Re. 24531

Feb. 26, 1957 G. J. MUCHER 2,783,343

DISCONTINUOUS WIRE-WOUND RESISTANCE AND METHOD OF MAKING

Filed Sept. 16, 1954

Fig. 1

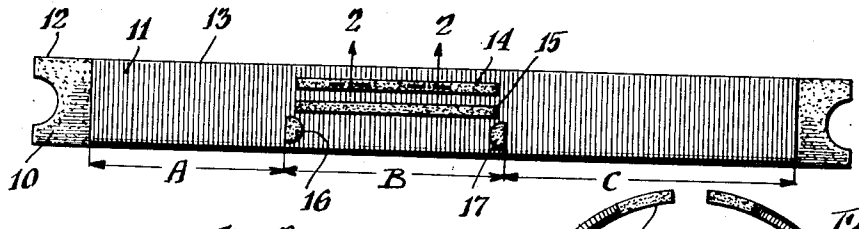



Fig. 2

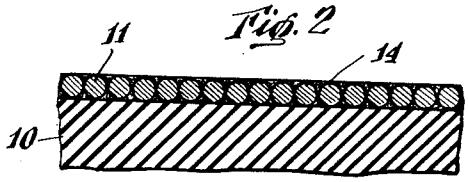



Fig. 3

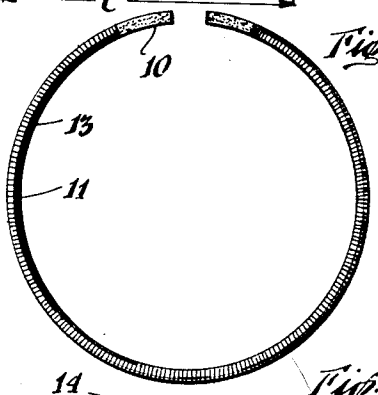



Fig. 4

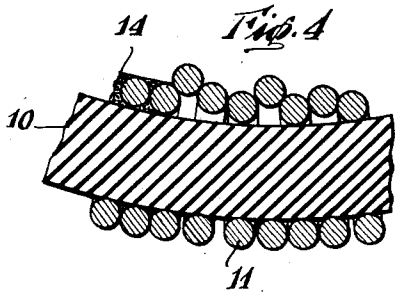



Fig. 5

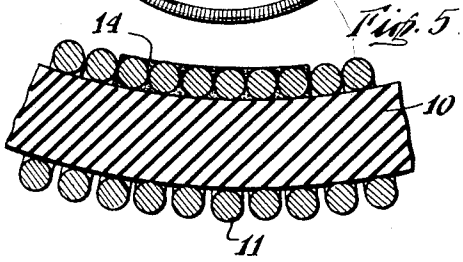



Fig. 6

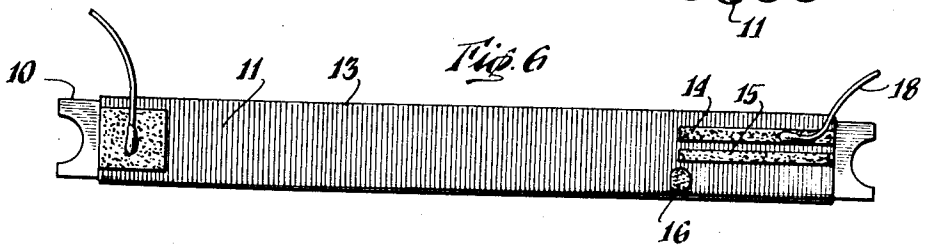
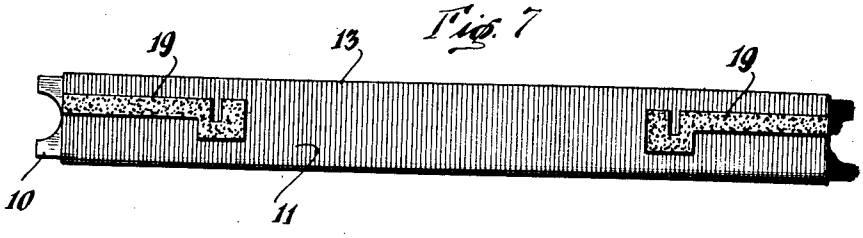



Fig. 7




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# DISCONTINUOUS WIRE-WOUND RESISTANCE AND METHOD OF MAKING

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7 Claims. (Cl. 201—63)

This invention relates to improvements in discontinuous wire wound resistances and, particularly to improved means for accurately shorting out one or more selected sections of the windings of such devices and to an improved method of manufacture thereof.

