

March 22, 1938.

N. C. SCHELLENGER

2,111,809

CONTROL DEVICE

Filed Oct. 7, 1933

3 Sheets-Sheet 1

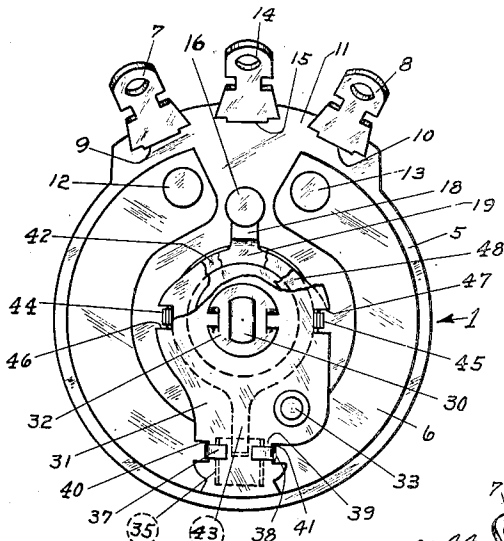


Fig. 3.

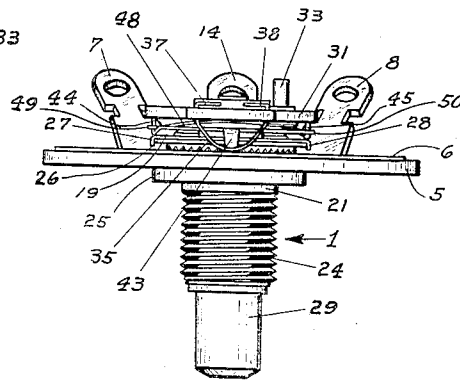


Fig. 2.

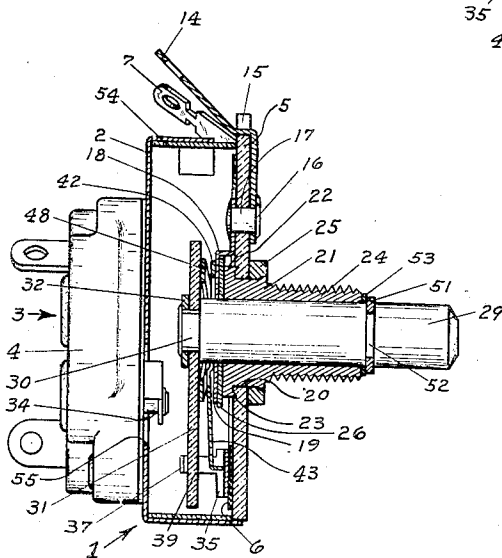


Fig. 1.

