current as if its resistance were negative, provided the frequency of the alternating current is not too high. A thermistor so used may be made to oscillate. The frequency of oscillation depends upon the heating and cooling ability of the thermistor, i. e., its thermal inertia. If the device is constructed to have low thermal inertia, it can be made to oscillate at relatively high frequencies.

It is an object of this invention to construct a thermistor having low thermal inertia.

A feature of this invention resides in a resistor device constructed to present a very small volume of thermistor material to the applied current.

Other and further objects and features of the invention will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is an elevational view with parts broken away of one device illustrative of the invention;

Fig. 2 is a plan view also with parts broken away of the device of Fig. 1;

Fig. 3 is an enlarged section of a portion of the device taken on the line 3—3 of Fig. 2; and

Fig. 4 is a further enlargement of the contact portion of the device.

The thermistor device 10 is secured in an envelope 11 by means of a plurality of electrically conductive supports 12, 13, 14 and 15. The supports, which may be of a suitable alloy wire, may be sealed in the press of the envelope 11, which may be of glass. Relative movement between the supports within the envelope may be inhibited by means of a member 16 which may be a glass bead fused around said supports.

This device 10, the details of which may be better seen in Figs. 3 and 4, may comprise a pair of flat spring members 20 and 21 held in spaced parallel relation by fastening means 22 and 23 and spacers 24 and 25. The fastening means 22 and 23 may be bolts and nuts as illustrated. The spacers 24 and 25 are of insulating material, preferably of a slightly compressible material, such as mica. The springs 20 and 21 may be of clock-spring steel. The fastening means 22 and 23 may be in electrical connection with one of the springs, for example, 20 as illustrated. The other spring 21 may be insulated from the bolts by a member 26 which may also be of mica or other suitable insulating material.

Near one end of springs 20 and 21 and secured to adjacent surfaces thereof are two resistor bodies 27 and 28. (See Fig. 4.) The bodies 27 and 28 may comprise short lengths of metal wire having a very thin coating of high resistance-temperature coefficient material thereon. The wires may be of tantalum, tungsten or like metal and the coating may be of boron, a mixture of boron and silicon which may for convenience of expression be designated as boron-silicon, or other semiconductive material having a suitable resistance-temperature coefficient. The resistor bodies 27 and 28 may be secured to the springs 20 and 21, respectively, by welds or other suitable means.

The resistor bodies 27 and 28 are urged toward each other by means of the springs 20 and 21, and a small filament 30 is interposed between them. The filament 30 which may be of tungsten or tantalum, may be conveniently supported by sandwiching it between the insulating spacers 24 and 25. The assembly just described is as previously indicated supported within the envelope 11 by supports 12, 13, 14 and 15.

The support 12 may be welded to the tip of bolt 22 with a bent-over end portion thereof resting

against the wall of envelope 11 as may be best seen in Fig. 2. The support 13 is secured, as by welding, to the filament 30, and support 14 may be secured to the inner end of spring 21 also by welding. The support 15 may be secured to the tip of bolt 23 with a bent-over projection resting against the wall of the envelope 11 as with support 12. The bent-over portions of supports 12 and 15 extend, respectively, in opposite directions to act as cooperating props or braces against the envelope walls. The supports 12, 13 and 14 are extended to the exterior of envelope 11 since they serve also as electrical connectors. Support 12 makes connection to spring 20 by way of the bolt 22. The supports 13 and 14, as previously indicated, are connected directly to filament 30 and spring 21, respectively. The disc 31 which is employed as a support for the getter used in evacuation of the envelope may be secured to auxiliary support 32 which is in turn secured, as by welding, to support 14.

The thickness of the insulating spacers 24 and 25 should be approximately the same as that of the resistor bodies 27 and 28, respectively. Then upon assembly of the device the exertion of sufficient pressure by fastening means 22 and 23 to slightly compress the spacers will firmly press the resistor bodies 27 and 28 against the sides of filament 30. The pressure should be sufficient to assure mechanical stability of the contacts with substantially no deformation of the contact surfaces. By employing relatively hard materials for the contact surfaces the requisite mechanical stability may be obtained with minimum deformation. In a device so constituted proper contact conditions will be maintained under rather severe conditions of shock and vibration.

The thermal and thus the resistance characteristics of the device may be controlled to some extent by means of the atmosphere surrounding the thermistor. For example, the envelope 11 may be evacuated to a relatively low pressure or may be filled with a gas, such as helium, at a pressure that is substantially atmospheric. If a gas is employed, it should be one that will not react unfavorably with the elements of the device, particularly the thermistor bodies.

