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CIRCUIT CONTROLLER

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6 Claims. (Cl. 29—155.5)

This invention relates to circuit controllers, and is more particularly directed to the resistance strips employed in connection with such controllers.

The present application is a division of my copending application, Serial No. 602,362, filed March 31, 1932, which is a division of my copending application, Serial No. 518,281, filed February 25, 1931, and in its preferred embodiment, is directed to the type of variable resistor comprising a resistance wire wound upon a flat strip or bar of insulating material commonly referred to as the resistance strip, which strip is brought to a cylindrical shape substantially concentric with a shaft upon which a contact arm is affixed, the individual turns of the resistance strip being progressively engaged by means of the contact shoe carried by the arm.

The resistance wire of the present invention is adapted to be engaged along the flattened surface of the strip, the contact being along the length of a turn of wire lying in the plane of the strip, and not along the edge of the strip, as is the usual practice.

I have found that the coils of the resistance wire along the wide cylindrical surfaces adjacent the edges of the resistance strip are held securely and are more nearly uniform in height and spacing than those on the edge of the strip. The strip may be also held in a cylindrical configuration without altering the uniformity of the winding on the inner cylindrical surface, which is engaged by the contacting means.

One object of the present invention is to provide a resistance strip which may include several wires having different current conducting capacities, the relative length of each wire being varied as desired. By the use of wires of varying resistance characteristics, it is possible to gain an increased flexibility of resistance gradients. In connection with this feature, the application is particularly directed to the manner of providing connection between the respectively adjacent coils of the different resistance wires in order to effect a permanent electrical connection therebetween, and to provide a smooth and graduated resistance change by means of the contacting shoe engaging the resistance strip.

The present invention is further characterized by the provision of a novel insulating strip for winding the resistance wire thereon, this strip being constructed preferably from insulating fibre, phenolic condensation products, or the like, and is preferably formed as a laminated structure, which, when heated, may be drawn into an arcuate or cylindrical shape in order to dispose it concentrically with respect to the contacting means. The strip is formed as a flat elongated rectangular member, which has its edges preferably carefully rounded and trued so as to assist

in the accurate placing of the individual turns of the wire. Preferably, the strip is provided with spaced grooves along its edges, and the resistance wire is placed in these grooves when wound upon the strip in order to provide accurate spacing between the respective turns of the wire.

The grooves formed on the edge of the strip may be, relative to the diameter of the wire, quite deep, and wire turns along the central part of the flat side of the strip may be secured in position by depositing a suitable cement along the center of each side of the wound strip. This cement is applied after the winding of the wire upon the strip, and upon setting or hardening, the cement forms a definite tie between the central parts of the coil and the side of the strip, which serves to anchor the turns against any lateral shifting when engaged by the contactor. This cement is preferably a dense cellulose cement and possesses great strength, but is not brittle upon setting. Bending of the strip into arcuate form does not cause the cement to crack or split from between the coils.

If desired, the strip may not be provided with grooves at the edges thereof, but in such cases, I prefer also to provide a line or band of cement along each edge, in order to assure that the wire is wound upon the strip and is anchored against any possibility of lateral shifting.

Another feature of the present invention is the provision of a resistance strip which may be wound with wire of different diameters at different points along the lineal extent thereof, which are joined for effecting a smooth and positive engagement of the contacting means therewith. This engagement is particularly achieved when the resistance strip is used in connection with the contacting means described in my above-mentioned copending application Serial No. 518,281. The windings are joined or bonded to each other by the use of a small piece of soft metal foil, which is provided at the junction of the windings, and which bridges a sufficiently large number of the turns to make a good connection.

The method of bonding disclosed in the present invention is distinctly advantageous in connection with this type of resistance strip. This comprises placing a small piece of lead wire over the point of juncture, and then pressing the wire or foil into engagement with the wires and embedding them in the foil. This may be accomplished either manually or automatically. In manual operation, the foil is first threaded under adjacent turns of the winding, and then the upper portion is looped over the underlying portion and pressed into position.

Another feature embodied in the resistance strip of the present invention is the particular construction provided at the terminal ends of 60

the strip, whereby a large number of the turns adjacent each of the ends of the strip are short-circuited, as by means of metal foil or the like, in order to provide a good contacting engagement with the base of the terminal member positioned thereabove, this construction being such that no change of resistance can be effected until after the contacting means has left the portion of the resistance strip lying under the terminal member.

Numerous other objects and advantages of the present invention will appear more fully from the following detailed description, which, taken in connection with the accompanying drawing, will disclose to those skilled in the art the particular construction, and method of securing the features set out above.