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3 Sheets-Sheet 2

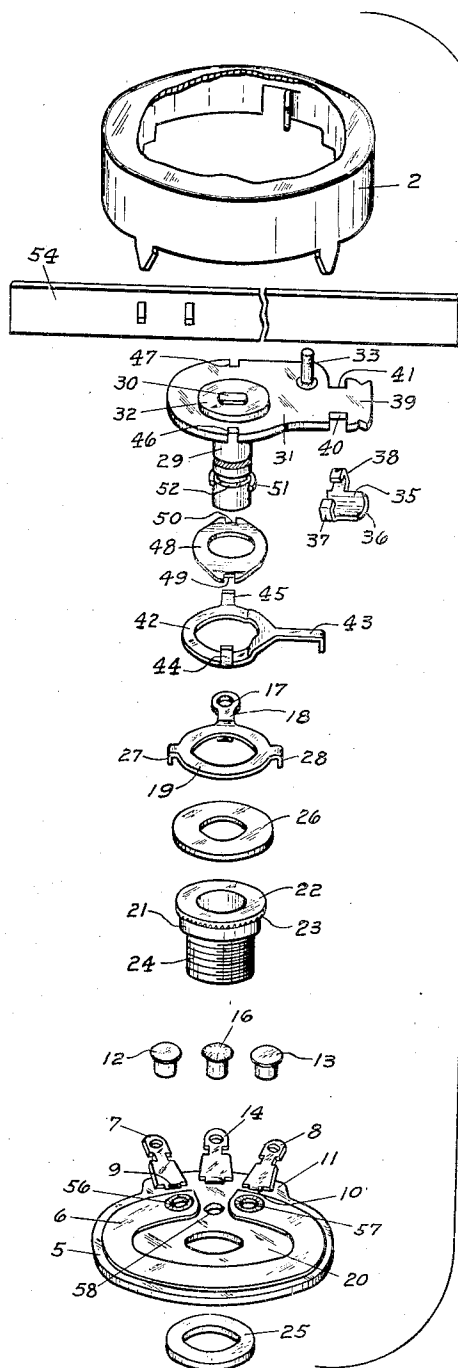


Fig. 4.

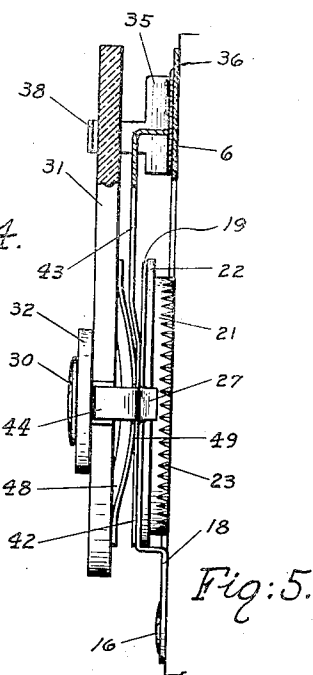


Fig. 5.

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3 Sheets-Sheet 3

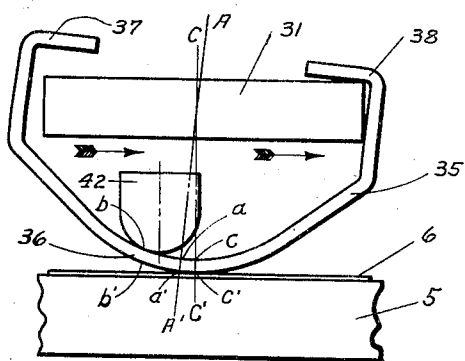


Fig: 6.

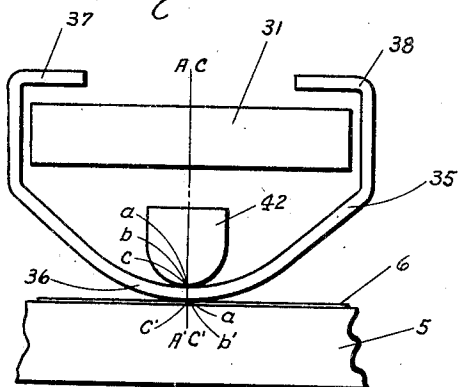


Fig: 7

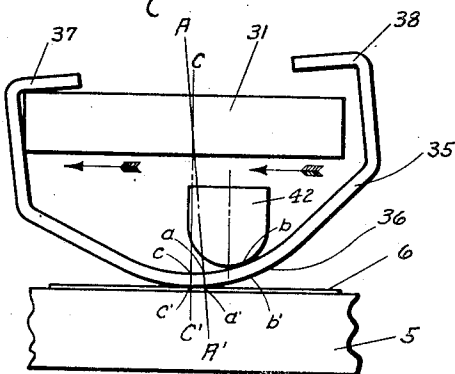


Fig: 8

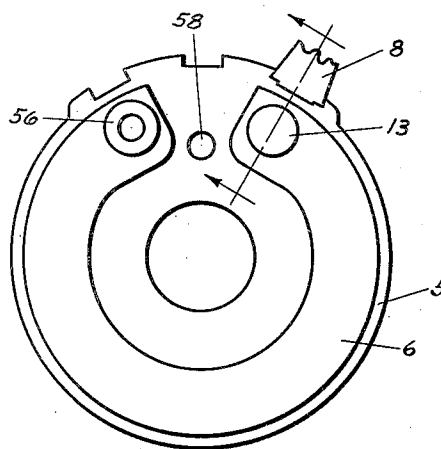


Fig: 9.

