

June 8, 1937.

N. C. SCHELLENGER

2,082,980

VARIABLE RESISTANCE

Filed Dec. 10, 1934

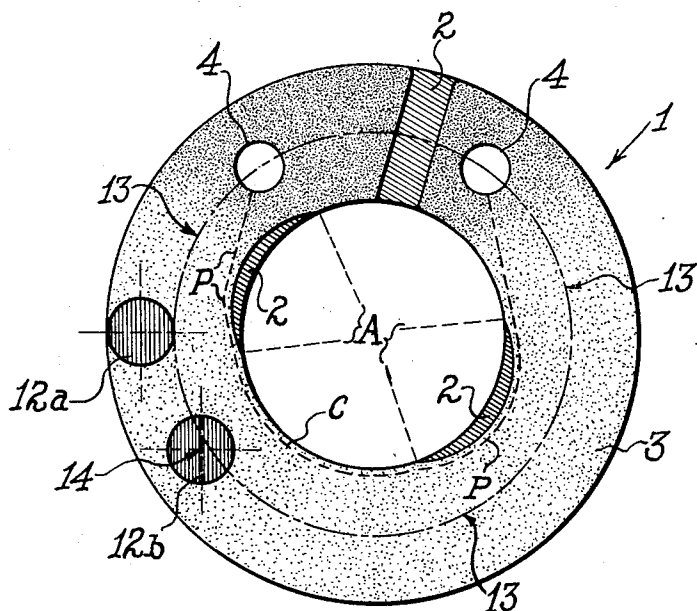


FIG. 1.

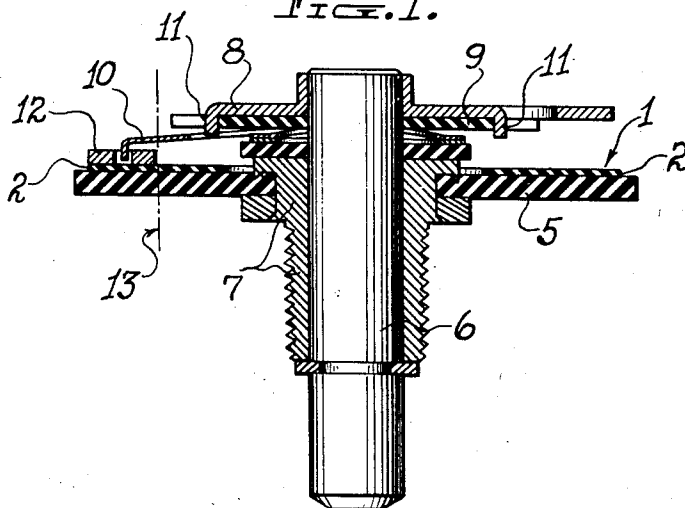


FIG. 2.

INVENTOR.

NEWTON C. SCHELLENGER.

BY.

Heurthume ATT'Y.

UNITED STATES PATENT OFFICE

2,082,980

VARIABLE RESISTANCE

Newton C. Schellenger, Elkhart, Ind., assignor to
Chicago Telephone Supply Co., Elkhart, Ind.,
a corporation of Indiana

Application December 10, 1934, Serial No. 756,718

2 Claims. (Cl. 201—55)

My invention relates to variable resistances of the type employing flat, arcuate elements, and to the methods of making and contacting such elements.

It is well known that, in devices of the class described, the current of any circuit with which such devices might be associated, passes about these resistance elements in the shortest possible path; i. e., the path of least resistance. This results in the inner edge of such elements carrying practically all of the current, whereby the remaining transverse expanse of the element serves little or no purpose.

The contacting members of variable resistors employing arcuate elements of the type described have been made heretofore to operate at a radius that places the contact portion in engagement with the element substantially upon and adjacent to the centerline thereof. The extremities of such contact portion transversely of the element are spaced substantially equidistantly from the inner and outer edges of such element but the inner extremity of the contact portion intercepts practically all of the current adjacent the inner edge of the element.

From the above, it will be seen that the resistance values obtainable from such an arrangement are absolutely of the highest order obtainable without altering the structure; which order is the lowest value that the resistance element is constituted to produce. In other words, the maximum resistance obtainable from an element, used as has heretofore been the case, is not substantially in excess of its lowest possible value, due to the short-circuiting of effective resistance by the configuration of the element, and by the manner in which such elements have been contacted.

It follows, then, that, whereas there is room for expansion to raise the value of an element, there is practically no feasible way of lowering the value without altering the ingredients, quality or quantity of the conducting material.