In the drawing:

Figure 1 is a rear elevational view of a resistance strip embodying one feature of my invention;

Figure 2 is an elevational view of a resistance strip provided with a terminal member for connecting the strip to an external circuit;

Figure 3 is an elevational view of a strip, embodying several features of the invention;

Figure 4 is a fragmentary diagrammatic sectional view, taken substantially on the line 4-4 of Figure 1 and showing the method of joining adjacent turns of two different kinds of wire for providing a junction therebetween;

Figure 5 is a fragmentary sectional view taken substantially on the line 5-5 of Figure 3, and showing a different method of performing the same connecting operation;

Figure 6 is an enlarged fragmentary detailed sectional view showing the terminal assembly disclosed in Figure 2;

Figure 7 is an enlarged fragmentary detail view of the resistance strip, disclosing the grooves formed in the edges thereof for securing the turned wire in spaced relation; and

Figure 8 is a sectional view taken substantially on the line 8-8 of Figure 2.

Referring now in more detail to the drawing, in Figure 1 I have disclosed an insulating member, indicated at 5, which is preferably composed of a strip of laminated phenolic compound of a special composition, which renders the same sufficiently flexible to permit bending when hot of the relatively short length which is employed into cylindrical shape, in order to accommodate the resistance within a cup-shaped housing.

The strip 5 may be formed from any suitable insulating material, such as fibre or the like, if desired. The edges 6 and 7 of the strip are preferably rounded, and are trued with respect to each other to provide parallel surfaces. The ends of the strip 5 are preferably notched, as indicated at 8, for accommodating a rivet or other suitable securing means when the strip is bent into cylindrical form, for securing the resistance strip in fixed position within the housing of the rheostat. The particular manner of securing the resistance strip, by means of the notches formed in the abutting edges thereof, is described in detail in my copending application, Serial No. 518,281, filed February 25, 1931.

Upon the strip 5 is preferably wound a resistance wire, indicated at 9, which is of relatively small diameter, for example, .002 of an inch, and which extends along the strip for a substantial length thereof. The wire is bare, and is spaced approximately .0001 of an inch between turns, which provides for approximately 466 turns per

lineal inch. Of course, these dimensions may be varied greatly without departing from the invention disclosed. From the opposite end of the strip 5, a second resistance wire 10 is wound about the strip, this wire possessing different current carrying characteristics than the wire 9, and may, or may not be, of the same diameter. The two windings 9 and 10 meet at a point adjacent that indicated by the reference numeral 11, and are suitably connected together by means of the metal foil member 12.

Referring now in detail to Figure 4, which illustrates one method of connecting the windings 9 and 10, I have disclosed therein a strip of metal foil 12, which is preferably of soft metal, such as lead or the like, the strip having one end thereof threaded, as by means of a needle or the like, under the adjacent pairs of turns of the windings 9 and 10. This portion of the metal foil is indicated by the numeral 13. After the portion 13 has been inserted under the respective pairs of turns of the windings 9 and 10, the remaining portion of the foil member 12 is bent over, as indicated in dotted lines in Figure 4, and engages the upper surfaces of the windings. Suitable pressure may then be applied, either by means of a press, or by means of the compressive expansion of the resistance strip within the housing by means of the securing rivet, as described in my copending application, Serial No. 518,281, 30 filed February 25, 1931, for pressing the metal foil member firmly about the turns of the windings, in order that good electrical contact may be made therebetween. The foil member, being made of relatively soft metal, is easily pressed downwardly so as to fill up the interstices between the adjacent turns of the windings and to afford a compact and effective connecting means.

Considering now Figure 2, it will be noted that the resistance strip is similar to the resistance strip 5 of Figure 1, and has been correspondingly identified. In order to assure that the winding of the resistance wire will be accurately held in spaced relationship upon the resistance strip during movement of the contacting means, I preferably provide a band of cement, indicated by the numeral 14, along the central part of the flat side of the strip. If desired, similar bands of cement 15 and 16 may be provided along the edges 6 and 7 of the strip for further assuring that the individual turns of the resistance wire will be held in proper spaced relationship. Preferably bare wire is employed, as with the method of making contact disclosed in my copending application Serial No. 518,281, bare wire with very little space between the respective turns thereof is entirely feasible, and there is not the difficulty of removing the enamel, or other insulation, which is the case in rheostats where enameled wire or the like is employed. The cement used for providing the bands 14, 15 and 16, is preferably a tough, dense cellulose cement that possesses great binding strength, but does not become brittle upon hardening. Thus, bending of the strip 5 into arcuate form after winding will not cause the cement to crack or split from between the coils of the winding.

Considering now the left hand end of the strip 5 of Figure 2, it will be noted that a plurality of the individual turns 17 of the resistance wire wound upon the strip are covered by a soft metal foil member 18, which, as shown more clearly in Figures 6 and 8, is pressed down about each of the turns 17 of the winding, and completely fills the spaces between adjacent turns. This foil

member 18 may be pressed into engaging relation with the turns 17 either by hand or by a machine press. Disposed in contacting relation with the foil member 18 is the terminal member 20, which is provided with the lead portion 21, and with the cut-out portion 22 fitting about the notch 8 in the resistance strip 5. This terminal member is described in detail in my copending application, Serial No. 602,007, filed March 30, 1932.

