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METHOD OF MAKING RESISTANCE DEVICES

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Fig. 1.

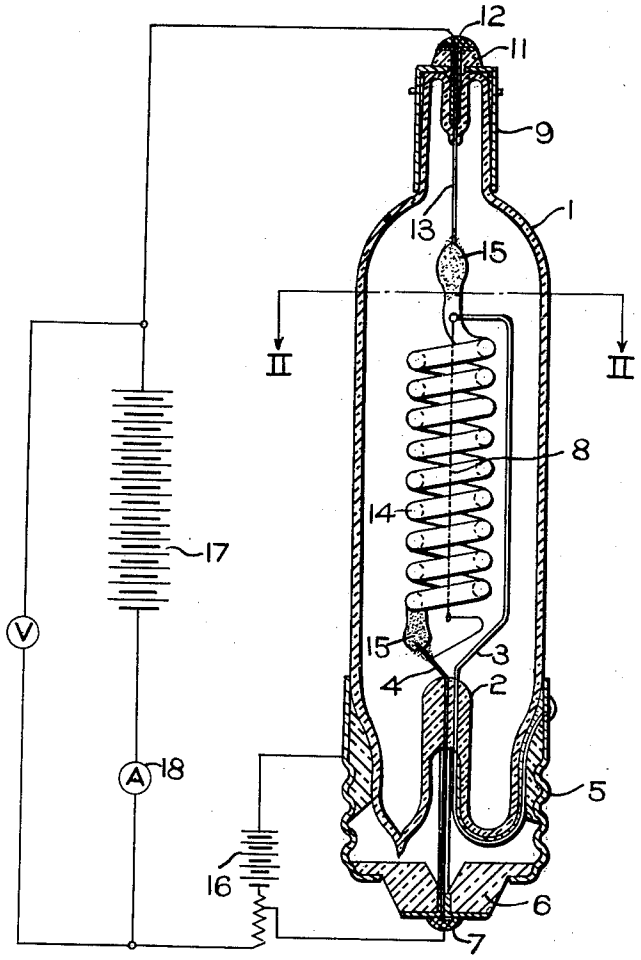
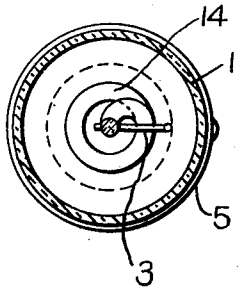


Fig. 2.



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METHOD OF MAKING RESISTANCE DEVICES.

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My invention relates to resistance devices, and it has particular relation to devices having very high resistance of the order of several hundred megohms.

One object of my invention is to provide a high-resistance device that remains constant in resistance over long periods of time and is unaffected by the current carried thereby, when in use.

Another object of my invention is to provide a method for manufacturing high-resistance devices that will enable a continuous measurement of the resistance thereof to be made during the course of manufacture.

Another object of my invention is to provide a high-resistance device the resistance of which may be easily and conveniently varied.

In many instances, it is highly desirable to have a constant resistance of the order of several hundred megohms. Resistors of such values are useful in various amplification circuits employing thermionic tubes, photo-electric-cells or the like, being used therein either as grid-leaks or coupling elements between various devices.

It has been customary in the past to manufacture high-resistance devices either by coating insulators with graphite, or the like, by scoring continuous films of conducting material carried by insulators, or by sputtering the conducting material from cathodes upon insulating carriers.

Of these methods, sputtering has been found to produce the best results, in so far as the characteristics of the finished product are concerned, but it is unduly expensive and does not permit measuring the resistance of the device during the process of manufacture.

According to my invention, I provide a long insulating carrier with a conductive coating by evaporating a metal in proximity thereto, at the same time applying a negative potential between the carrier and the source of metal being evaporated.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, will best be understood by reference to the following description, taken in connection with the accompanying drawing, in which,

Fig. 1 is an elevational view, partly in section, of a prefe red form of a resistance device constructed according to my invention, showing the circuit connections employed in the process of manufacture.

Fig. 2 is a cross-sectional view of my device, taken on a line corresponding to the line II—II of Fig. 1.