In the manufacture of discontinuous wire wound resistances that are subsequently to be bent in the form of an arc or circle for use in a potentiometer or the like (specifically in those processes employing the well known metal spray, conductive paint or metallic plating shorting techniques), appreciable difficulty is encountered in accurately determining the correct transition point between adjacent sections of constant and variable resistance, and in preventing undue displacement of the wire of the variable resistance sections when the resistance card is bent. Such difficulties are particularly severe in high resistance coils wherein fine wire on the order of .001" to .002" in diameter is exetremely closely wound. In such cases the size and closeness of the windings renders it impractical to apply known production techniques, such as metal spraying, in the usual manner to short out sections of the wire because the spray cannot conveniently be controlled to the degree of accuracy required. Furthermore, when the resistance card is subsequently bent, the rigid plate formed by the sprayed, painted or plated bond of a constant resistance section inevitably causes a crowding of the wires of the adjacent variable resistance section which may result in an undesirable pile-up of wires and may even result in a breakdown of the insulation on the wires with consequent shorting out of one or more turns of the variable resistance section. In extreme cases, several turns of the winding may actually override one another, thereby changing the electrical value which is to be imparted.

A general solution to this type of problem is known wherein the resistance wire is wound on a card and a plurality of adjacent turns are bonded together by a metal spray to form a shorted out section slightly less than the length of the desired constant resistance section. The wire is then cut at the junction of the constant and variable resistance sections, and the first turn of the variable resistance section is soldered to the bonded wires; whereby the transition point between the constant and variable resistance sections is defined with a high degree of accuracy.

Although the described arrangement is highly advantageous in most applications and is readily adaptable to high production techniques, it is not entirely suitable to all applications because the soldering of individual turns is quite costly. Therefore, such a process is usually reserved for special applications in which an extremely high degree of precision is required. As a solution to this problem that is readily adapted to high production techniques, applicant has found an improved method of application of the metal spray to the section to be shorted out, which can readily be adjusted to provide the required high degree of accuracy in determining the transition point between the constant and variable resistance sections and, at the same time, is effective to eliminate the crowding of the wires of the adjacent variable resistance section.



Briefly, in one form of his invention, applicant has found that the combination of two substantially parallel strips of sprayed metal, extending to a point just short of the end of the desired constant resistance section, and a separate dot or island of sprayed metal that is arranged either above or below the level of such strips and overlaps the junction of the constant and variable resistance sections, provides an effective shorting bond that eliminates the crowding of the wires of the adjacent variable resistance section. Furthermore, in such an arrangement, the spray metal dot or island can conveniently be trimmed after application to the exact junction of the constant and variable resistance sections to provide an extremely accurate manufacturing control. In a modification of the invention, applicant has found that a hook-shaped strip of sprayed metal, or any other configuration thereof that permits relative movement of the wires within the shorted-out section, is also highly effective to absorb the pile-up of the resistance wire.

Thus, the principal object of the invention is to provide a discontinuous wire wound resistance card, having extremely closely wound turns, wherein the wire of the constant resistance section is effectively bonded to eliminate crowding of adjacent variable resistance sections, and the junction of the constant and variable resistance sections is determined to a high degree of accuracy, and to provide an improved method of manufacturing such a resistance card.

A further object is to provide a discontinuous wire wound resistance card in which one or more selected portions of the windings may be conveniently and accurately shorted out.

A still further object is to provide a resistance card to produce a discontinuous resistance output having stable variable resistance characteristics.