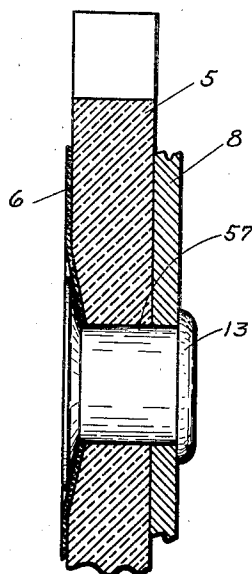


Fig: 10

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UNITED STATES PATENT OFFICE

2,111,809

CONTROL DEVICE

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Application October 7, 1932, Serial No. 692,665

9 Claims. (Cl. 201-55)

This invention relates to control devices for electric circuits and particularly to variable resistance units for use in radio sets.

More particularly the invention relates to a variable resistance device adapted for connection in a volume control circuit and including a resistance element provided with terminals for connecting the resistance element in the circuit and a contactor connected to the circuit and arranged to sweep over the surface of the resistance element in contact therewith for varying the effective resistance of the circuit.

In certain circuits, for example radio set circuits, and especially radio circuits of the "high gain" type, it is important that the variable resistance devices be so constructed that a smooth, continuous variation of effective resistance may be accomplished by the movement of the contactor over the surface of the resistance element. Heretofore, it has been found difficult to construct a variable resistance device or rheostat wherein the variation in effective resistance could be effected smoothly. The devices of the prior art are subject to the disadvantages that undesired voltage changes are introduced at the volume control device owing to unintended sudden variations in resistance occurring as the contactor is moved over the surface of the resistance element. Such undesired variations in voltage in the volume control circuit are amplified and reach the reproducer circuit as relatively high voltage variations and consequently cause loud and undesirable noises in the reproducer.

I have found that such undesired voltage variations are the result of a plurality of causes but principally are due to the nature of the contact between the contactor and the resistance element. As is well known, the surface of any material, irrespective of how smooth it may appear, is more or less rough and it is impossible, as a practical matter, to make any two surfaces actually contiguous except at a few spaced points. When the contactor of a rheostat is placed in contact with the surface of the resistance element, the surfaces touch at but a few spaced points, and especially in volume control control units wherein the contact area of the contactor is usually of relatively small size.

As the contactor is moved over the surface of the resistance element, various points on the two surfaces are brought into mutual contact and then separated and the point of contact shifts relatively to a fixed point on the contactor. Since these points of intermittent contact are

on different portions of the active surface of the contactor with respect to any fixed point on the contactor, and since, in the usual type of contactor the active area has appreciable length in a direction longitudinally of the direction of movement of the contactor toward and away from the terminal or terminals, it will be apparent that, as the contactor is moved and mutual contact is successively made and broken between the surfaces, at spaced points thereon, the distance between such points of contact and the terminal or terminals will vary in a manner different than the distance from a fixed point on the surface of the contactor. In other words, when the contactor is moved, the effective point of contact shifts nearer to or farther away from the terminal or terminals in a manner not in accordance with the movement of a fixed point on the contactor relatively to the terminal or terminals and hence the effective length of the resistance element connected in circuit with the contactor and consequently, the effective resistance does not vary in accordance with the position of the contactor relative the terminal or terminals. The effective resistance will increase or decrease erratically and in jumps and this will result in undesirable disturbances at the reproducer.

A further unevenness in variation of effective resistance results from the "stopping" or "bouncing" of the contactor as it is moved over the surfaces of the resistance element. As is well known, when a resiliently supported member is pushed along a surface with which it has pressure engagement there is a tendency, especially if one or both of the surfaces is slightly rough, for the moving member to stop intermittently due to frictional resistance and then suddenly jump forward. It will be seen that if this is permitted to occur in a volume control device, the effective length of the resistance element will vary erratically and undesirable variations in voltage will be produced with the consequent undesirable disturbances in the radio circuit and objectionable noises at the reproducer.

