Aug. 15, 1939. N. C. SCHELLENGER 2,169,594

ELECTRICAL RESISTANCE AND METHOD OF MAKING SAME

Filed Oct. 12, 1935 2 Sheets-Sheet 1

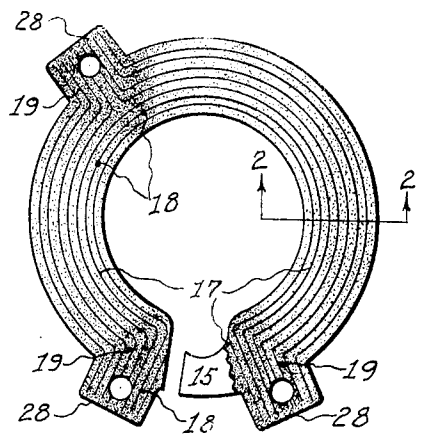


FIG. 1.

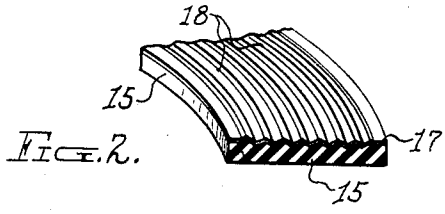


FIG. 2.

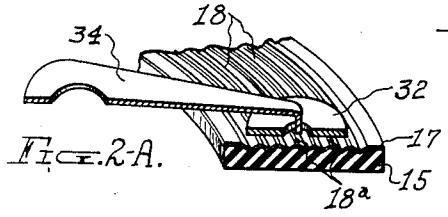


FIG. 2-A.

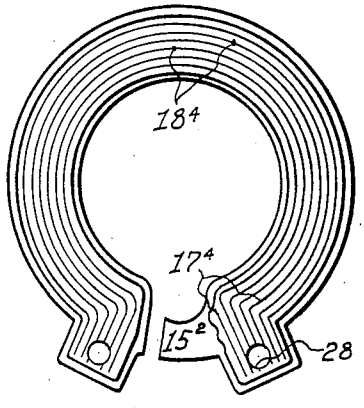


FIG. 3.

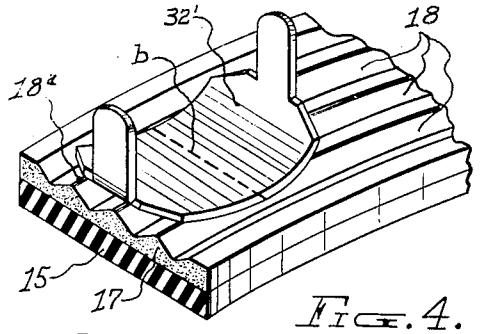


FIG. 4.

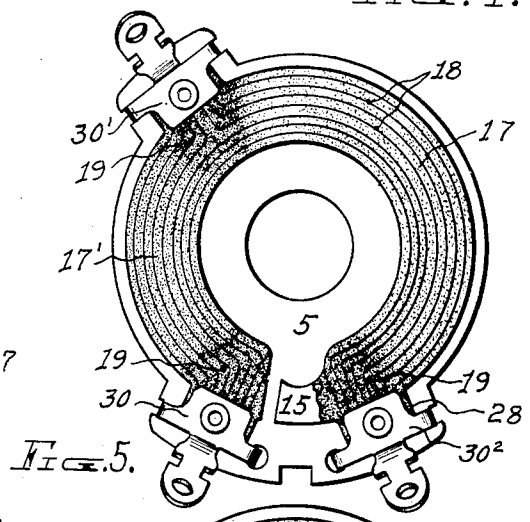


FIG. 5.

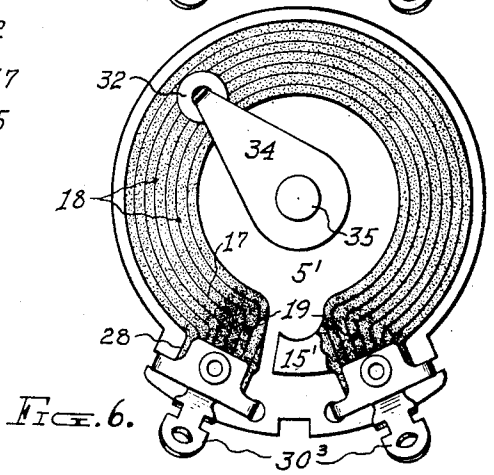


FIG. 6.