Another object of the invention is to provide an improved construction for a discontinuous wire wound resistance card whereby a compact and economical product can readily be produced by conventional high production techniques.

Preferred forms of the invention are shown in the drawings, in which:

Fig. 1 is a side elevation of a wire wound resistance card having a center section of resistance shorted out in accordance with the invention;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a plan view of a resistance card formed for assembly in a potentiometer;

Fig. 4 is a sectional view of a portion of a resistance card, formed for assembly in a potentiometer, illustrating the piling-up of turns that occurs between sections of conventionally bonded wire;

Fig. 5 is a sectional view, similar to Fig. 4, in which the wire is bonded in accordance with the invention;

Fig. 6 is a side elevation of a wire wound resistance card having an end section shorted out in accordance with the invention; and

Fig. 7 is a side elevation of a wire wound resistance card having two end sections shorted out in accordance with a modification of the invention.

Referring to Fig. 1 there is shown a conventional type of potentiometer resistance card assembly that comprises a resistance card **10** on which a continuous resistance wire **11** is wound. Card **10** is usually made of a flat strip of thermosetting material which may conveniently be inserted in a winding machine for the purpose of applying the resistance wire, and is provided with at least

one straight edge **12** whereby the wire wound thereon forms a smooth and continuous contact edge **13**. Subsequently, the assembled coil is heated in a suitable manner and bent into a circular form, as shown in Fig. 3, for assembly in a potentiometer frame wherein contact edge **13** is traversed by a contact wiper fixed on a suitable shaft of the potentiometer.

In general, a resistance card of this type is designed to provide increasing resistance as the wiper of the associated potentiometer is moved over contact edge **13** as, for example, from left to right in Fig. 1. However, in many instances it is required that a constant resistance output be provided that corresponds to a predetermined degree of rotation of the potentiometer shaft. Although a variety of methods have been proposed to effect this result, in accordance with the present invention it is accomplished by shorting out a plurality of adjacent turns of wire **11** to form a shorted out section having a resistance equal to that of the last turn of the adjoining variable resistance section.

The manner of forming such a shorted out section can best be shown by a specific application, as illustrated in Fig. 1, wherein it is assumed that the potentiometer is to produce variable resistance outputs during the period that its wiper contact traverses the sections A and C of the resistance card, and is to produce a constant resistance output, corresponding to the resistance of the last turn of section A, while the wiper contact is traversing section B. To prepare such a shorted out section, all the turns in section B and a small portion of the adjoining ends of sections A and C are thoroughly cleaned to expose the bare wire. The resistance card is then suitably masked and a metal spray is applied in such manner that two parallel strips **14** and **15** and two auxiliary dots or islands **16** and **17** are formed on the surface of the wire. The dots or islands **16** and **17** may be of any desired configuration but are preferably round since this form is usually the easiest to make.

The masking operation is so performed that strips **14** and **15** are positioned within the limits of the constant resistance section, and islands **16** and **17**, respectively, overlap the junctions of the constant resistance section with each of the adjoining variable resistance sections. The spray metal employed may be of any suitable type, such as zinc, that forms a good electrical bond with each of the individual turns of resistance wire **11** (as in Fig. 2) and at the same time forms a continuous conductive path over the entire area of strips **14**, **15** and islands **16**, **17**. Thus, the resistance of a section of wire, slightly in excess of the proposed constant resistance section B, is effectively shorted out. Thereafter, an operator with the aid of a microscope and precision instruments determines the exact location of the ends of the constant resistance section and removes the shorting material, by scraping or abrading, from each of islands **16** and **17** that overlap the adjoining variable resistance sections.

By this arrangement it is apparent that a constant resistance section can be defined with a high degree of accuracy in a manner that can be accomplished with conventional high production metal spray techniques. The only requirement being that the spray mask must be applied with sufficient accuracy that one or more turns of wire of the proposed constant resistance section at each end of strips **14** and **15** remain exposed, and that islands **16** and **17** overlap at least one turn of the adjoining variable resistance section. Thus, islands **16** and **17** are effectively vernier adjustments to permit the constant resistance sections to be limited precisely to their required dimensions.

