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N. C. SCHELLENGER

1,903,142

RESISTANCE STRIP AND METHOD OF MAKING SAME

Filed April 30, 1930

Fig. 1.

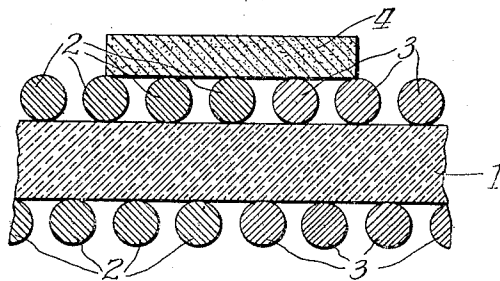


Fig. 2.

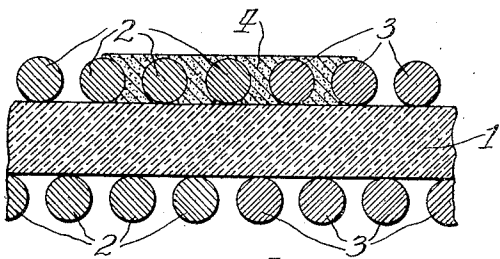


Fig. 3.

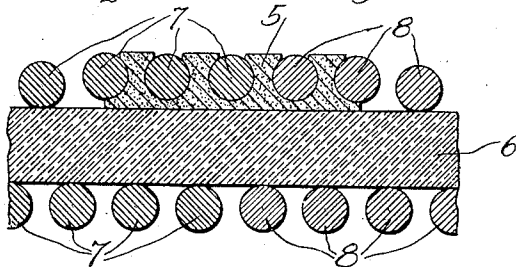


Fig. 4.

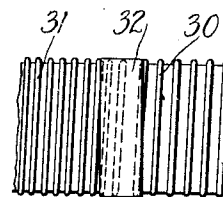
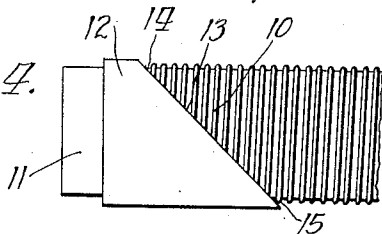


Fig. 5.

Fig. 6.

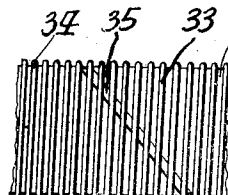
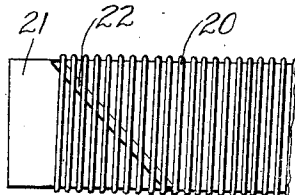


Fig. 7.

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RESISTANCE STRIP AND METHOD OF MAKING SAME

Application filed April 30, 1930. Serial No. 448,520.

This invention relates to resistance strips and to the method of making such strips.

Resistance units in the form of rheostats containing a high resistance wire wound element and suitable contacting means for engaging that element to vary the resistance of a circuit, are commonly used as volume controls for radio sets, control resistors for X-ray apparatus, and other similar uses. In order that the control devices may be made compactly, it is customary to wind the resistance element with a wire of very small diameter and composed of a nickel or nickel alloy which has a high specific resistance.

The wire of the element is usually wound upon a strip of insulating material, which strip is usually bent into an arcuate form and mounted in a suitable frame to make up the completed rheostat.

Because of the smallness of the wire used in elements of this kind, it is difficult to securely fasten the ends of the wire to the resistance strip so that it will not unravel or unwind therefrom during the handling of the strip in the manufacture of the rheostat. Various arrangements have been tried heretofore to securely fasten the ends of the wire, but insofar as I am aware each of these arrangements has a serious drawback in that the mechanical or electrical properties of the resistance strip are impaired thereby, and in certain instances the cost of manufacture is made unduly high by their use. Because of the nickel content of the wire used in elements of this kind, it is not practical to fasten the wire by soldering the end turns of the units together.

