Jan. 31, 1967 R. M. BAUER 3,302,154
CARBON PILE RESISTOR
Filed July 28, 1964

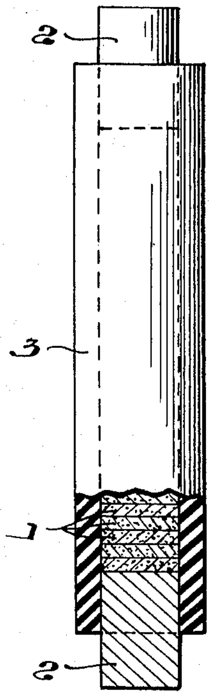


Fig. 1.

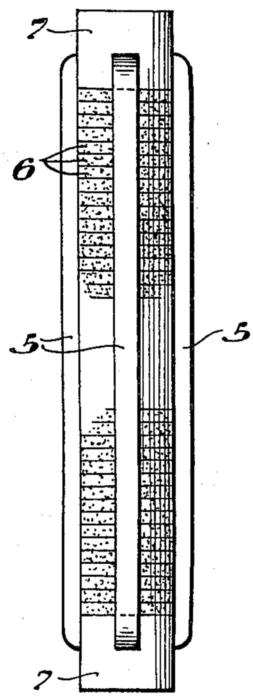


Fig. 3.

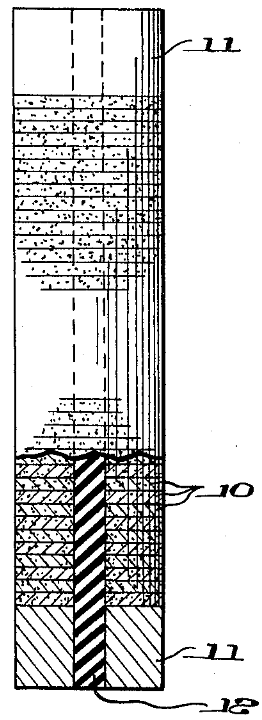
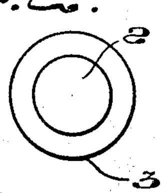
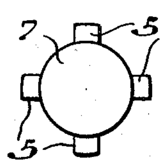


Fig. 5.

Fig. 2.





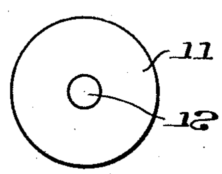


Fig. 4. Fig. 6.

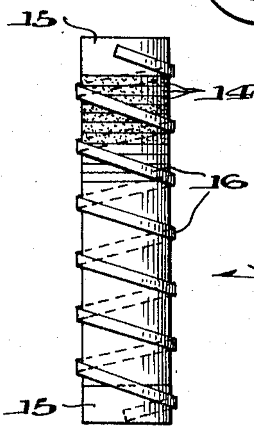


Fig. 7.

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CARBON PILE RESISTOR

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This invention relates to carbon pile resistors, which include resistors in which the carbon has been graphitized.

When a carbon pile resistor is subjected to repeated longitudinal compression and release, the resistor gradually changes its electrical resistance from about 20% to 40%. This change is brought about by the mechanical adaptation or fit of the numerous contact surfaces against one another. That is, as the resistor is alternately compressed and released, the individual resistance elements or carbon discs shape themselves to one another and make more intimate contact. As the contact areas are increased in this way, the resistance of the pile decreases both when under pressure and when free of it.

There had been attempts to solve this problem, but as far as I am aware none of them has been successful enough to be put into use. For example, the carbon discs have been made cup shape in order to receive tiny springs that tend to separate the discs when the pressure on the pile is released. This system cannot be used with small pile resistors and it is expensive. Another effort to solve the problem has been by way of altering the composition of the carbon segments, but it was not successful. A further method that has not shown any improvement is the use of oil as a hydrostatic means of producing the desired repeatability of resistance.

It is among the objects of this invention to provide a carbon pile resistor, which returns to substantially the same electrical resistance every time it is released from the forces that change the pressure between the elements of the pile, which can be made very small, which is simple and inexpensive, and which does not require any special form of carbon segments.

In accordance with this invention, a pile of carbon resistance discs is engaged at its opposite ends by terminal members. Extending lengthwise of the pile and gripping the terminals and discs is longitudinally resilient means, which normally holds the discs in predetermined relative positions lengthwise of the pile. Consequently, after forces have been applied to the terminals axially of the pile in opposite directions to change its resistance and such forces have been removed, the resilient means restores the discs to substantially their original relative positions. The resilient means may take the form of an encircling tube, an axial rod, or bands spaced circumferentially around the resistance pile.

The invention is illustrated in the accompanying drawings, in which

FIG. 1 is a side view, partly broken away, of a carbon pile in a resilient tube;

FIG. 2 is an end view thereof;

FIG. 3 is a side view of a modification using longitudinally extending bands of resilient material;

FIG. 4 is an end view of the resistor shown in FIG. 3;

FIG. 5 is a side view, partly broken away, in which a resilient rod extends through the center of the resistor;

FIG. 6 is an end view of the resistor shown in FIG. 5; and

FIG. 7 is a side view of a further modification.

Referring to FIGS. 1 and 2 of the drawings, a pile of any desired number of carbon resistance segments or discs **1** is engaged at each end by a terminal **2** that preferably has the same diameter as the disc. The carbon discs and the inner end portions of the two terminals are enclosed in a resilient tube **3** that tightly grips the terminals and the edges of the discs to normally hold each disc in a predetermined position relative to the other discs. The tube may be made of any one of several different materials, such as natural rubber, silicone rubber, synthetic plastics etc. Ordinarily, the tube will hold the discs in such a way that they touch one another rather lightly in order to provide a predetermined electrical resistance.