In addition to their shorting function, strips **14**, **15** and islands **16**, **17** also serve to minimize crowding of adjacent unbonded wires, especially in the case of extremely closely wound coils. In such instances, it is found that if a conventional spraying, painting, or plating technique is employed, the adjacent wires tend to pile up next to bonded sections, in the manner indicated in Fig. 4, when card **10** is formed for assembly in a potentiometer frame. However, by the use of parallel strips, in which the upper strip **14** is located relatively close to contact edge **13**, it is found that any piling up of wire that occurs is localized between the strips or below strip **15**, whereas the portions of the turns covered by strips **14** and **15** remain in contact with the card, as illustrated in Fig. 5, and there is no undue crowding of adjacent wires. This results is achieved because of the fact that the parallel strips do not form an unyielding solid plate, as in conventional practical, but permit a certain degree of compression without cumulative crowding or pile-up at the ends.



It may be noted that a single strip **14** may be all that is required to obtain the above results in many instances. However, the second strip **15** is employed to insure continuous shorting. Preferably strip **14** is placed close to contact edge **13** to minimize the effect of intermittent resistance. However, islands **16**, **17** may be placed closest to the contact edge, should the nature of a particular problem so require, to obtain more critical control at the hop-off points.

The method described above is equally adaptable to short out a resistance section at the end of the card, as indicated in Fig. 6. In this case, obviously, only a single island **16** need be employed with each pair of strips **14** and **15**. Also, inasmuch as strips **14** and **15** are relatively rigid, they may conveniently be employed as connecting point areas to which a lead or tap **18** may be soldered to connect the resistance card with its associated circuit.

As a modification of the invention, it is also found that spray metal shorting strips are advantageous to lessen piling up of the wire within a shorted area when formed in the shape of a hook or loop **19**, as shown in Fig. 7. In this arrangement, when the resistance card is curved and crowding occurs, no difficulty is experienced because the loops which tend to override each other shift into the slot of the hook or pile up along its shank in the middle of the card. However, it is found that no overriding occurs in the variable resistance section of the card. If desired, hook **19** may be used in combination with an island **16**, as described in connection with Figs. 1 and 6, to obtain a high degree of accuracy in defining such a shorted out section.

Obviously, other patterns of spray or paint bonding may be employed to produce a similar effect. For example, the bonding material may be applied as a series of overlapping dots, or in a woven or zig-zag pattern, as long as there is sufficient room to permit some overriding of the bonded wires at points intermediate the ends of the bonded section.

As thus far described, the invention as shown is applied to a linear resistance. However, since its is well known that potentiometers are frequently employed to represents non-linear fucntions simply by varying the gauge and/or spacing of the resistance wire or by varying the shape of the card on which the wire is wound, it is apparent that the present invention may also be applied to non-linear equipment.

Thus, among others, the several objects of the invention as specifically noted above are achieved. Obviously, numerous changes in construction and rearrangement of the parts may be made without departing from the scope of the invention as defined by the claims.

I claim:

1. The method of manufacturing a discontinuous resistance card including a section of constant resistance and a section of variable resistance comprising the steps of forming a resistance card of a length to accommodate such sections, winding said card with a resistance wire over the entire length occupied by both said resistance sections, forming an electrical bond between adjacent

turns of the constant resistance section over the portion extending from the first turn of said section to a point at least one turn short of its junction with the variable resistance section, forming a vernier electrical bond between adjacent turns of wire at the junction of said sections, said vernier bond including a plurality of turns of the constant resistance section and at least one turn of the adjacent variable resistance section to extend the bonded section of wire slightly in excess of the constant resistance section, determining the exact junction of the two sections, and removing the vernier electrical bond from all turns of the variable resistance section except the first turn thereof.