In my present invention, I provide a new and improved method of securely holding the end turns of such a resistance unit together so that they cannot unwind from the insulating strip upon which they are placed. In the preferred embodiment of my invention, the last few turns are imbedded in a soft metal such as lead or other similar metal, so that the metal practically completely encases these turns.

This arrangement provides a simple yet highly satisfactory method of fastening the

ends of a small resistance wire in place on a resistance strip.

In certain resistors of this type, particularly those used as volume controls in radio sets and other similar devices, it is often advantageous to have the element designed to give a low resistance progression when the contactor is placed in the immediate vicinity of the ends of the element; that is, when the contactor which engages the resistance element is resting in its extreme end position, the resistance of the element engaged thereby is preferably very low. As the contactor is turned away from this point, preferably the addition of resistance is very gradual at first, so that the volume control will have what is known in the trade as a smooth takeoff, and can therefore be turned from its zero position without producing undesirable extraneous noises in the radio set.

My present invention also provides a simple and efficient method of tapering the end turns of a resistance element of this type, so that the rheostat in which it is installed will have a smooth takeoff. By placing the soft metal into which the end turns of the elements are embedded at an angle with respect to the longitudinal axis of the element, an effective resistance value of the end turns of the wire can be tapered from zero at the extreme end to maximum at a point several turns away from the end turn of the element.

It will be noted that, by this varying cross-section of the metal foil, the length of each individual turn of resistance wire is progressively diminished as the end of the strip is approached. This provides a low resistance gradient adjacent the ends of the resistance strip, which is desirable in some cases. The gradually increasing length of wire from the edge of the strip upon which the contactor arm engages to the foil progressively increases the resistance of the turns of wire as the contact moves away from the terminal, and thus provides a graduated increase of resistance per unit of movement of the contactor arm adjacent the terminal.

My invention may also be advantageously used to connect the individual sections of a so-called split wound resistor. A resistor of this

type usually comprises several sections each of which is wound to have a different resistance per turn of winding, so that as a contactor passes over the element the rate of increase of resistance is varied as different sections of the element are engaged. Heretofore, in the manufacture of a rheostat element of this type, considerable difficulty has been experienced in electrically connecting the various sections of the element, since because of the smallness of the wire employed a suitable twisted connection could not be made between these sections. Also, because of the nickel content of the wire, the sections could not be satisfactorily soldered together.

In practicing this embodiment of my present invention, the last few turns of the one section and the first few turns of the adjacent section are embedded in a suitable soft metal, such as lead, which lead practically completely encases these turns, making a good electrical connection thereto and therebetween. Because of the completeness of the encasement of the turns in the metal, moisture is excluded to such an extent that corrosion is negligible and the good electrical contact between the two sections is thereby maintained over a long period of time. If desired, the resistance change per turn of the wires between these sections can be tapered by placing the soft metal piece used to connect the two sections together at an angle with respect to the longitudinal axis of the element so that different portions of the turns are short circuited by being embedded in this metal.

Other objects of my invention, not specifically mentioned here will be apparent from a reading of the detailed description and claims which follow.

Now, to acquaint those skilled in the art with the teachings of my invention, reference is made to the accompanying drawing in which a preferred embodiment of it is shown by way of example, and in which:

Figure 1 is a cross-sectional view longitudinally through a resistance element embodying the teachings of my invention showing the soft metal strip before it has been pressed over the wires of the element;

Figure 2 is a view similar to Figure 1 showing the soft metal pressed into engagement with the wires of the element;

Figure 3 is a similar view showing a modified application of the soft metal to the wires of the element;

Figure 4 is an elevation view of the end of a resistance element showing the application of a tapered, soft metal piece thereto;

Figure 5 is an elevational view of a resistance element at the junction of two of its sections showing the application of a piece of soft metal thereto;

Figure 6 is an elevational view of the end of an element similar to that shown in Figure

4 showing another application of soft metal thereto; and

Figure 7 is another elevational view of an element at the junction of its two sections showing a slightly modified application of soft metal thereto.