It is quite important that the resistance gradients of elements conform within exceedingly low tolerances to the specification of any circuit in which they are to be used. This is particularly true in the case of the modern radio, which has been developed to such a degree as to be highly sensitive and delicate, and is, therefore, most acutely susceptible to being thrown off balance by any unrefined or imperfect elements incorporated within its structure.

It is difficult to manufacture an element, which, upon completion, will give the exact value

desired, since there are bound to be certain imperfections and departures that make correcting of the element necessary. It will be seen from the preceding paragraphs, that it is better to have an element record a departure on the low side of the desired value than otherwise.

In accordance with the present invention, I employ resistance elements having values less than those required, and raise the values thereof until they conform precisely to any prescribed values. Hereinafter, I disclose the method and apparatus for contacting such elements, whereby all short-circuiting influences are minimized, to produce more accurate and efficient variable resistances.

It is, therefore, an object of my invention to provide an inexpensive, durable resistance element of the type described, which will possess any desired predetermined characteristics.

It is another object of my invention to provide a variable resistor possessing remarkable qualities of conformance to any given requirements, and which will vary the effective resistance gradually, smoothly and quietly, without aberration or distortion.

It is still another object of my invention to provide a novel method of making resistance elements whereby such elements will possess substantially the precise resistance characteristics prescribed.

It is a further object of my invention to provide a novel method of contacting resistance elements whereby a smooth gradation of resistance will be had, and whereby maximum efficiency in operation and performance will be obtained.

In the drawing:

Fig. 1 is a plan view of an element whereupon I have diagrammatically illustrated certain aspects of the present invention.

Fig. 2 is a vertical mid-sectional view of a variable resistor constructed in accordance herewith, illustrating a method of contacting an element, and the structure for executing such method.

Referring now more specifically to the drawing in which like reference characters refer to like parts throughout:

With the exception of the structure that relates expressly hereto, the variable resistor illustrated in Fig. 2, and described herein for purposes of illustrating an embodiment of the present invention, is essentially the same as that shown and described in my copending application Serial No. 721,728, filed April 21, 1934.

A resistance element 1 is composed of a flat,

insulative base 2 of circular configuration. Disposed upon the base 2, to substantially cover it, is a thin film of conducting material 3, which is less than 360° of arc in extent, and which is provided with terminal recesses 4 adjacent its ends.

The resistance element 1 is mounted upon a base 5 of a variable resistor so as to be coaxial with a shaft 6 and shaft mounting 7 thereof.

A contactor mechanism is rotatable with the shaft and comprises a drive arm 8, insulative plate 9 and a resilient conductor arm 10, which is fastened to the plate 9 for rotation therewith. The drive arm 8 is pressed tightly upon the shaft, and has no movement relative thereto. The arm 8 transmits the drive torque to the contactor arm 10 through the plate 9 by the downwardly depending fingers 11.

A contact shoe 12 is provided at the extremity of the resilient arm 10 for making contact with the resistance element 1. As the shaft 6 is rotated, the contact shoe is moved over the resistance element to vary the effective resistance.

The resistance element 1 is constituted to have a resistance value lower than is desired. To raise the value a predetermined amount I remove portions of the conductive film, as is illustrated at A, Fig. 1. The current is thereby forced from its normal path C about the inner edge of the element, to follow a longer path P. Thus, the effective length of resistance traversed by the current is actually increased, and a higher value is obtained.

By controlling the exact amounts removed, an element may be corrected in one operation with such precision and accuracy that a proof test is not even necessary. I have found a stationary, rotary cutter satisfactory for this purpose. The elements are advanced upon the rotating blades the exact amount necessary to effect a removal of film, which in length and depth, gives the desired increase in value.

There is no definite formula, so far as I am aware, which may be employed to determine the amount of conductive matter to be removed from an element of any given value, to raise such value any prescribed amount. This must be done by the trial and error method, where, by process of elimination, the extent of removals may be determined. Once ascertained, dies may be provided to effect removal of the exact amount of film necessary for attaining the value desired, and, thereafter, all elements treated by such die or dies will be raised in value the exact amount.

As an example, I have found that an arcuate element of any given value may be raised in value 25%, where the conductive surface from terminal to terminal is 302° in extent, and its outer and inner peripheries, before removal, are defined by radii .6875" and .344", respectively, by removing that portion of the inner periphery over approximately two-thirds of the circumference thereof, which will be defined by a radius .402" in extent; a removal .058" in depth throughout. Such removal, when placed appropriately with respect to the terminals, will always raise the value of an element of the above dimensions 25% of its original value.