INVENTOR

NEWTON C SCHELLENGER

BY Leland Simpson

ATT'Y.

ELECTRICAL RESISTANCE AND METHOD OF MAKING SAME

Filed Oct. 12, 1935 2 Sheets-Sheet 2

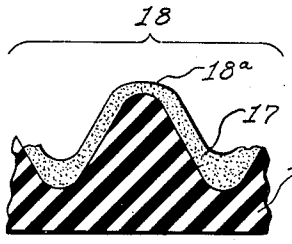


FIG. 7.

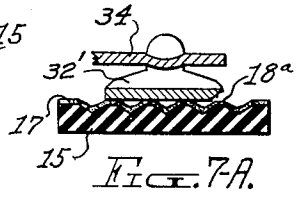


FIG. 7-A.

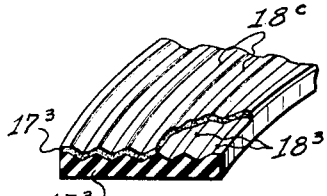


FIG. 8.



FIG. 8-A.

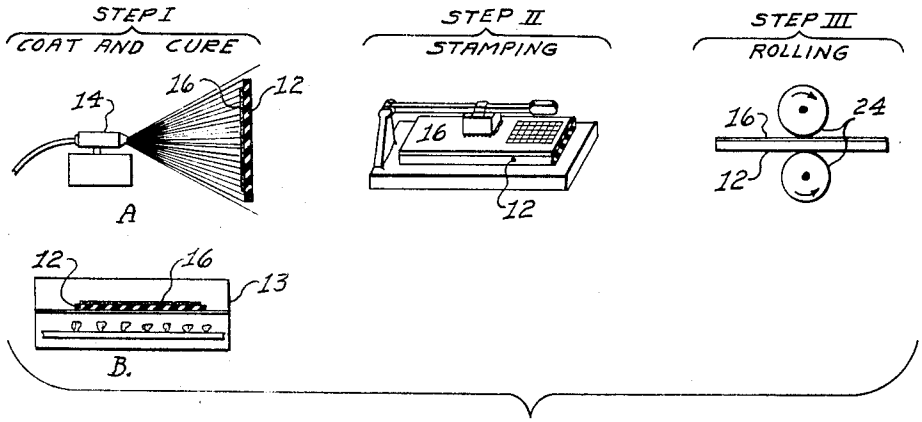


FIG. 9.

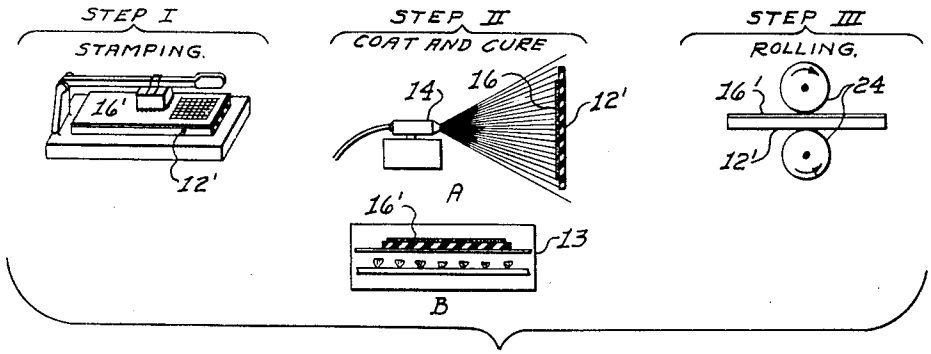


FIG. 10.

INVENTOR.

NEWTON C. SCHELLENGER.

BY. Cullen & Livingston ATT'Y.

