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VARIABLE RESISTANCE CONTROL UTILIZING METAL FOIL TO WIRE TURNS

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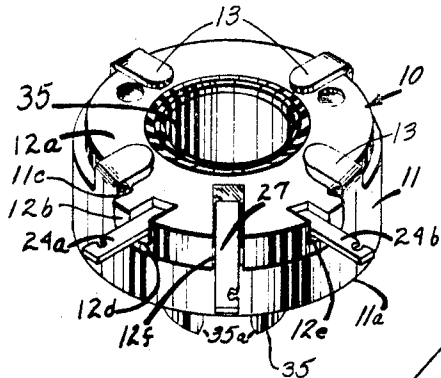
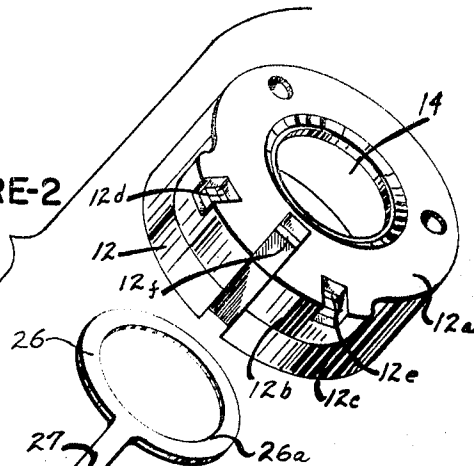


FIGURE-1

FIGURE-2



PLACING METAL FOIL ON STRIP
OF INSULATING MATERIAL.

WINDING RESISTANCE WIRE
AROUND STRIP AND FOIL.

CLINCHING TERMINAL TO STRIP
AND CUTTING STRIP TO LENGTH.

CUTTING FOIL AT ENDS OF
CENTER SECTION.

REMOVING CUT FOIL FROM BE-
TWEEN RESISTANCE WIRE AND STRIP.

FLUXING STRIP IN ACID, DIPPING
STRIP IN SOLDER.

FIGURE-8

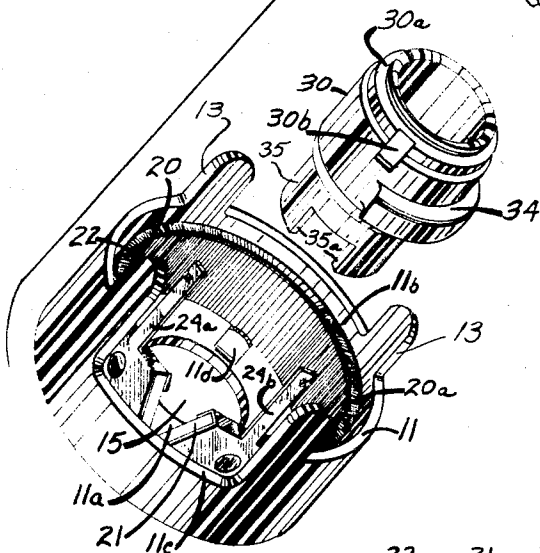


FIGURE-3

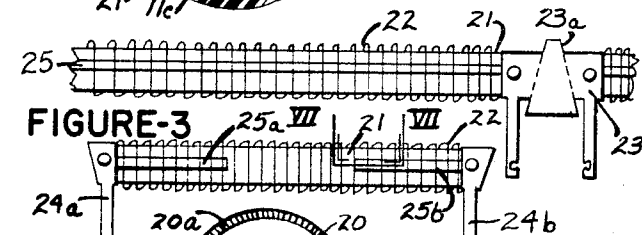


FIGURE-4

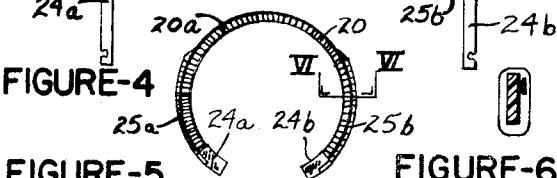


FIGURE-5

FIGURE-6



FIGURE-7

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VARIABLE RESISTANCE CONTROL UTILIZING METAL FOIL TO WIRE TURNS

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ABSTRACT OF THE DISCLOSURE

Variable resistance control having wirewound resistance element with shorted end turns. A piece of metal is inserted at each end between several end turns of the resistance element and a winding strip to short adjacent turns at each extremity of the resistance element. The pieces of metal are sweated with solder to the resistance element to insure a short circuit condition between adjacent turns at each end of the resistance element.