Referring specifically to the drawing, a container 1, preferably evacuated, is provided, at one end, with a re-entrant press 2 on which are mounted a filament-supporting device 3 and a second electrode 4. The end of the container adjacent the re-entrant press is surrounded by a threaded metallic base 5 having an insert 6 of insulating material therein, the insert being provided with a central metallic contact member 7 to which is connected the electrode 4. The filament-supporting device 3 is conductively connected to the base 5, and a filament 8 is suspended between the upper end of the supporting device and the electrode 4.

The end of the container opposite to that provided with the threaded base is covered by a metallic cap 9 which carries, centrally of an insulating insert 11, a contact member 12 that is connected to an electrode 13.

A spiral 14 of glass, or other insulating material, is connected, at one end, to the upper electrode 13 and, at the other end, to the lower electrode 4, the junctions between the spiral and the electrodes being covered by a conducting substance 15, such as platinum black or the like.

A source of filament potential 16 is connected between the base 5 and the contact member 7, and a second source of potential 17 is connected between the contact members 7 and 12, the negative terminal of the latter source being connected to the upper contact member 12.

A milliammeter 18 is provided in series with the second potential source, and a voltmeter is connected between the contact member 12 and the contact member 7.

In the preparation of my device, the container carrying the filament and the insulating spiral is first sufficiently exhausted to prevent the filament from oxidizing when incandescent, and the filament is then energized by passing current from the source 16 therethrough.

I preferably maintain the filament at such a temperature that rapid evaporation of the filament material takes place. The evaporated material condenses on the interior of

the glass spiral, building up a conductive, yet highly resistive, layer thereon. The average thickness of this layer is shown by calculation to be less than one one-thousandths of the diameter of a molecule of the material used, indicating that the film is not continuous over the whole surface of the spiral. The extreme tenuity of the film thus precludes the crystallization of the metal with lapse of time, and insures unusual constancy of the resistance thereof.

In order to measure the resistance during the evaporating process, a high potential from the source 17 (several hundred volts, preferably) is applied through the milliammeter 18 between the ends of the spiral, the spiral being kept negative with reference to the filament in order to obviate thermionic emission from the filament. The amount of current flowing is obviously a measure of the resistance of the layer, and the process is stopped when this resistance has reached the proper predetermined point.

As will be apparent to those skilled in the art, the container may be maintained in operative connection with a vacuum pump during the entire evaporating process, the end caps being applied after the entire device is completed and calibrated.

If, during the process of manufacture, an excessive amount of material is deposited on the spiral, I have found it possible to increase the resistance of the layer by heating the whole container. I am not prepared to state exactly what happens during this heating, but believe that the conductor layer is reduced, either by evaporation or by driving the particles of the material into the interior of the spiral where they are not effective as elements of the conductive layer.

It is, of course, obvious that the resistance may be reduced at any time merely by a repetition of the evaporating process, thus permitting the user to adjust the device to suit his individual needs.

The purpose of coiling the glass rod is to increase the effective length of the film and to reduce the voltage gradient across it, rendering the resistance useful although the applied potential be of the order of several thousand volts.

Resistors made according to my invention, even those rated as high as five hundred megohms, have proved to be extremely stable under relatively high voltages, laboratory measurements failing to disclose any deterioration with time.

Although I have shown and described my invention as applicable to a specific form of device, many other modifications will be apparent to those skilled in the art. It is my intention, therefore, that my invention be limited only in so far as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. The method of making a high-resistance device which comprises the steps of providing an insulating carrier, causing the evaporation of conductive material from a source thereof, applying a negative potential to the carrier with reference to the source and causing the conductive material to deposit on the carrier.

2. The method of making a high-resistance device which comprises the steps of providing an insulating carrier, causing the evaporation of conductive material from a source thereof, applying a negative potential to the carrier with reference to the source, causing the vaporized material to deposit on the carrier, passing a current through the material deposited on the carrier and stopping the vaporization at the point where the current passing through the deposited material indicates that the proper resistance has been reached.

In testimony whereof, I have hereunto subscribed my name this 11th day of August, 1926.

VLADIMIR K. ZWORYKIN.