One of the objects of my invention is the provision, in an electric control device, of a variable resistance device wherein the effective resistance of the device may be adjustably varied in a predetermined manner without irregularities and without the introduction of uncontrollable and undesirable variations in effective resistance.

Another object of the invention is the provision of a variable resistance device which will be strong and rugged, compact and efficient and

which will be inexpensive to and practicable of manufacture.

Another object of the invention is the provision, in a variable resistance device of the type having an arcuate resistance element and a contactor actuated by an arm for movement over the surface of the resistance element, of a novel type contactor and a novel supporting and actuating mechanism therefor.

Another object of the invention is the provision, in a variable resistance device, of a novel resistance element which has great durability and which will not change materially in electrical characteristics throughout a long period of use even though subjected to adverse conditions such as heating, moisture, vibration and the like.

Other objects of the invention will appear from the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a side elevational view partly in cross-section showing, by way of illustration, a combined switch and variable resistance device embodying the invention;

Fig. 2 is an end elevational view of the variable resistance device with the casing member removed;

Fig. 3 is a top plan view of the variable resistance device, with one portion of the casing removed and portions of the parts broken away to show the construction;

Fig. 4 is an exploded view of the rheostat portion of the device, the switch and its housing being omitted;

Fig. 5 is an enlarged fragmentary side elevational view, partly in cross-section, showing certain details of construction;

Figs. 6, 7, and 8 are enlarged diagrammatic fragmentary views, with certain proportions exaggerated, illustrating the operation of a portion of the device;

Fig. 9 is a top plan view showing the base member with one terminal in position; and

Fig. 10 is a fragmentary enlarged view, partly in cross-section, showing a portion of the resistance element.

In Fig. 1 is shown a combined rheostat and switch device consisting of a rheostat unit 1 including metallic cup-like casing member 2 and a switch unit 3 including a cup-like casing member 4 formed of insulating material and secured to the outside of the rheostat casing member 2.

The rheostat 1 with the casing member 2 removed is shown in Figs. 2 and 3 and comprises a disc-like base member 5 formed of insulating material and having thereon a flat annular coating of carbonaceous coating material, the top surface portion of the base member 5 thus constituting a resistance element 6. Two terminal members 7, 8 are locked by means of integral, laterally extending wing portions, in slots 9, 10 formed in a laterally projecting portion 11 of the base member 5 and are secured to the base 5 by rivets 12, 13, which latter constitute electrical connections between the terminal members 7, 8 and the end portions of the resistance coating 6, respectively.

A third terminal member 14 is disposed between the other terminal members 7, 8, and is likewise locked in a slot 15 and is secured to the base member 5 by a rivet 16, the rivet 16 passing through a perforation 17 in a laterally projecting portion 18 of an annular current collector 19, disposed on the same side of the base 5 as the resistance coating 6.

The base member 5 is provided with an axial perforation 20 through which extends a cylindrical

bushing 21 having on one end a shoulder 22 lying against the base 5, the edge of the shoulder 22 being knurled to provide a series of teeth 23 which bite into the base member 5 to secure the bushing 21 against rotation in the base member 5; this bushing has at its other end a threaded extension 24 to receive a mounting nut (not shown); the bushing 21 is secured to the base member 5 by a friction washer 25 which latter is locked on the bushing 21 by peening or swaging an edge of the bushing against the washer 25. The shoulder 22 of the bushing 21 projects from the base member 5 to provide a raised seat for the current collector 19 which latter is axially aligned with the bushing 21 and insulated therefrom by an insulating washer 26. The current collector 19 has an opening considerably larger than the diameter of a shaft 29 and is positioned about the shaft and prevented from contacting the same by a pair of ears 27, 28 which engage the periphery of washer 26. The washer 26 is provided with an opening to fit snugly about the shaft.

