Nov. 17, 1936. N. C. SCHELLENGER 2,061,106

RESISTANCE ELEMENT

Filed April 17, 1933

Fig. 1.

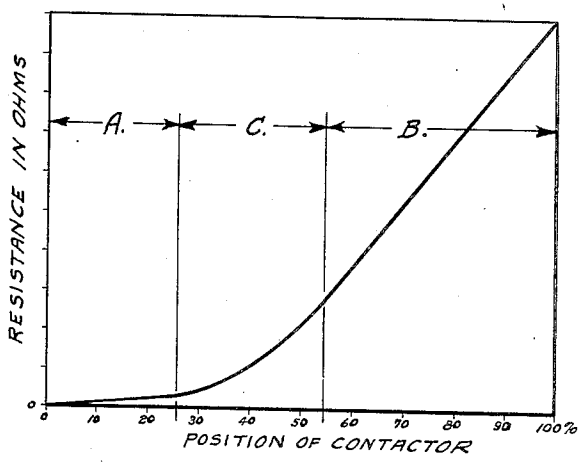
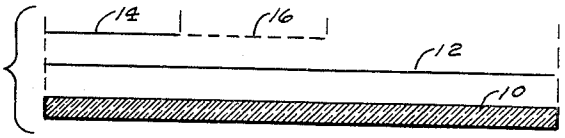


Fig. 2.



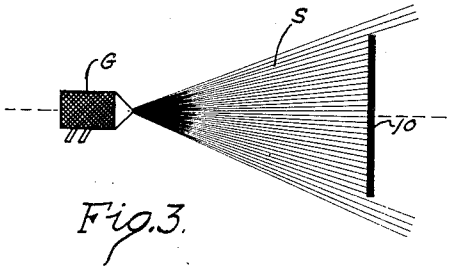


Fig. 3.

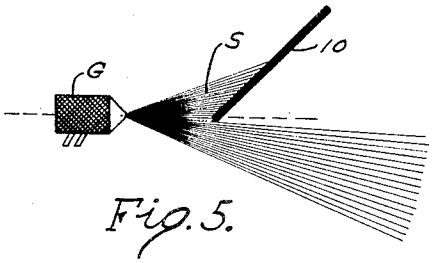


Fig. 5.

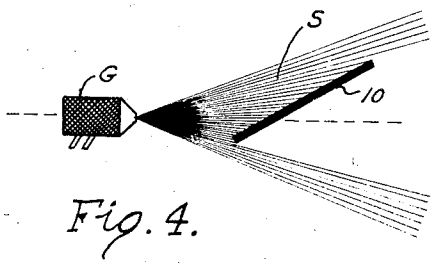


Fig. 4.

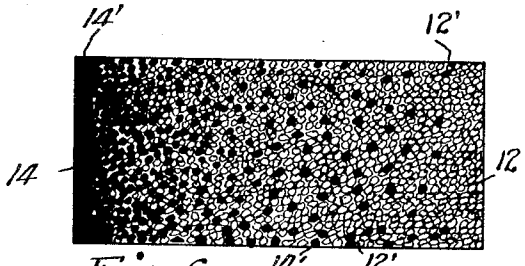


Fig. 6.

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2,061,106

UNITED STATES PATENT OFFICE

2,061,106

RESISTANCE ELEMENT

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Application April 17, 1933, Serial No. 666,444

3 Claims. (Cl. 201—76)

My invention relates to an electrical device and more particularly relates to a carbonaceous element for a rheostat.

In many forms of electrical apparatus, and especially in radio sets, it is desirable to use a rheostat in which the change of resistance is not directly proportional to the rotation of the knob or movement of the contactor. The rate of change of the resistance with knob rotation may be several thousand times as great in some portions of the rotation range as in others to give smooth control. Therefore, to prevent a very abrupt and disagreeable change in the output of the radio set when the point of mergence of the aforementioned resistance sections is reached and passed, it is desirable to merge such sections having widely different resistance per unit length as gradually as possible.

It is also desirable, in many instances, to use a rheostat having a very low minimum resistance in order to properly control very strong signals.