Patented Aug. 15, 1939

2,169,594

UNITED STATES PATENT OFFICE

2,169,594

ELECTRICAL RESISTANCE AND METHOD OF MAKING SAME

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

Application October 12, 1935, Serial No. 44,693

2 Claims. (Cl. 201—73)

This invention is in part a continuation of my copending application Serial No. 732,604, filed June 27, 1934, for "Variable resistance devices," which has matured into Patent Number 2,118,112, and relates to electrical resistances and a method of making same, whereby constantly smooth, positive, uniform, and noiseless resistance variation and contact may be had in volume controls, rheostats and like devices useful in the radio and electrical arts generally.

My invention may be related more particularly to the class of resistance or control utilizing a resistive element comprised of a conducting agent carried in some form of binder or vehicle, such for example, as carbonaceous particles or graphite suspended in varnish.

Such a resistive composition results, upon the setting, curing, or drying of the binder, in an element having a characteristically, though minutely rough surface, often impossible of detection to the unaided eye, but visible under magnification, or otherwise evidenced by its unstable, erratic behavior in an electrical circuit where a wiping or similar variable contact is established with such surface.

However, the invention is not necessarily restricted to the carbonaceous type of resistor, but is equally applicable to other types, whether compositely or chemically formed, and broadly to any irregular resistive surface which can be impressed and/or rolled or distorted, substantially in the manner to be described.

In variable resistance devices employing a contact shoe or button adapted to move across a carbonaceous resistive surface, I find that the contact members do not consistently establish contact with the entire area engaged in any given position, but touch such surfaces indifferently at, and on, superficial points.

This appears to be due largely to the fact that the original surface of the resistive element is not itself perfectly smooth, even when treated by ordinary methods, but is minutely pitted, ridged or cratered.

Therefore, when the relatively smooth, plane surface of a contact shoe engages the relatively pitted surface of a resistance element of this class, a number of undesirable things result: among others, the tendency of the contact member or shoe to shift or rock from one minute point to another, giving rise to electrical disturbances, fluctuations, and noise in the output of the circuit under control.

There is a further tendency of the contactor to wear away the minute peaks and upstanding particles of the resistor surface and deposit them elsewhere along the contact path. Where such contact path happens to be one of changing resistance gradient, as is commonly the case—that is, where one section of the path may have a low unit resistance, while the section immediately adjacent has a much higher unit resistance—then the unit resistance value along one or another portion or region of such path will be altered and render the device useless for its designed purpose.

In cases where a high-resistance path of the order of 100,000 ohms or more must be crowded into a narrow section of the resistance element, say as much as a half inch or less of arc, the slightest shifting or fluttering of the contact shoe when in motion or at rest, due to dirt or minute resistive-surface irregularities, can cause a great change in the derived circuit resistance and derange the otherwise uniform operation of the control necessary in the sharply critical type of device now demanded in the radio and communication arts.

It is broadly an object of my invention to provide a resistance element having uniformly smooth contact surfaces and substantially unalterable overall resistivity and continuity.

More particularly, it is an object of my invention to provide by the method disclosed, a novel resistance element having surface conformations adapting it to constant, uniform, electrical and mechanical engagement by a movable contacting member.

Another object is the provision of a resistance element having a contactable surface of rolled configurations resulting in a plurality of contact surfaces lying in substantially concentric, radial paths relative to a contacting member.

Still another object of the invention is the provision of a novel resistance element or structure accomplishing the afore-mentioned objects, and additionally therewith the further object of preventing the migration or carrying-over of particles of the resistive substance onto other portions of the element by the contact member.

It is further an object of the invention to contribute to the art a novel resistance element having a ribbed, grooved, corrugated, or lined contact surface, deformed or pressed for the purposes, in the manner, and by the method herein set forth.

It is yet a further intention of my disclosure to accomplish successfully the foregoing several objects in a manner particularly distinguishing from any prior, known art in which irregular, roughened contact surfaces may have been ob-

tained or utilized, and/or in which various grooving and channeling expediencies may have been resorted to for the same or related purposes.