2. The method of manufacturing a discontinuous resistance card including a section of constant resistance arranged between two sections of variable resistance comprising the steps of forming a resistance card of a length to accommodate such sections, winding said card with a resistance wire over the entire length occupied by said resistance sections, forming an electrical bond between adjacent turns of the constant resistance section over the portion extending between points at least one turn short of each of its junctions with the variable resistance sections, forming vernier electrical bonds between adjacent turns of wire at each end of said constant resistance section, each of said vernier bonds including a plurality of turns of the constant resistance section and at least one turn of the adjacent variable resistance section to extend the bonded section of wire slightly in excess of the constant resistance section, determining the exact junction of the constant resistance section with each of the variable resistance sections, and removing the vernier electrical bond from all turns of the variable resistance sections except the first turn of each of said sections.

3. The method of manufacturing a discontinuous resistance card including a section of constant resistance and a section of variable resistance comprising the steps of forming a resistance card of a length to accommodate such sections, winding said card with a resistance wire over the entire length occupied by both said resistance sections, forming an electrical bond between adjacent turns of the constant resistance section over the portion extending from the first turn of said section to a point at least one turn short of its junction with the variable resistance section, said electrical bond comprising a pair of spaced metallic strips substantially parallel to one another and perpendicular to the individual turns of said resistance wire, forming a second electrical bond between adjacent turns of wire at the junction of said sections, said vernier bond comprising a metallic island in contact with a plurality of turns of the constant resistance section and at least one turn of the variable resistance section, determining the exact junction of the two sections to extend the bonded section of wire slightly in excess of the constant resistance section, and removing the electrical bond from all turns of the variable resistance section except the first turn thereof.

4. A discontinuous resistance card including a section of constant resistance and a section of variable resistance comprising a resistance card of a length to accommodate such sections, a resistance wire wound over the entire length occupied by both said resistance sections, an electrical bond connecting adjacent turns of the constant resistance section over the portion extending from the first turn of said section to a point at least one turn short of its junction with the variable resistance section, and a vernier electrical bond connecting adjacent turns of wire



at the junction of said sections, said vernier bond connecting a plurality of turns of the constant resistance section and at least the first turn of the variable resistance section to extend the bonded section of wire slightly in excess of the constant resistance section.

5. A discontinuous resistance card including a section of constant resistance arranged between two sections of a variable resistance comprising a resistance card of a length to accommodate such sections, a resistance wire wound over the entire length occupied by said resistance sections, an electrical bond connecting adjacent turns of the constant resistance section over the portion extending between points at least one turn short of each of its junctions with the variable resistance sections, and vernier electrical bonds connecting adjacent turns of wire at each end of said constant resistance section, each of said vernier bonds connecting respectively a plurality of turns of the constant resistance section and at least the first turn of the adjacent variable resistance section to extend the bonded section of wire slightly in excess of the constant resistance section.

6. A discontinuous resistance card including a section of constant resistance and a section of variable resistance comprising a resistance card of a length to accommodate such sections, a resistance wire wound over the entire length occupied by both said resistance sections, an electrical bond connecting adjacent turns of the constant resistance section over the portion extending from the first turn of said section to a point at least one turn short of its junction with the variable resistance section, said electrical bond comprising a plurality of metallic strips substantially parallel to one another and perpendicular to the individual turns of said resistance wire, and a vernier electrical bond connecting adjacent turns of wire at the junction of said sections, said vernier bond comprising a metallic island in contact with a plurality of turns of the constant resistance section connected by said first mentioned bond and with at least the first turn of the variable resistance section to extend the bonded section of the wire slightly in excess of the constant resistance section.

7. The method of manufacturing a discontinuous resistance card including a section of constant resistance and a section of variable resistance comprising the steps of forming a resistance card of a length to accommodate such sections, winding said card with a resistance wire over the entire length occupied by both said resistance sections, forming an electrical bond between adjacent turns of the constant resistance section over the portion extending from the first turn of said section to a point at least one turn short of its junction with the variable resistance section, forming a vernier electrical bond between adjacent turns of wire at the junction of said sections, said vernier bond including a plurality of turns of the constant resistance section and at least one turn of the adjacent variable resistance section to extend the bonded section of wire slightly in excess of the constant resistance section, determining the exact junction of the two sections, and removing the electrical bond from all windings of said wire except where such bond is touching a constant resistance winding.

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