The shaft 29 is journaled in the bushing 21 and has a flattened end portion 30 carrying a flat plate-like actuator 31 formed of insulating material and seated against the shoulder formed by the flattened portion 30 of the shaft 29. A washer 32 against which the end 30 of the shaft 29 is riveted, clamps the actuator 31 against the shoulder. The actuator 31 lies in a plane parallel to the plane of the base member 5 and spaced therefrom. Extending from the actuator 31 and parallel to the axis of the shaft 29 is a metallic pin 33 positioned to engage a switch actuating cam 34 constituting a portion of the switch unit 3.

Disposed in contact with the resistance element 6, and arranged to sweep over the surface thereof, is a contactor 35 formed of a thin strip of metal and having a curved portion 36, the bottom surface of this portion being thereby adapted to make line contact with the surface of the resistance element 6, which line extends radially of the resistance element 6, and transversely of the direction of movement of the contactor 35 on the resistance element 6. A pair of oppositely disposed ears 37, 38 extends from the side edges of the curved portion 36 of the contactor 35. The end portions of the ears are straight and are bent inwardly and formed with right angle bends whereby the extreme end portions lie in a plane substantially parallel to the plane of the actuator member 31 and the portions adjacent the extreme end portions lie substantially in parallel planes at right angles to said extreme end portions. The end portions of the ears 37, 38 are bent around a neck 39 of the actuator formed by oppositely disposed slots 40, 41, and are positioned to be engaged alternately thereby to pull or draw the contactor from a point spaced in advance of the line of contact between contactor and resistance element.

A conductor 42 formed of spring material and having an annular form, with an arm 43 extending laterally therefrom is disposed with the axis of its annular portion aligned with the axis of the annular portion of the current collector 19 and the arm 43 extending to the contactor 35, the extreme end of the arm 43 being bent at right angles to the principal portion thereof. The end edge of the arm 43 is arcuate and bears upon the top surface of the contactor 35 to press the latter into firm contact with the resistance element 6. The conductor 42 is positioned by a pair of ears

44, 45 bent up from diametrically spaced points on the annular portion and entering suitably positioned notches 46, 47 formed in the actuator.

A warped spring washer 48 having notched, radially projecting ears 49, 50 is interposed between the actuator 31 and the conductor 42 for pressing the latter against the current collector 19 and is positioned by the ears 44, 45 of the conductor 42 which extend through the notched ears 49, 50 in the washer 48. The shaft 29 is held in the bushing 21 by a split washer 51 engaging a peripheral slot 52 formed in the shaft 29 and is spaced from the end of the bushing 21 by a thrust washer 53.

The arm 43 of the conductor 42 and the annular portion adjacent the arm 43 are offset from the plane of the remainder of the annular portion which raises the juncture of the arm 43 and annular portion out of contact with the collector 19 thereby giving the arm a greater free length; thus increasing its range of spring movement and making the pressure it will exert upon the contactor 35 less critical of adjustment.

The rheostat member is assembled in the casing member 2, the side wall of which supports an insulating strip 54, the base member 5 constituting with the casing member 2 a rheostat housing. The switch unit 3 is suitably mounted in the end wall of the casing member 2, the switch actuating cam 34 extending through a perforation 55 in the end wall of the casing and lying in the path of movement of the pin 33.

The manner of employing and the operation of the device is as follows:

The rheostat unit 1 may be connected as a voltage divider, in which case the side terminals 7, 8 and the center terminal 14 are connected to the circuit conductors (not shown). If the rheostat unit 1 is to be employed as a simple rheostat, only one of the side terminals (7, for example) and the center terminal 14 are connected to the proper circuit conductors (not shown).

The effective resistance connected in the circuit is adjustably varied by rotating the shaft 29, which, through the agency of the actuator 31 and conductor 42, pulls or draws the contactor 35 along the surface of the resistance coating 6 to a position wherein there will be connected between the contactor 35 and the terminal 7 a length of the resistance element 6 corresponding to the desired resistance whereby the desired amount of resistance is connected between the terminal 7 and the contactor 35.