The present invention relates to electrical controls, and, more particularly, to a variable resistance electrical control of the type commonly referred to as a fader control and to a method of making the same.

Variable resistance fader controls are commonly employed for changing in the alternative the volume of the pair of loudspeakers. For example, in an automobile provided with front and rear loudspeakers, it is preferable to adjust or balance the volume of both of the loudspeakers with a single control thereby permitting the volume of one of the loudspeakers to be increased while the volume of the other loudspeaker is being decreased. The use of a single control also facilitates adjustment of the volume of both loudspeakers to the same intensity at any given location.

Many types of fader controls are available on the market. In one particular type of fader control, the end turns of the resistance element are coated with a conductive paint to short-circuit the end turns of the resistance element. The conductive paints are, to a certain degree, brittle and flexing or jarring of the resistance element frequently causes a crack in the conductive paint thereby increasing the resistance between adjacent end turns. In other fader controls, the end turns of the resistance element are covered with a metal strip. Such construction, however, causes a step to be formed between the resistance path and the edge of the strip resulting in an uneven feel or jump in the shaft as the contactor is wiped across the step. Heretofore, attempts to short the end turns together with solder have been unsuccessful since the resistance wire, e.g., Nichrome wire, forming the end turns generally contains chromium which is not wettable by solder. It would, therefore, be desirable to provide an improved fader control construction employing a solder foil for shorting end turns and an improved method of shorting adjacent end turns of a resistance element therefor.

Accordingly, it is an object of the present invention to provide an improved fader control. Another object of the present invention is to provide an improved method for shorting adjacent end turns of a resistance element employed in a fader control. An additional object of the present invention is to short adjacent turns of a resistance element together by inserting an elongated strip of metal foil between the turns wound on a winding strip and then sweating the foil with solder to the turns. A further object of the present invention is to provide an electrical control with a wirewound resistance element having some turns at least partially embedded in a strip of metal foil. Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty characterizing the in-

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vention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly, the present invention is concerned with an improved resistance element for a variable resistance fader control having a metal foil inserted between some of the turns of a resistance element and a winding strip for shorting the turns together. In another embodiment the metal foil is sweated with solder to the turns for shorting the turns together. The present invention is also concerned with an improved method of shorting the end turns of a resistance element wherein an elongated strip of metal foil is initially placed against a winding strip of insulating material. A resistance wire is then wound on the strip of insulating material to secure the foil to the strip. Terminals are clinched to the ends of the strip and electrically connected to the foil and the resistance wire. The foil is then cut into three sections and the center section of the foil is removed from between the resistance wire and the insulating strip. If the strip is mounted in a cylindrical housing, the strip is curled to the shape of the housing of the control before being assembled into the housing. For certain applications, the electrical contact between the metal foil and the turns provides adequate shorting of adjacent turns. However, in a preferred form of the invention, the strip after being curled, is dipped into a soldering flux to clean the foil and the resistance wire and then dipped in molten solder to sweat the foil to the adjacent turns. After the sweating operation, the strip is washed and ready for assembly into the housing of the fader control.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein the same reference numerals have been applied to like parts and wherein: FIGURE 1 is an isometric view of an electrical control made in accord with the present invention; FIGURE 2 is an exploded view of the control shown in FIGURE 1; FIGURE 3 is a side view of the resistance element of the control shown in FIGURE 2 during various stages of manufacture; FIGURE 4 is a side view of the resistance element shown in FIGURE 3 after the terminals have been trimmed; FIGURE 5 is a top plan view of the resistance element of FIGURE 4 after the curling and sweating operation; FIGURE 6 is a cross section of the resistance element taken along line VI—VI of FIGURE 5; FIGURE 7 is a grossly enlarged fragmentary section of the resistance element taken along line VII—VII of FIGURE 4; and FIGURE 8 is a diagrammatical representation of the invention.