These and other objects residing in the invention will appear in view of the following particular description and the annexed drawings, in which like reference characters refer to similar parts, and in which:

Fig. 1 is a top plan view of one form of surfaced or processed element;

Fig. 2 is a fragmentary sectional view along the line 2—2 of Fig. 1, showing the contact ridging before it is rolled or deformed;

Fig. 2—A is a fragmentary sectional view taken along the line 2—2 of Fig. 1, similar to Fig. 2, except that the ridging has been deformed or reduced by rolling, and the view includes a contacting member;

Fig. 3 is a top plan view of an element showing a variant form of surface ribbing or grooving;

Fig. 4 is a magnified vertical section, in perspective, including a curved-faced shoe and showing radial contact along circumferential paths;

Fig. 5 is a top plan view of a mounted element having a variable resistance gradient;

Fig. 6 is a plan view of a complete control unit including a surfaced resistance element;

Fig. 7 is a magnified section of pressed ridging, and

Fig. 7—A shows sectionally and in greater detail the pressed marking of Fig. 7 relative to a contact shoe, similarly to the view of Fig. 2—A;

Fig. 8 is a magnified fragment in perspective of a modified form of element before rolling, while

Fig. 8—A shows the same fragment as Fig. 8, after rolling, in elevation;

Fig. 9 is a diagrammatic illustration of the steps of the process, and

Fig. 10 is a diagrammatic illustration of the steps in an alternative method of the process.

My one method of the invention, diagrammatically shown in Fig. 9, I employ a base of resinous or other insulating material 12 such as Bakelite, for example, and by a spraying or coating means 14 (step I-A) I apply a layer of carbonaceous or the like resistive material 16 thereto, which is allowed to set or may be cured to a state of near-plasticity by any usual means, as in the gas oven 13. (My application filed November 2, 1934, Serial No. 751,192, which has matured into Patent Number 2,061,107, discloses one method of spraying or coating resistive elements.) Thereafter, the coated strip 12 is subjected to stamping or imprinting, as indicated in step II of Fig. 9. Subsequently, in accordance with step III, the imprinted element 12 is subjected to rolling under appreciable pressure between rollers 24 having suitably uniform, polished, rolling surfaces whereby to level, lower, reduce or deform the markings of the imprinting step II.

The configuration resulting from the imprinting of step II is preferably in the nature of concentric ridges or ribs 18 (Figs. 1, 2, 5, 6) having sloping sides of a preferred pitch of about 60°, and otherwise formed somewhat in the nature of a machine thread, the peak or upper edge parts of which are rounded rather than sharp (see magnified view of Fig. 7) to prevent crumbling and facilitate the displacement of resistive matter under the rolling or reforming step.

Such a construction and configuration I find very closely approaches ideal performance and gives results superior to anything thus far available in the nature of an element for commercial production.

However, the imprint or surface marking may take the spiral configuration 18^4, as in Fig. 3, or other suitable forms. Where such other forms are contemplated, it is preferable that they result in closely contiguous or continuous ribs or ridges which will be to greater or less degree deformed or compressed under rolling pressure, and result in an approximately linear contact path or paths, substantially radial and concentric to the axis of the contact arm, it being emphasized that the higher the overall resistance rating of the element, the more closely is it desirable to approach the foregoing conditions.

An alternative method of producing a surfaced or processed resistance element in accordance with my invention, I show diagrammatically in Fig. 10, wherein a similar Bakelite or other like insulating base 12' is first stamped or imprinted with furrows, ridges, or indentations of desired configuration (similarly as in step II of Fig. 9), and thereafter the imprinted strip 12' is spray-coated, painted, or otherwise provided with a layer of resistance material 16' (Fig. 10, step II–A) as was done in step I of Fig. 9, and after suitably drying or setting by any usual means, or in oven 13, to the requisite degree of plasticity, depending in each case upon the constituency of the coating used and the physical properties of the base stripping or stock selected, the imprinted strip 12' with its resistive agent 16' is rolled as shown in step III of Fig. 10, thus depressing, deforming, reducing, relieving, or flattening the ribbing previously imprinted and at which the coated resistive matter will conform itself.