The electric circuit may be traced from the side terminal 7 through the resistance element 6 to the contactor 35, from the contactor 35 through the conductor 42 to the current collector 19 and through the latter and its securing rivet 16 to the center terminal 14. If the rheostat 1 is connected as a voltage divider, there is, in addition, a circuit from one side terminal (7, for example) to the other through the resistance element.

In Fig. 6 is shown certain of the parts in the positions which they assume, during the rotation of the shaft 29 in a counter-clockwise direction, (as viewed in Fig. 3). It will be seen that the actuator 31 bears against the leading ear 36 of the contactor 35 to exert a dragging action upon the contactor 35, drawing the latter over the surface of the resistance element 6. The contactor 35, which is driven by the neck portion 39 of the actuator 31 engaging the upstanding ears 37, 38 of the contactor, assumes the position shown in Fig. 6. In this position, the plane (A-A'), which includes the center-line of curved portion 35 of the

contactor 35 intersects the top surface of this portion of the contactor 35 at a point (a) lying between the point of contact (b) of the conductor 42 with the top surface of the contactor 35, and the point of intersection (c) between the top surface of the contactor 35 and the plane (C-C') which plane passes through the point (c') where the bottom surface of the contactor 35 touches the resistance element 6.

When the shaft 29 is rotated in the opposite direction (clockwise, as viewed in Fig. 3), the parts are moved to the positions shown in Fig. 8. During this movement, as the actuator 31 is moved away from the now trailing ear 38 of the contactor 35, the conductor 42 does not move with the actuator 31, because of the play provided between the ears 37, 38 of the contactor 35 and the actuator 31, and the conductor 42 presses against the top surface of the contactor 35 at a point (b) on the portion of the contactor 35 that is out of contact with the resistance element 6 and causes the contactor 35 to rock on the resistance element 6 toward the position shown in Fig. 8. The friction between the spring washer 48 and the actuator 31 is less than the friction between the conductor 42 and the current collector 19, whereby the conductor 42 is not moved until the ears 44, 45 thereof are engaged by the edges of the slotted portions of the actuator 31.

Prior to the time the ears 44, 45 of the conductor 42 are engaged by the edges of the slotted portions of the actuator 31, the neck portion 39 of the actuator 31 engages the now leading ear 37 of the contactor 35 and draws the contactor 35 along the resistance element 6, the conductor 42 remaining stationary with respect to the resistance element 6, thus effecting a wiping action between the surface of the conductor 42 and the upper surface of the contactor 35 to thereby clean and polish the contact areas. Upon continued movement in a single direction by the actuator 31, the ears 44, 45 of the conductor engage the edges of the slotted portion of the actuator 31 and the contactor 35 and conductor 42 are moved as a unit, the latter serving to maintain a steady pressure of the contactor 35 against the resistance element 6, and also serving to conduct the current from the contactor 35 to the current collector 19.

When the ears 44, 45 of the conductor 42 are engaged by the notched portions of the actuator 31, the parts assume the positions shown in Fig. 8, wherein the actuator 31 bears against the now leading ear 37 and the conductor 42 bears upon the top surface of the contactor 35 at a point back of the center-line of the contactor 35. It will be seen that the parts have the same relative positions as shown in Fig. 7 except that the positions are reversed.

From the foregoing it will be seen that this invention provides a variable resistance device or rheostat wherein the contactor makes line contact with the resistance element in a direction transverse to the line of movement of the contactor. Such an arrangement insures that the length of resistance element connected between the contactor and the respective terminals will vary in a predetermined manner as the contactor is moved over the surface of the resistance element. It will be seen that there can be no undesired variations in the effective length of the resistance element in circuit between the resistance element and the respective terminals because there can be no appreciable shifting along the line of movement of the contactor, by the point of contact between the contactor and the resistance element due to

high and low spots in the contacting surfaces. Since the line of contact extends in a direction normal to the direction of movement of the contactor, the only shift in the effective point of contact is along this line and hence no appreciable change in the length of effective resistance can take place except that due to the predetermined movement of the contactor.