Referring now to the drawings, there is illustrated an electrical control generally referred to as a variable resistance fader control and indicated at 10 comprising a cup-shaped metal housing 11 supporting a resistance element 20 and a rotor 30. Telescopically mounted within the housing 11 and closing the open end of the cup-shaped housing 11 is an inverted cup-shaped insert 12 molded of a suitable insulating material. As shown in FIGURE 1, the end wall 12a of the insert 12 forms one of the outer end walls of the control 10 and the end wall 11a of the housing 11 forms the other outer end wall thereof. The open end 11b of the housing 11 is provided with a cut-away section 11c and an arcuate boss 12b extending radially outwardly from the insert 12 fits into the cut-away section 11c of the housing 11 to orient the insert 12 with the housing 11. A skirt 12c depending from the wall 12a and mounted within the housing 11 insulates the resistance element 20 from the metal housing 11. A plurality of tabs 13 integral with the housing 11 are folded over the end wall 12a of the insert 12 to secure the housing to the insert. Both of the end walls 11a and 12a of the housing 11 and the insert 12 respectively are provided with apertures 14 and 15 and the rotor 30 is journaled therein.

The resistance element 20 circumposes the rotor 30 and abuts against the inner wall of the depending skirt 12c

of the insert 12. More particularly, the resistance element 20 comprises a winding strip 21 of insulating material (see FIGURES 3 and 4) having a plurality of turns of resistance wire 22 wound thereon. Any type of wire, e.g., Nichrome wire, having the proper resistance per unit length can be used. Suitable end terminals 24a and 24b in electrical contact with the ends of the resistance wire 22 are clinched to the ends of the winding strip 21. In a preferred form of the invention, the end terminals 24a and 24b and the end turns of the resistance element are sweated to a pair of elongated strips of metal foils 25a and 25b (see FIGURES 4 and 5) shorting the end turns together (see FIGURE 7). The resistance element 20 is disposed in the insert 12 with the upper edge of the resistance element 20 abutting against the end wall 12a for spacing the lower edge of the resistance element 20 away from the end wall 11a of the housing 11. The end terminals 24a and 24b project upwardly through slots 12d and 12e provided in the insert 12 and extend radially outwardly beyond the slots (see FIGURE 1) forming an angle supported on the walls defining the lower side of the slots. A collector ring 26 having an opening 26a abuts against the end wall 12a of the insert 12 and a center terminal 27 extends radially outwardly from the collector ring 26 through a slot 12f provided in the insert 12. The rotor 30 molded of suitable insulating material is provided with a cylindrical shoulder 30a engaging the inner edge of the opening 26a for positioning the collector ring coaxially with the apertures 14 and 15.

For the purpose of transferring electric current from the resistance element 20 to the collector ring 26 a contactor 31 having a pair of spaced contact fingers 32a and 32b electrically connected to each other wipingly engages the resistance element 20. The contactor 31 comprises a ring portion 31a in slideable engagement with the collector ring 26 and a pair of downwardly extending ears 33 integral with the contactor 31 and received in a pair of diametrically disposed grooves 30b provided in the rotor constrain the contactor 31 to rotate with the rotor 30. In order to limit rotation of the contactor 31, the rotor is provided with an arcuate boss 34 engageable with a stop 11d (see FIGURE 2) extending inwardly from the end wall 11a of the housing 11. A hollow shaft 35 fixedly secured to the rotor 30 extends outwardly of the housing and a pair of tabs 35a extending axially from the shaft 35 may be flattened outwardly to secure a not-shown rotatable member thereto for rotating the contactor 31.

Referring now particularly to a preferred method of making the resistance element 20, the foil 25 (see FIGURE 3) is unwound onto the winding strip 21 of insulating material with a side of foil 25 flush with the winding strip 21. The winding strip 21 and the foil 25 are then fed into a winding machine and the resistance wire 22 is wound around the winding strip 21 and the foil 25 securing the foil to the strip. At predetermined spaced intervals, pairs of terminals 23 (see FIGURE 3) are clinched to the winding strip electrically connecting the resistance wire and the foil to the terminals. The winding strip is then preferably cut to short lengths as shown in FIGURE 4 by removing a triangular section 23a from each pair of terminals 23 to produce a resistance element 20 having a pair of end terminals 24a and 24b at the ends thereof. The foil 25 between each pair of end terminals 24a and 24b is severed into three sections, and the portion of the foil forming the center section is removed from between the resistance wire 22 and the winding strip 21 to space foil sections 25a and 25b. The resistance element 20 with the foil sections on the outside of the strip is then curled (see FIGURE 5) so as to fit inside of the insert 12, dipped in flux, and immersed in molten solder to sweat the foil to the resistance wire and to the terminals. The resistance element is removed from the molten solder and, after being washed to remove the flux, the element is ready for assembly into the insert 12. The resistance element can be dipped in molten solder without shorting the