The structure resulting from this alternative method gives results substantially equivalent to those effected by the method of Fig. 9. A detailed perspective of such resulting structure is shown in Figs. 8 and 8—A, wherein a base member 15^3 has first been stamped with ridges 18^3 and thereafter the resistive coating 17^3, of proper plasticity or body for rolling, is laid down and finally the coated strip and ridges 18^c are rolled to give the contact surfaces 18^b, Fig. 8—A.

It should be particularly observed, that by either of the forms of my method herein set forth, the resistive part of the element is provided with a surface having relatively recessed and standing portions in the general nature of furrows, ridges, or bossing, susceptible by virtue of shape and dimension (the latter being obviously relative to the constituency and size of cabonaceous matter in the resistive coating used, as will readily appear to those skilled in the art) to uniform rolling or similar reforming. The impressed configurations may or may not be forced into the base member under the method of Fig. 9, depending upon the degree of pressure used and the hardness of the base material. In Fig. 4, the base is shown undeformed.

An important function of such recessed structure, in general, (as pointed out broadly in my co-pending application identified above) is that of trapping or settling-down any particles of resistive matter (e. g., carbon or graphite) which may be worn off by the movement of the contact member. In this respect, the concentric grooving of Fig. 1 herein is notably effective, and the spiral configuration 18^4 shown in part of Fig. 3 is also desirable.

By rolling such surface indentations, a further highly important result is achieved, namely, a relatively smooth, compacted contact surface

of uniform level across the path of the contactor, and over and along the relieved portions.

The reason for this is believed to lie in the fact that the minute disturbing particles otherwise normally present on such surface are more readily displaced and dispersed by the general redistribution and distortion which takes place in the mass of resistive material (and to less degree in the base) when the surface is rolled or compacted, some of the displaced mass of course tending to shift toward the recessed regions, particularly from and about the peak or ridge portions of the indentations.

This latter provision of the invention also, in part, distinguishes it importantly from known art and practices.

After the processed element has been installed in a control, there is some further surfacing by the wear of the contact shoes, which in any case have relatively fine surfaces (and which are often gold plated) so that within certain limits, the performance resulting from this novel structure tends to improve with use, in contrast to the old types where the wearng down of one irregular spot merely exposed others and thus contributed little if anything toward improving continuity.

It will be further observed that with this novel element, the contact shoes, whether of the flat, button type of Fig. 2—A or the arcuate-faced, rocking type of Figs. 4 and 7—A, cannot establish the haphazard contact usual with the prior, rough-surfaced elements.

Perfect continuity is possible with the present element not only because the surfaces actually contacted are rendered relatively free from imperfections, but also because a plurality of such surfaces lie in a path radial to the axis of the contacting means, as well as circumferentially or concentrically progressive thereto.

This being one of the highly important features of the invention, it cannot be too greatly emphasized that the "continuity" sought should lie directionally along the path of rotation of the contactor, and, when the contactor is at rest or in motion there should also be continuity in a radial direction. This is intended to be shown quite clearly in Fig. 4, where a rocking type of contactor **32'**, has its face curved convexly in the direction of its travel, so that the actual contact area of the shoe is the narrow band *b* indicated in dotted lines.

In this figure, contact is shown made along a radial path *b* with the three tracks or ridges **18**, (see also the sectional view of Fig. 7—A) and it will be appreciated from mere inspection of this figure how continuity along the arcuate path of travel may be maintained with either or all of the three ridges **18**, and the processed surfaces **18a**. It should also be observed in this figure the manner in which the three radial points (surfaces) of contact along the path *b* tend to stabilize the shoe in this (radial) direction.

In Fig. 1, I show a novel resistance element, made in accordance with the provisions of my invention, which comprises an annularly shaped base member **15** of insulating material, having co-extensive connection tabs **28**, and on said member a layer of carbonaceous resistive substance **17**, in which are deformed or repressed ribbings or channels **18**, arranged concentrically, but branching onto the said tabs **28**, where good, low resistance, electrical connection may be made with lugs **30**, (which are adapted to be crimped or otherwise secured to these tabs as in Fig. 5) by means of a relatively heavy coating of low resistance carbonaceous paint **19** applied in the region of these tabs **28**, and which overlies the high resistance coating **17** in and about the grooves **18** and under the riveted portions of lugs **30**. (For a more particular discussion of this construction, reference is made to my co-pending application mentioned above.)