The removals A, Fig. 1, are merely arbitrary representations, and may be larger or smaller, or positioned elsewhere, about the inner periphery, to attain the desired result. The crescent or "fingernail" shape of the removals has

been found to be convenient and suitable, although other shapes may be used if desired.

In order to realize the full advantages gained by the removals discussed above, and to preserve accurate values thus obtained, I have provided a method and device for contacting such elements, which causes substantially the entire conductive surface of an element to be utilized.

As is shown in the drawing, I make the contactor arm 10 of sufficient length to position the contact shoe 12 completely or substantially outside of the median line 13 of the element 1. The position of the shoe 12 in Fig. 2 is designated at 12a, Fig. 1, and illustrates the shoe completely without the centerline of the element. If it is not desired to position the shoe completely without the centerline, it may be brought inwardly a certain degree as is shown at 12b, Fig. 1.

In this latter instance, care should be taken to position the shoe so that its center 14, or the center of the area of contact thereof, also represented by 14, Fig. 1, is outside of the centerline of the element.

In either case the innermost portion of the shoe is substantially removed from the inner edge of the element, and is thereby removed from the normal path C of the current. This insures that the current will be intercepted through longer paths of resistance, and will preclude the short-circuiting of effective resistance through paths shorter than the paths P created by the removed portions A, after the contactor has moved past said removed portions.

The path of effective resistance through an element contacted as above described is materially lengthened, whereby, for the same degree of rotational movement of the contactor, a longer path of effective resistance is traversed. Obviously, then, a highly refined gradation of resistance values is realized; i. e., for any increment of movement of the contactor, less actual resistance is traversed, making delicate variations and shaded gradations possible.

The present invention may be applied to old variable resistors to raise the resistance values thereof, and to improve their operating characteristics, as well as to new devices.

In the manufacture of resistance elements, a great saving of time and expense is realized by practicing the present invention. One suggested procedure is as follows:

Resistance elements may be manufactured in groups of different resistances, and all intermediate values may be attained quickly and accurately by my method. For purposes of illustration, resistance elements of over a thousand ohms may be made in groups; each group to contain all elements having the same value, and there being, say, a difference of 500 ohms between the various groups. Thus, there would be a group containing only those elements having a resistance of 1,000 ohms; another having those elements of 1,500 ohms, and others having only elements of 2,000, 2,500, 3,000, etc., ohms, respectively. All values of an intermediate order may be attained by selecting from the group next lowest to the desired value, and removing portions from the inner edge thereof until the desired value is reached.

Thus, still following the above example, if it is desired to produce an element having the value of 2,750 ohms, an element would be selected from the 2,500 ohm group of elements. The element would then be treated with a cutter or die of the size or calibre necessary to effect a re-

removal that will raise the value of such element 250 ohms, or 10 percent of its original value.

If the extent of removal has been determined, and it need only be determined once, it is but
5 a matter of seconds to raise the value of the element, as above, with unbelievable precision and accuracy.

From the methods and structure described herein, it will be seen that I have provided a
10 novel, economical and efficient means of producing resistance elements and variable resistors possessing all of the refinements and precision required by the commercial fields today. Whereas, the inventions herein disclosed have
15 been set forth with particularity, such disclosures are to be construed as illustrative rather than limiting, and the scope of the inventions shall only be defined by the appended claims.

I claim as my invention:

20 1. In a variable resistance device, an arcuate resistance element, comprising a wide conductive member formed in a flat circular arc with spaced ends, an arcuately movable contact engaging the conductive member at points spaced from its

inner edge, a terminal adjacent each end, the major portion of the inner edge of the resistance element being formed upon a substantially circular arc, and a curved recess in an intermediate portion of said inner edge whereby the cross
5 section of the resistance is gradually decreased and then gradually restored to normal width.

2. The method of making an arcuate resistance element of a predetermined value for a
10 variable resistance device, which comprises making a resistance element of arcuate form and with an inner edge formed on substantially a circular curve and with a resistance value less
15 than the value desired, determining the value thereof and then cutting away an intermediate portion of the inner edge to form a curved recess whereby the cross section of the resistance is gradually decreased and gradually restored to
20 normal width and the length of the inner edge increased, to raise the resistance value to the predetermined value while maintaining the general shape of the resistance curve.

NEWTON C. SCHELLENGER.