turns in the center section of the element since the resistance wire is not wetted by the solder. As best shown in FIGURE 7, the contact resistance between the turns and the foil is decreased since the turns of the resistance wire, in addition to being in direct contact with the foil, also are partially embedded in the metal deposits 28 bonded to the foil sections 25a and 25b. The resistance element need not be curled if the control is of the rectilinear type instead of the rotatable type. Moreover, it is to be understood that in certain applications the foil 25 need not be sweated to the resistance wire since the pressure contact formed between the foil and the turns of the resistance wire by tightly winding the resistance wire around the winding strip and the foil produces a sufficiently low resistance connection. Only in preferred applications is the sweating step necessary.

In a particular embodiment, an elongated strip of metal foil $\frac{3}{16}$ inch wide and .001 inch thick was positioned on a winding strip $\frac{3}{16}$ inch wide. The foil can be of nickel or any material, e.g., copper, easily wettable by a molten metal such as solder. A substantially thicker and more malleable foil material is preferred when the sweating step is eliminated to reduce cost. It is critical, however, when the sweating step is employed that the foil does not melt in the molten metal. Thus the foil material must have a substantially higher softening temperature than the molten metal and be readily wettable while the resistance wire should be substantially unwettable. The resistance element 20 as best shown in FIGURE 5 of the drawings is provided with a 240° shorting section. By connecting the end terminals 24a and 24b of the resistance element of the fader control 10 to a pair of not-shown loudspeakers and the center terminal 27 to one side of a not-shown input signal, rotation of the shaft 35 of the fader control 10 in one direction introduces resistance into the circuit of one of the loudspeakers decreasing the volume thereof and removes resistance from the circuit of the other loudspeaker increasing the volume thereof. The signal to both loudspeakers can also be balanced. The angle between the contact fingers 32a and 32b generally is at least as large as the angle defined by the unshorted portion of the resistance element. Otherwise, all of the resistance could not be removed from both loudspeakers when the shaft is in the center position.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention and a method of making the same, and an additional embodiment thereof, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A variable resistance control comprising a housing, a wirewound resistance element disposed in said housing, said resistance element comprising a winding strip of insulating material, a resistance wire wound around the winding strip with adjacent turns spaced from each other, a first piece of metal shorting a plurality of the turns of the resistance wire at one end thereof to said first piece of metal to form a first shorted end portion, a second piece of metal shorting a plurality of the turns of the resistance wire at the other end thereof to said second piece of metal to form a second shorted end portion, said resistance wire having a single unshorted portion extending between the two shorted end portions, a first end terminal electrically connected to said first shorted end portion of the resistance wire, a second end terminal electrically connected to said second shorted end portion of the resistance wire, and a contactor comprising a pair of spaced contact fingers wipingly engaging the resistance element between the ends thereof, and a third terminal electrically connected with the contactor.

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2. The control of claim 1, wherein a plurality of metal deposits are bonded to the first and second pieces of metal and at least partially embed the turns of the resistance wire shorted to the first and second pieces of metal.

3. The control of claim 1, wherein said contact fingers are spaced apart a sufficient distance to permit the simultaneous engagement of one of said contact fingers with said first shorted end portion and the other of said contact fingers with said second shorted end portion whereby the unshorted portion of the resistance wire may be effectively removed from the electrical circuits between the third terminal and the first and second end terminals.

4. The control of claim 1, wherein the resistance element is curled with the ends spaced from each other in the housing and the first and second pieces of metal are disposed on the outer surface of the winding strip with the contact fingers wipingly engaging the inside surface of the resistance element.

5. The control of claim 1, wherein the first and second end terminals are integral with the first and second pieces of metal, respectively, and the distal ends of the

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first and second pieces of metal are secured to the resistance wire.

6. In a variable resistance control, the combination of a housing, a winding strip disposed in the housing, a resistance wire wound around the winding strip, an elongated piece of metal disposed adjacent to and in electrical contact with a plurality of turns of the resistance wire on one side of the winding strip, means bonded to the piece of metal and disposed between adjacent turns electrically connecting the adjacent turns to the piece of metal, and a movable contactor wipingly engaging the resistance wire disposed on the other side of the winding strip.

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