In the embodiment shown in Figure 3, I have provided a resistance strip 5 which has wound thereon three different resistance wires, these wires being indicated, respectively, by the numerals 23, 24 and 25. The resistance wire 25 is of substantial diameter, as compared to the wires 23 and 24, and provides for relatively small change in resistance per unit of length with respect to the other two wires. The junction of the wires 23 and 24, and the wires 24 and 25, is similar to that described in connection with Figure 1, but, in the present embodiment, the metal foil members 26 and 27 are not placed in position manually, as described in connection with Figure 4, but are pressed into contact engaging relation between the respective turns of the different windings by means of a machine operated press.

Considering in detail Figure 5, I have shown the resistance strip 5 disposed below the feeding mechanism of a machine press. A suitable upper bed portion 28 is adapted to rest upon the upper surface of the resistance strip 5, and is provided with a cut-out portion adapted to receive the ram or punch 29. A suitable soft metal wire, indicated at 30, is fed through the slot 31 into the cut-out portion in which the ram 29 operates, and is sheared off by downward movement of the ram to a length corresponding to the width of the cut-out portion. The ram 29 then forces the soft metal foil strip 27 downwardly into contact engaging relation with the windings 24 and 25, and serves to press the metal around the adjacent peripheries of each of the windings, thus forming an effective electrical contact therebetween.

It will be noted in Figure 3 that I have provided a relatively wide band of cement, indicated by the numeral 32, along the central portion of the flat side of the resistance strip 5, and have provided relatively narrow portions or bands of a cement along the edges of the strip. This is similar to the disposition of the cement shown in Figure 2.

In the enlarged view of the strip shown in Figure 7, the cement is omitted from the edges of the strip, and in place thereof the edges are provided with spaced grooves 35, these grooves 35 being adapted to receive the individual turns 36 of the resistance wire winding. If desired, cement may also be applied to the wire winding engaging in the grooves 35, after the strip has been wound, but I have found that this is unnecessary when the parallel extending edges of the strip are provided with grooves for receiving the wire, since the grooves serve to space the wire a definite distance between the respective turns thereof, and also hold the wire in proper spaced relationship. As shown in more detail in Figure 8, the edges of the insulator strip 5 are rounded, in order to present no sharp corners to the wire being wound thereon.

It is apparent that the wire may be held in spaced relation along the strip by means of either cement, disposed along the flat surface of the

strip and the extending parallel edges thereof, or by means of spaced grooves formed in the edges, or both means may be employed if desired. Also, the strip may be wound with wire of varying sizes, and having varying current carrying characteristics, in order to increase the flexibility of resistance gradients, the method of interconnecting the adjacent turns of two types of wire being applicable to either situation. Also, the composition of the strip, together with the cementing means used in connection with the winding, permits the strips to be bent into cylindrical form without danger of impairing the spaced relation between adjacent turns of the winding. Since bare wire is employed in this resistance strip, it is imperative that this spaced relationship be maintained, and to this end I have provided a resistance strip which may be either grooved and supplied with a cementitious material, or with a plurality of bands of cementitious material, in order to maintain the required spaced relationship between the individual turns of the windings.

I do not intend to be limited to the exact details shown and described in the illustrated embodiment of my invention, but only in so far as defined by the scope and spirit of the appended claims.

I claim:

1. The method of joining adjacent turns of two coils of wire wound upon insulating material which comprises inserting a sheet of soft metal foil under said turns against the insulating material, lapping a portion of said foil over said turns, and pressing both portions of the foil into firm engagement with said turns.
2. The method of joining adjacent turns of two coils of wire wound upon insulating material which comprises inserting a strip of inelastic conductor under said turns against the insulating material, lapping a portion of said conductor over said turns, and embedding said turns in said conductor.
3. The method of joining adjacent turns of two coils of wire wound upon insulating material which comprises inserting a strip of inelastic conductor under said turns against the insulating material, lapping a portion of said conductor over said turns, and pressing the lapped portion of said conductor against the turns and the insulating material to embed said turns of wire in said conductor.
4. The method of joining adjacent turns of two coils of wire wound upon insulating material which comprises forcing a soft metal strip against said adjacent turns supported by said insulating material to press the metal around the adjacent peripheries of each of the windings.
5. The method of joining adjacent turns of two coils of wire which comprises forcing a soft piece of inelastic conducting material against said adjacent turns to press the metal around the adjacent peripheries of each of the windings and embed the turns in said conducting material.
6. The method of joining adjacent turns of two coils supported by a non-conducting solid support which comprises forcing a soft conducting metallic strip against a plurality of the adjacent turns of each of the coils to embed the turns in the conducting material.

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