To reduce the electrical resistance, the resistor is compressed axially in any well-known manner to cause the various discs to engage one another more tightly and over greater areas so that the contact resistance between them will be reduced. When this compression of the resistor occurs, the resilient tube that tightly grips the terminals is compressed axially. When the compressive forces are removed from the resistor, the tube will expand lengthwise and thereby tend to pull the carbon discs apart. Since the tube will expand to its original length, the pressure of the discs against one another will be reduced to what it was originally and therefore the maximum electrical resistance of the resistor will remain substantially constant regardless of how many times the resistor is compressed axially and then released.

On the other hand, if the carbon discs are held under pressure when the tube is applied to them, then it will maintain that pressure and the resistor will have minimum resistance. To increase the electrical resistance in such a case, the terminals are pulled in opposite directions to stretch the tube and reduce the pressure between the discs. When the tension on the terminals is released, the elastic tube will contract to its original length and thereby restore the pressure of the discs against one another.

It will be seen that with this invention no special preparation of the carbon discs is required and that the means by which repeatability of resistance is obtained is simple and inexpensive. Also, the tube holds the terminals and all of the carbon discs together as a unit.

In the modification shown in FIGS. 3 and 4, bands **5** of resilient material extending lengthwise of the pile of carbon resistance discs **6** are substituted for the tube of FIG. 1. The bands may be made of the same material as the tube **3**. The ends of these bands adhere to the terminals **7**, and the intermediate portions of the bands adhere to the edges of the carbon disc. A simple way to attach the bands is to apply bands of a suitable composition in its uncured state to the terminals and disc edges and then cure the composition to cause it to become resilient and to stick to the discs and terminals. Such bands are especially feasible when the normal condition of the resistor is one in which the discs are under compression. The elastic bands hold the discs that way until the terminals are pulled away from each other to stretch the bands and reduce the pressure between the discs. When the tension on the resistor is released, the elastic bands will pull the discs back tightly together again.

The resistor also can take the form of a combination of FIGS. 1 and 3. That is, the resistor discs may be completely enclosed as shown in FIG. 1, but by a resilient material such as shown in FIG. 3, which is applied in an uncured state and then cured.

Instead of having the resilient members engage the outer edges of the discs as described thus far, the resistor may be made like the one in FIGS. 5 and 6. In it the carbon discs **10** and metal terminals **11** may be provided with axial openings therethrough, through which a resilient rod **12** extends. The rod may be made of one of the materials mentioned in connection with tube **3**. The diameter of the rod is such that it will tightly grip the terminals and the inner edges of the carbon discs to normally hold all of them in predetermined relative positions. After the resistor has been compressed axially or stretched and the compressing or stretching forces have been removed, the longitudinally expanding or contracting rod will return all of the discs to their original positions. Thus, repeatability of resistance is assured.

In still another embodiment of the invention shown in FIG. 7, the pile of resistance discs **14** and their end terminals **15** are encircled and held together by a coil spring **16** that tightly engages them or is bonded to them. If a metal spring is used, there must be a layer of insulation between it and the encircled member. Preferably, the spring is formed from a plastic, which can directly engage the discs and terminals. After the length of the resistor has been changed to change its electrical resistance, and then released, the spring will return the resistance discs to their original relative positions.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A variable resistance carbon pile resistor comprising a straight pile of carbon resistance discs, terminals engaging the end discs in the pile and movable toward and away from each other, and longitudinally resilient means extending lengthwise of the pile and gripping the terminals and discs to normally hold them in predetermined relative positions lengthwise of the pile, the length of said resilient means being changeable by said terminals when they are moved axially of said pile in opposite directions by external forces to change the resistance of the pile, whereby when said resilient means is allowed to return to its original length it will restore the discs to substantially said predetermined relative positions.

2. A carbon pile resistor according to claim **1**, in which said resilient means is a tube encircling said discs and terminals.

3. A carbon pile resistor according to claim **1**, in which said resilient means are circumferentially-spaced bands adhering to said terminals and the edges of the discs.

4. A carbon pile resistor according to claim **1**, in which said discs and terminals are provided with axial openings therethrough, and said resilient means is a rod extending

through said openings and gripping the terminals and the inner edges of the discs.

5. A carbon pile resistor according to claim **1**, in which said resilient means is a coil spring encircling said discs and terminals.

6. A variable resistance carbon pile resistor comprising a straight pile of carbon resistance discs, terminals engaging the end discs in the pile and movable toward and away from each other, and longitudinally compressible resilient means extending lengthwise of the pile and gripping the terminals and discs to normally hold them in predetermined relative positions lengthwise of the pile, the length of said resilient means being reducible by said terminals when they are moved axially of said pile toward each other by external forces to press said discs tightly together, whereby when said resilient means is allowed to expand axially to its original length it will restore the discs to substantially said predetermined relative positions.

7. A variable resistance carbon pile resistor comprising a straight pile of carbon resistance discs, terminals engaging the end discs in the pile and movable toward and away from each other, and longitudinally elastic means extending lengthwise of the pile and gripping the terminals and discs to normally hold them tightly together, the length of said resilient means being increasable by said terminals when they are moved axially of said pile away from each other by external forces to reduce the pressure of the discs against one another, whereby when said elastic means is allowed to return to its original length it will pull the discs back tight together again.

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