In my Patent No. 1,771,236, I disclose a means of making a resistance element for use in a rheostat, where it is necessary to have the rate of resistance-increase constant through one range and where, through another range, the rate of resistance-increase, although constant, is much more rapid than the first range. However, in such disclosure it is only possible to join the different sections abruptly, whereas it is often desirable to have the sections merge gradually.

It is, therefore, an object of my invention to gradually merge positions having a very great difference in the rate of change of resistance.

Another object is to obtain very low resistance values between the movable contactor and each stationary terminal when the contactor is close to the terminal, since contact is made directly with the lowest specific resistance coating by both the end terminal and the movable contactor.

Other objects of this invention are to provide an improved device of the character described, that is easily and economically produced, sturdy in construction, and having a maximum efficiency and accuracy.

With these and related objects in view, my invention consists in the following details of construction and combination of parts, as will be more fully understood from the following specification, taken in conjunction with the accompanying drawing, in which:

Figure 1 is a graph showing a resistance-length curve for a typical resistance element made in accordance with my invention wherein the resistance increases non-uniformly with the change in position of a contactor, or in other words, the resistance increases non-uniformly with a uniform increase in the effective length of the resistance element in the electrical circuit;

Figure 2 is an exploded diagrammatic longitudinal sectional view of the resistance element formed with a plurality of resistance coatings on a base member;

Figure 3 is a diagrammatic side elevational view of a spray gun positioned to apply a substantially uniform coating of a resistance composition to the base member;

Figure 4 is a diagrammatic side elevational view of a spray gun positioned to apply a coating of a resistance composition to the base member whereby the coating gradually diminishes in density across the base member;

Figure 5 is a diagrammatic side elevational view of a spray gun positioned to apply a coating of a resistance composition across a portion of the base member or base coating whereby the density of such coating gradually diminishes to a vanishing point adjacent the center thereof.

Fig. 6 represents a microscopic plan view of the contact surface of a composite resistance element made in accordance with my invention, illustrating the interspersion of particles of an overlying coating upon an underlying coating at their point of mergence.

Whereas, for purposes of illustration it has been necessary to show the conductive coatings of the resistance elements described herein as being of substantial thickness, it must be realized that such coatings are frequently only two to three thousandths of an inch in thickness, and but rarely exceed eight thousandths of an inch. Likewise, hereinafter where it has been necessary to refer to the mergence of adjacent coatings as "taper" or "tapering" of one such coating upon another, the "taper" refers not so much to an actual gradual diminution in thickness of the top coating, but rather to a lateral, progressively increased spacing between the particles of the top coating upon the bottom coating, whereby a gradual blending of the superficial areas of the adjacent coatings is effected.

Referring in detail to the drawing, I show in Figure 1 a typical resistance-length graph, wherein the resistance increases smoothly and non-uniformly as the contactor is moved from the zero resistance end of the resistance. The specific resistance of the element is such that section B has a higher specific resistance than section A. These sections are merged gradually and without any substantial abrupt change as is represented by the gradually curving elbow through the contactor range C.

An exploded diagrammatic view of the resistance element, from which the above described curve is obtained, is shown in Figure 2.

The linear extent of the element is equal to the abscissae of the graph shown in Figure 1, and the effective resistance of the resistance element with the various coatings, is projected upon the graph to more clearly show the resistivity rela-

tionship. The same graphic representation is obtained irrespective of the shape of the element, i. e. whether arcuate or rectangular in shape. A base member 10 is employed, which may be either an insulator or a conductor of relatively high resistance, and to which an applied conductive coating 12 will adhere.

A mixture of different forms of carbon in a shellac solution is suitable for the resistance coatings as disclosed in my prior Patent No. 1,771,236, granted July 22, 1930. However, the resistance of the mixture can be varied by changing the proportions of the conductive matter ingredients to the non-conductive ingredients. It is, of course, understood that any composition, having the necessary characteristics may be employed, such as a sugar solution, which is heated in a closed chamber, whereby an even deposit of carbon will be formed on the plate or strip, or the material may be heated in the presence of a hydrocarbon liquid or vapor whose carbon will be deposited on the heated body. Also, paper may be moistened with a sticky solution such as a solution of glue, varnish, or sugar, and then graphite may be rubbed upon the paper.