Referring now to the drawing in more detail, Figure 1 shows a resistance element of the type employed in a volume control such as is disclosed in my co-pending application, Serial No. 422,028, filed January 20, 1930. This element comprises an insulating strip 1 around which are wound resistance wires 2 and 3, these wires forming separate elements of a resistor capable of being employed in the manner set out in my co-pending application. The wires 2 and 3 are preferably space wound on the insulator 1, and prevented from moving longitudinally thereon in any preferred manner. As shown, the wires 2 are the last few turns of one section of a resistance element and the wires 3, the first few turns of an adjacent element wound on the same insulator 1. In practice, the diameter of a winding 2 and 3 will be of the order of two or three thousandths of an inch, and the thickness of the insulator 1 approximately one thirty-second of an inch.

To connect the last few turns of the winding 2 to the first few turns of the winding 3, I have provided a piece of soft metal 4 which is laid over the windings 2 and 3, and subsequently pressed to embed the turns of those windings into the metal 4 in the manner shown in Figure 2. Preferably, the element 4 comprises a piece of lead foil or small lead wire, although other suitable soft metal may be employed in lieu thereof. As will be noted in Figure 2, after the piece of metal 4 has been pressed into the spaces between the wires 2 and 3, those wires are practically completely encased in this metal. As a result, a good electrical contact is secured from the wire 2 to the metal 4 and from the metal 4 to the wire 3, thereby joining the two sections 2 and 3 of the element electrically together. Furthermore since the wires are practically completely embedded in the metal, air and moisture are excluded from the electrical contact and corrosion is thereby reduced to such a point that it can be neglected, and the electrical connection relied upon for a long period of time. The metallic piece 4 projects beyond the outside surface of the wires 2 and 3 for a very short distance so that the space occupied by the splice between the two sections is very little greater than that occupied by the wires themselves.

In the embodiment of the invention shown in Figures 1 and 2, the metallic piece 4 which may be either a piece of lead foil or a small lead wire, is placed on the outside of the windings after they have been wound on the insulator 1. In Figure 3, the arrangement is reversed, that is, the metallic member 5 is

placed adjacent the insulator 6, and the wires 7 and 8 wound over this metallic member and subsequently pressed into it in the manner shown. The effect of the embodiment shown in Figure 3 is the same as that shown in Figures 1 and 2, and since the wires are again practically completely embedded in the metal 5, a good electrical contact between the wires 7 and 8 is achieved and that contact will remain unchanged for a long period of time.

The invention may also be applied to the end sections of a resistance element in the manner shown in Figures 4 and 6. In Figure 4, the end of the winding 10 on the resistance on the insulator 11 is embedded in a soft metal sheet 12, which sheet is shown as a piece of foil laid over the end turn of the element 10 and pressed down thereagainst to embed those turns in it. As shown, the foil is provided with a tapered edge 13 which tapers the effective length of the wire 10 from practically zero at the point 14 to the maximum possible length at the point 15. This gradual increase in these effective lengths as the distance from the end of the winding increases insures that the contactor of the rheostat into which the element is placed will move from the end of the element without encountering any large variations in resistance and consequently the rheostat will have what is known as a smooth takeoff.

In the embodiment shown in Figure 6 the end turns of the winding 20 are held on the insulator 21 by a soft metal strip 22 which is a wire placed under the winding 20 and into which the winding is subsequently pressed. In fabricating this embodiment of my invention, the soft metal wire 22 is placed adjacent to the strip 21 and the wire 20 wound thereover, the wire being wound under considerable tension which partially embeds it in the soft metal 22. The end of the strip is subsequently pressed to complete the embedding of the wire 20 in the metal 22, thereby serving to securely lock the end turns of the wire 20 and to prevent them unwinding from the insulator 21. The wire 22 may be placed at an angle as shown to taper the effective resistance of the end turn of the winding 20 in the manner hereinbefore pointed out.