Where a variable overall resistance gradient is desired, successive layers of resistive material **17'** (Fig. 5) are applied over the basic, high-resistance layer **17**, with suitable low-resistance connection being made in the manner just described, to corresponding connection lugs **30**, **30'** or **30²**, on tabs **28**.

An enlarged study of the channels or tracks **18** is particularly shown in the perspective section of Fig. 2, which represents the annular punching **15**, cut along the line **2—2** of Fig. 1, and is intended to illustrate the raised initial condition of these markings **18** before being rolled, (see also Figs. 7 and 7—A) showing the insulating base **15**, the resistive layer **17**, and the imprinted channels or tracking **18**.

In Fig. 2—A, the section of Fig. 2 is shown, after a rolling or reducing of ridging **18**, which results in a narrow contact path or surface **18a** which is very nearly flat and practically free from superficial particles and irregularities. A control contact member or shoe **32** on contact arm **34** shows relatively the nature of the multiple radial and arcuate or concentric contacts established thereby with the pressed or relieved surfaces **18a** on the ridges **18**.

The relative disposition of elementary parts, including a form of my novel resistance element, as embodied in an operative control unit, is illustrated in Fig. 6, showing a mounting member **5'**, a resistant element including the base **15'**, resistive coating **17**, and channeling **18** therein, and a contact shoe **32** on arm **34** rotatable about the shaft **35**. This view also shows the secondary low-resistance terminal coating **19** leading under lugs **30³**.

As already pointed out, my invention is not restricted to the preferred concentric ridging shown in Fig. 1, but may be modified to include other desirable configurations and conformations accomplishing substantially the same objects. Such contact surfaces are desirably the result of deforming, or compressing resistive matter which has been either formed about predetermined basic conformations, or has been pressed into corresponding configuration, subsequently to be further treated in accordance with my method.

A further modification in configuration, already referred to in part, and one that results in an element comparable in performance to my preferred form of Fig. 1, is that of a slowly progressive spiral **18⁴** generated relatively about the axis of the contact shaft or corresponding center of the element itself, as illustrated in Fig. 3. Somewhat the same results are achieved where the concentric circles of Fig. 1 are laid slightly off center relative to the axis of the control shaft.

The spiral form of track or ridge has the additionally desirable feature of cleansing or brushing the contact shoe and preventing formation of grooves therein, for the reason that the ridges progress not only in an arcuate sense, but also angularly across the face of the shoe in cycles as it travels about its axis, in a manner simulating a sweeping motion which tends to push any adhering carbonaceous dust off the shoe face.

It should be remarked that, in general, not only should the several rolled surfaces resulting

from a given conformation or configuration be relieved of minute superficial irregularities, but they should stand at substantially uniform level throughout the contact path to prevent any shifting of the contact shoe along radial lines, as from an inner ring surface to an outer one (see Figs. 2—A, 4 and 7—A), since such shifting, whether due to superficial particles or dimensional variations, is a source of serious derived circuit disturbance. Hence the rolling or reforming process must also be directed toward this end.

While I have illustrated and particularly described a preferred method and preferred resulting structure in accordance with the provisions of my invention, as well as suggested modifications thereof, it will be apparent that further modifications might be made without departing from the scope of the invention, and I do not desire to be restricted or limited to the precise details set forth herein, except as may be provided in the appended claims, which I desire to protect by Letters Patent.

I claim:

1. A method of making resistance elements which comprises applying a resistive coating of carbonaceous paint to a surface, heat-curing said paint, stamping formations which have relatively narrow top portions therein, and compressibly reforming said formations to produce substantially flat, contiguous contact surfaces thereon.

2. The method of making a resistance element which comprises spraying a resistive coating onto a base member, curing said coating to produce a hard dense film, stamping ridge-like grooves therein, and rolling said stamped portions to produce substantially flat, contiguous contact surfaces thereon.

NEWTON C. SCHELLENGER.