Another coating 14, of any desired resistance characteristics, depending upon the slope of the curve that is required, is sprayed onto the low resistance end of the coating 12, as shown in Fig. 2, so that it extends only part way across the surface of the prior coating 12, and "feathers" out or tapers in thickness and in density 16 through a distance C at its end. The main portion of the coating, together with coating 12, determines the slope of the resistance curve through the range A of Fig. 1. The tapering section 16 creates the gradually curved elbow C of Fig. 1, and the coating 12 determines the slope of the steepest section B of Fig. 1.

So far as I am aware, the only successfull way of achieving these results is by depositing the conductive material upon the web by means of spraying, since no other method of deposition permits of such fine, controllable distribution and interspersion.

This will become more obvious from the inspection of Fig. 6. Here I have diagrammatically illustrated a microscopic view of a portion of my resistance element in order that I may more clearly point out the differences between composite elements made by spraying, as shown and described herein, and other well known methods of coating.

In Fig. 6, I have illustrated an overall coating corresponding to the coating 12 of Fig. 1, by white particles 12', with a coating, corresponding to the coating 14 of Fig. 1, superimposed thereon, represented by the dark particles 14'. The view of Fig. 6 is taken at the point where the coating 14 tapers away to the coating 12, as at 16 in Fig. 1.

By virtue of a spray being operated and controlled as has hereinbefore been discussed, the particles 14', of the dark coating are massed closely together to form a solid coating 14 over the coating 12, and gradually taper out upon coating 12. This solid coating 14 has a uniform rate of resistance increase throughout its length, and as was mentioned in connection with Fig. 1, the coating 12, has a different, though uniform resistance increase throughout its length.

The densely massed particles 14' of the coating 14 were deposited by disposing that portion of the element upon which they rest closest to the spray gun. The portons of the element more remote from the spray gun received the particles in less compact relation. Thus, the density of the coating is inversely proportional as the distance from the spray gun. Hence, the particles 14' become scattered and more sparsely settled whereby more and more of the particles 12' appear at the surface.

For any unit area, the resistance is equal to the combined resistances of the particles; varying in the proportion that the dark particles 14' vary to the light particles 12'. Virtually, coalescence is effected between the coatings.

In Figure 3, I illustrate a novel means of applying a resistance coating to a base 10. The resistance composition is sprayed, through a spray gun G, across the vertically positioned base 10. A substantially uniform coating may thus be produced upon one face of the entire strip. By inclining the base 10, as shown in Figure 4, a continuous, transversely tapering coating may then be applied to the base. Obviously, as the spray S diverges the density of the coating decreases proportionally as the distance from the nozzle of the spray gun is increased.

A modified manner of applying a tapering coating is illustrated in Figure 5, by inclining the base 10 and positioning the spray gun G so that the coating is applied to but a portion of the base and/or the base coating. Thus, a limited tapering coating is provided, which gives a smooth curve of a limited extent.

The characteristic of the spray gun is to give substantially a uniform coating on the base 10, as shown in Figure 3, and a tapering coating on the base, as shown in Figures 4 and 5; the length and sharpness of the taper may be varied through wide limits by adjusting the angle of the base member relative to the direction of the spray coating; and by adjusting the spraying conditions of the nozzle of the spray gun.

I have illustrated and described but a limited application of my invention. Nevertheless, I contemplate that any coating or combination of coatings, either conductive, insulatory or both, may be applied by my novel method to secure a resistance element having the desired characteristics.

I claim as my invention:

1. A variable resistance element comprising a plurality of superposed conductive coatings, one of said coatings being of less extent than an immediately adjacent coating, said coating of lesser extent having an edge which tapers from the density of the body of the layer to zero density by progressive separation of particles of the conductive coating.

2. A variable resistance element comprising a plurality of superposed conductive coatings comprising finely divided carbonaceous material and a binder, one of said coatings being of less extent than an immediately adjacent coating, said coating of lesser extent having an edge which tapers from the density of the body of the layer to zero density by progressive separation of particles of the conductive coating.

3. A variable resistance element comprising a plurality of superposed conductive coatings comprising finely divided resistance material and a binder, one of said coatings being of less extent than an immediately adjacent coating, said coating of lesser extent having an edge which tapers from the density of the body of the layer to zero density by progressive separation of particles of the conductive coating, the surfaces of the conductive coatings being intact and unbroken.

NEWTON C. SCHELLENGER.