Figure 5 shows a fragmentary elevation of an element in which two windings 30 and 31 are joined by a soft metal member 32 in the manner shown in detail in Figures 1, 2 and 3, the metal 32 in this instance being as narrow as possible so that a minimum number of turns are short circuited by being embedded in it. In Figure 7, the windings 33 and 34 are joined by a soft metal wire 35 preferably placed under them adjacent to the strip 36 before the wires 33 and 34 are wound on it. The winding operation is made under considerable tension and partially embeds the wires in the metal 35, and a subsequent press-

ing securely embeds them in the metal. Because of the angled position of the wire 35 and consequent tapering of the effective lengths of the end turns of the windings 33 and 34, a smooth takeoff between the windings 33 and 34 is assured.

The wire 35 and the wire 22 may also be placed down over the outside of their respective resistance wires, and the wires embedded therein by the application referred to in the same manner as the foils 12 and 32 are placed over their respective resistance wires. In certain instances within the teachings of my invention, the foils such as 12 and 32 may advantageously be placed under the wire rather than over it as shown in the illustrative figures.

The resistance elements manufactured in this manner are simple and compact and therefore may be fabricated at minimum cost. The particular method of holding the end turns of the wire and the last turns of adjacent sections is at a further advantage in that it does not materially stiffen the insulator upon which the wires are wound and consequently the insulator can be formed to an arcuate shape more readily. The forming of the insulator to an arcuate shape does not disturb the bond between the soft metal and wire of the element, and therefore does not impair the electrical connection between individual sections or loosen up the connection so that corrosion may take place within it.

In practicing the invention, I have found that a lead foil of approximately five thousandths of an inch thickness works satisfactorily with nickel or alloy wires of from two to five thousandths of an inch in diameter, and elements manufactured in this manner have proven satisfactory in all instances. While lead is preferable because of its low cost, other suitable soft metals may be advantageous in certain instances and may be substituted for lead within the teaching of my invention.

Having thus described my invention, what I consider new and desire to have protected by Letters Patent is pointed out in the appended claims.

1. The method of making a wire wound resistance element which comprises, winding the wire on an insulating strip, engaging the last few turns of the wire with a piece of soft metal and pressing those turns into the metal.

2. The method of tapering the resistance value of the end section of a wire wound resistance unit which comprises pressing a piece of soft metal of tapering cross-section into the last few turns of the section to thereby reduce the effective length of the turns in steps as the end of the section is approached.

3. A resistance element comprising, an insulating strip, a resistance wire space wound thereon, and a soft metal foil engaging the end turns of the wire, said metal foil being

partly disposed in the spaces between those turns to hold the wire on the strip.

4. A resistance element comprising, an insulating strip, a resistance wire space wound thereon, and a piece of soft lead engaging the end turns of the wire, said lead being partly disposed in the spaces between those turns to hold the wire on the strip.

5. A resistance element comprising, an insulating strip, a resistance wire space wound thereon and a piece of lead of varying cross-section engaging the end few turns of the wire, said lead being partly disposed in the spaces between those turns to hold the wire on the strip, and to taper the resistance value per turn as the end of the element is approached.

6. A resistance element comprising a plurality of turns of resistance wire wound on an insulating strip, the end few turns of said wire being embedded into a strip of soft metal of tapering cross-section which holds those turns from unwinding from the strip and tapers the effective length of said turns.

7. A resistance element comprising an insulating strip, a plurality of turns of resistance wire wound thereon, a second plurality of turns of resistance wire wound on the strip, the last few turns of the first plurality of turns being adjacent the first few turns of the second plurality of turns, a soft metallic member into which said adjacent turns are embedded to electrically connect them and to prevent them from unwinding from the strip.

8. A resistance element comprising an insulating strip, a resistance wire space wound thereon, and a soft metal foil engaging the end turns of the wire, said metal foil being angularly disposed in the spaces between those turns to short circuit the said end turns, whereby a low resistance progression is provided.

In witness whereof, I hereunto subscribe my name this 25th day of April, 1930.

NEWTON C. SCHELLENGER.

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