The conductor exerts a force to press the contactor into engagement with the resistance element and hence a large number of points on the contact and lying along the line of contact with the resistance element are brought into engagement with the resistance element. Since the contactor is not rigidly fixed to the actuator and since the conductor bears upon only a small area of the top surface of the contactor, the latter is free to rock laterally to accommodate itself to any irregularities in the surface of the resistance element.

Inasmuch as the conductor presses the contactor firmly against the resistance element and the arm of the conductor has a relatively long free-swinging length, there is no appreciable tendency for the contactor to bounce, whether induced by the roughness of the surface of the resistance element or due to vibration of the rheostat, but a uniform pressure is maintained.

Certain changes may be made in certain features of the construction without affecting the operation or novel advantages. For example, the lost motion between the conductor and the actuator may be eliminated and the conductor fixed rigidly to the actuator. In this case, the conductor will not ride up on the contactor as explained in the foregoing but will serve to press the contactor against the resistance element and will electrically connect the contactor with the circuit; furthermore, there will also be a wiping action between the conductor and the contactor since the conductor will be drawn across the surface of the contactor as the actuator moves out to engage either of the angle portions of the ears of the contactor.

In Figs. 9 and 10 is shown the base member and one of the cooperating terminals. The base comprises a flat disk of insulating material 5 having perforations 56, 57, 58 extending therethrough to accommodate the terminal rivets 12, 13, 16. The perforations 56, 57 are countersunk to receive the beveled head portions of the rivets 12, 13 whereby the tops of the head portions lie flush with the top surface of the base member 5.

Before the terminals 7, 8 and 14 are assembled in the base member 5, the latter is shielded at the central and marginal portions thereof and a carbonaceous conducting material is sprayed on the top surface of the base member 5 and on the surfaces of the countersunk portions of the perforations 56, 57 to deposit a conductive layer having an annular shape, as shown.

The coating material comprises finely divided conductive particles, for example, of graphite, dispersed in a suitable binder. The binder is a hard, smooth and non-hygroscopic material which will not deteriorate, wear unduly, or suffer a change in its electrical characteristics under adverse conditions of electrical use, friction, temperature, relative humidity or vibration and which has no tendency to check, peel or raise from the supporting member. Compositions of the vinyl resin group, for example, the composition commercially known as "Vinylite", and compositions of the nitrated cellulose group, such as pyroxylin are suitable for use as a binder.

Alternatively, the central portion only of the base member 5 is shielded, and the layer on the marginal portion of the base member 5 is scraped off in a suitable manner, as with a scratch brush.

The terminal 8 is attached by the rivet 13 which is seated in the perforation 57 with its beveled edge pressing against the coated, countersunk portion of the perforation 57 whereby good electrical contact is made between the head of the rivet 13 and the conducting material. The top surface of the head of the rivet 13 is only slightly below the surface of the resistance element 6 and thus a substantially uniform contact pressure is insured between the contactor 35 and the resistance element 6 as the contactor 35 is moved over the surface of the resistance element and onto the top surface of the rivet 13.

Alternatively, instead of the foregoing type of resistance element, there may be provided a resistance element of the type disclosed in certain of my copending applications and comprising a strip of paper coated with the carbonaceous conducting material and adhesively secured to the base member.

It will be understood that, in the foregoing and in the appended claims, the expression "line contact" is not to be limited to a theoretical line, that is, a mathematical entity having length but no breadth. It is obvious that such a result can not practically be achieved and therefore the expression "line contact" is to be taken to mean a line of contact having no appreciable breadth and as near to a theoretical line as is practicable to produce.

While I have shown and described the invention with particular reference to a combined switch and variable resistance unit for use in radio sets, the invention is not limited thereto and it is obvious that the invention advantageously may be practiced in any variable resistance device of the same general type, whether large or small, single or multiple unit, or whether alone or combined as a unit with other electrical devices or whether for use in radio or in other electrical circuits.