The use of two thermistor bodies, such as 27 and 28 renders the device more versatile than one having only a single thermistor body. Each of the bodies may be, for example, of different size and of different material or either. Different materials may be employed to give the bodies each a different resistivity with approximately the same resistance-temperature coefficient, or the coefficients may also be differed by use of suitable materials. For example, by making one thermistor material of boron and the other of a boron-silicon mixture, the contact to the boron may have a resistivity in the order of six times that to the boron-silicon. A device having thermistor bodies of the same dimensions and material may find particular use where it is desired to have two like, relatively high speed thermistors working under the same thermal conditions.

In a dual thermistor device of the type under consideration, there is also the advantage of interaction between the two thermistor elements. Because of this thermal interaction, one of the thermistor elements connected in one circuit may be employed to control the other thermistor element which may be connected in a separate circuit. The controlling thermistor element may be

made to act somewhat in the manner of a grid in a vacuum tube.

Besides being capable of oscillation, a device constructed in accordance with this invention, may under suitable conditions be made to act as an amplifier, modulator or other controllable impedance means.

Although the invention has been disclosed by means of a particular illustrative embodiment thereof, it is to be understood as not limited thereby but by the scope of the appended claims only.

What is claimed is:

1. A resistor device comprising three electrically conducting bodies, means for pressing two of said bodies into contact with opposite sides of the third, said two bodies each including at the point of contact a relatively thin, hard layer of high resistance-temperature coefficient resistor material, said three bodies being relatively shaped and oriented to provide substantially point contact therebetween, the pressure between said bodies being sufficient to maintain them in mechanically stable contact with minimum deformation thereof at the points of contact, and means for connecting each body to an electric circuit.

2. A resistor device comprising three conductive bodies, and means for pressing two of said bodies into contact with opposite sides of the third, said two bodies including at the point of contact a relatively thin layer of boron, the third body consisting of a hard surface metal, said three bodies being relatively cylindrical and oriented to provide substantially point contact therebetween, the pressure between said bodies being sufficient to maintain them in mechanically stable contact with minimum deformation of the contacting material, and means for connecting each body to an electric circuit.

3. A resistor device comprising two substantially parallel springs of conductive material separated adjacent one end by insulating material, a small boron surfaced body at the free end of one spring and a small boron-silicon surfaced body at the free end of the other spring, and a metallic filament secured in said insulating material between said springs and extending between said bodies, which are urged into contact with opposite sides of said filament by said springs, the mating contact surfaces of the bodies and filaments being convex to assure substantially point contact therebetween.

4. A resistor device comprising two substantially parallel springs of conductive material separated by insulating material, two small boron surfaced bodies each secured to adjacent portions of each of said springs, and a metallic filament secured in said insulating material between said springs and extending between said bodies, which are urged into contact with opposite sides of said filament by said springs, the mating contact surfaces of the bodies and filament being convex to assure substantially point contact therebetween.

5. A resistor device comprising two substantially parallel cantilever springs of conductive material separated adjacent one end by superposed sheets of relatively resilient insulating material, two small bodies each surfaced with a thin layer of high resistance-temperature coefficient material, secured in opposing relation, one at the free end of each spring, and a metallic filament secured between said insulating layers and extending between said bodies, said springs urging said bodies against opposite surfaces of said filament, the bodies and filament having convex sur-

faces relatively arranged to provide substantially point contacts therebetween.

6. A resistor device comprising a conductive member pressed between two bodies each having a semiconductive surface, said member and bodies being shaped and relatively oriented to provide substantially point contact therebetween, the materials forming each of said semiconductive surfaces having relatively high resistance-temperature coefficients each of different absolute value.

7. A resistor device comprising a conductive member pressed between two bodies each having a semiconductive surface, said member and bodies being shaped and relatively oriented to provide substantially point contact therebetween, the materials of said semiconductive surfaces each having a relatively different value of resistivity.

8. A resistor device comprising three conducting bodies, and means for pressing two of said bodies into contact with opposite sides of the third, said two bodies each including at the point of contact a relatively thin, hard layer of high resistance-temperature coefficient resistor material, said third body being of a relatively hard

metallic material, said three bodies being relatively cylindrical, said two bodies being in substantially parallel relation to each other with the third body substantially at right angles thereto, to provide substantially point contacts therebetween, the pressure between said bodies being sufficient to maintain them in mechanically stable contact with minimum deformation thereof at the points of contact.

9. A resistor device comprising an envelope, a plurality of electrically conductive supports secured through one wall of said envelope, two bodies each having a thin film of high resistance-temperature coefficient material thereon, resilient means for urging said bodies toward one another, insulating means for maintaining portions of said resilient means in spaced, substantially parallel relation, and a metallic filament secured through said insulating means and extending between said bodies, whereby said bodies are in substantially point contact with opposite sides of said filament, said conductive supports maintaining the assembly in spaced relation to the walls of said envelope and providing electrical connection to said bodies and filament.

GERALD L. PEARSON.