I claim:

1. In a variable resistance device, a resistance element, a contactor bearing upon said resistance element, actuating means including a drive member for effecting sliding movement between said contactor and said resistance element, a conducting element disposed in contact with said contactor and lost motion means connecting said contactor and said conducting means to said drive member whereby upon movement of said actuating element relative to said resistance element, said contactor is subjected to a rocking movement upon said resistance element, said conducting element being movable relatively to said contactor and along the surface thereof and said contactor and said conducting element being movable relatively to said resistance element.

2. In a variable resistance device, in combination, a resistance element, a contactor having a curved surface positioned to bear upon said resistance element, an actuating element for drawing said contactor in sliding contact with respect to said resistance element, a conducting element disposed to bear upon said contactor, means mounting said conducting element for limited sliding contact with respect to said contactor, and means actuated by the movement of said actuating element relative to said resistance element for effecting a rocking movement of said contactor on said resistance.

3. In a variable resistance device, a base, flat resistance means thereon, a contact shoe having a curved surface bearing upon said resistance means, and having substantially line contact therewith, a shaft extending through said base, an actuator on said shaft and positioned to engage said contact shoe for effecting sliding contact relative to said resistance means in a direction transverse to the line of contact between said shoe and said resistance means, a current collecting element carried by said base, a spring conductor bearing against said contact shoe and against said current collecting element, means connecting said contact shoe to said actuator and effective upon movement of said actuator, to rock said shoe relative to said resistance means, and means connecting said conductor to said actuator and effective, upon a predetermined extent of movement of said actuator, for moving said spring conductor relative to said contact shoe.

4. In a variable resistance device, a base, resistance means fixed thereto, a shaft extending through said base, an actuator on said shaft and movable relative to said resistance means, a contact shoe formed to make substantially line contact with said resistance means extending transversely of the line of movement of said shoe relative to said resistance means, lost motion means connecting said shoe to said actuator for effecting movement of said contact shoe on said resistance means consequent to the initial movement of said actuating arm from rest in any position, a spring conductor, and a second lost motion means positioning said spring conductor in contact with said contact shoe for holding the latter in contact with said resistance means, said last named lost motion means connecting said conductor to said actuator for movement thereby.

5. In a variable resistance device, in combination, a resistance element, a contactor slidable on said resistance element and formed to make line contact therewith along a line extending normal to the direction of movement of said contactor, a drive arm for imparting motion to said contactor, lost motion coupling means between said arm and contactor,

a resilient conductor engaging a surface of said contactor to make electrical connection therewith, the conductor urging the contactor against the resistance, and means mounting said contactor and said conductor for mutual wiping engagement.

6. In a variable resistance device, in combination, a base, resistance means, a contactor slidable on said resistance means and having a surface making transverse line contact with said resistance means, a current collector mounted on said base, a conductor, and means mounting said conductor for rubbing contact with said collector and said contactor, said conductor being the principal means of electrical connection between said collector and said contactor.

7. In a variable resistance device, in combination, a resistance element, a contactor positioned for sliding engagement with said resistance element, a non-conducting actuator for pulling said contactor over said resistance element, and a resilient current carrying conductor spaced from said actuator engaging the contactor and pressing said contactor against said resistance element.

8. In a variable resistance device, in combination, a resistance element, a contactor positioned for sliding engagement with said resistance element, actuating means including an insulating member for pulling said contactor over said resistance element, and a resilient current carrying conductor engaging the contactor and pressing said contactor against said resistance element.

9. In a variable resistance device in combination, a resistance element, a contactor slidably positioned on said resistance element, actuating means including an insulating member for imparting motion to said contactor, a resilient annular conductor having an arm extending therefrom for pressing said contactor against said resistance element, said arm and a portion of said annular conductor being offset from the remainder of said annular conductor for increasing the range and effectiveness of said spring arm.

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