May 15, 1962 E. BLANCO 3,034,542

APPARATUS FOR CONSTRUCTING WIRE-WOUND RESISTANCE ELEMENTS

Filed March 29, 1956 3 Sheets-Sheet 1

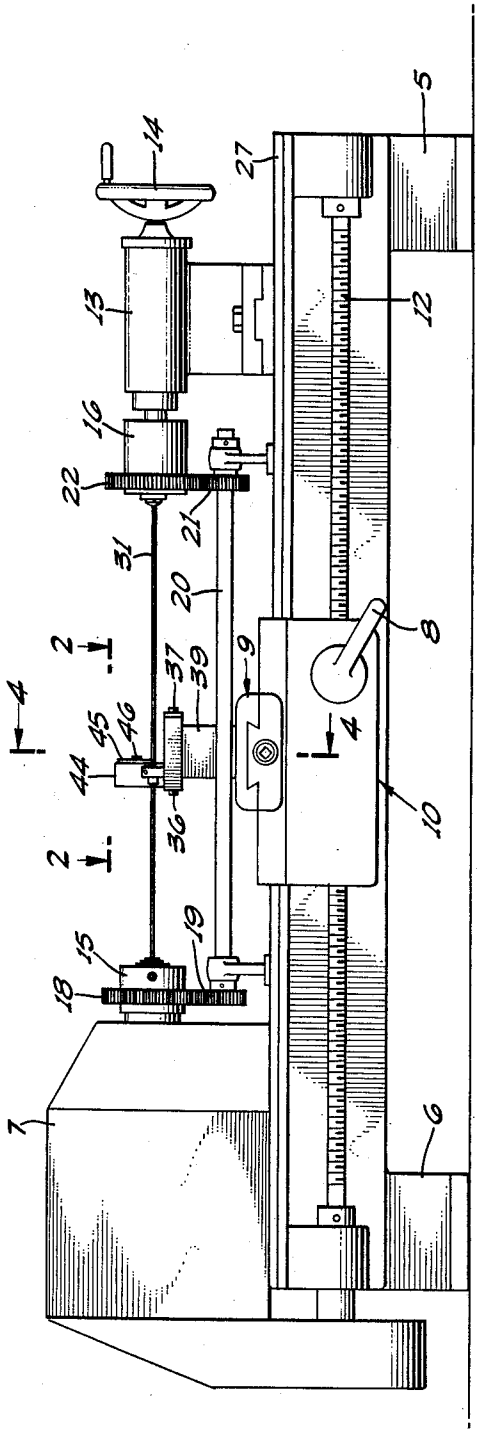


FIG. 1.

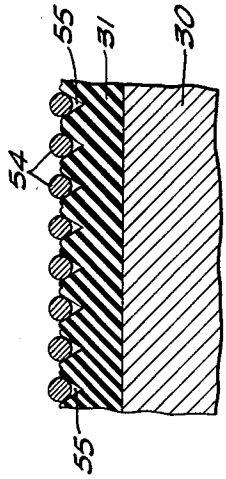


FIG. 6.

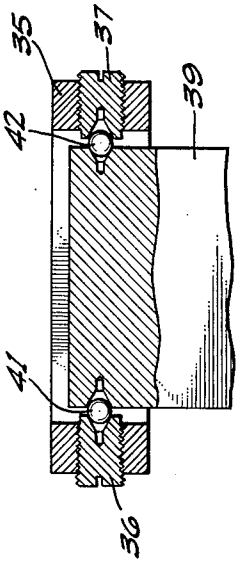


FIG. 3.

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APPARATUS FOR CONSTRUCTING WIRE-WOUND RESISTANCE ELEMENTS

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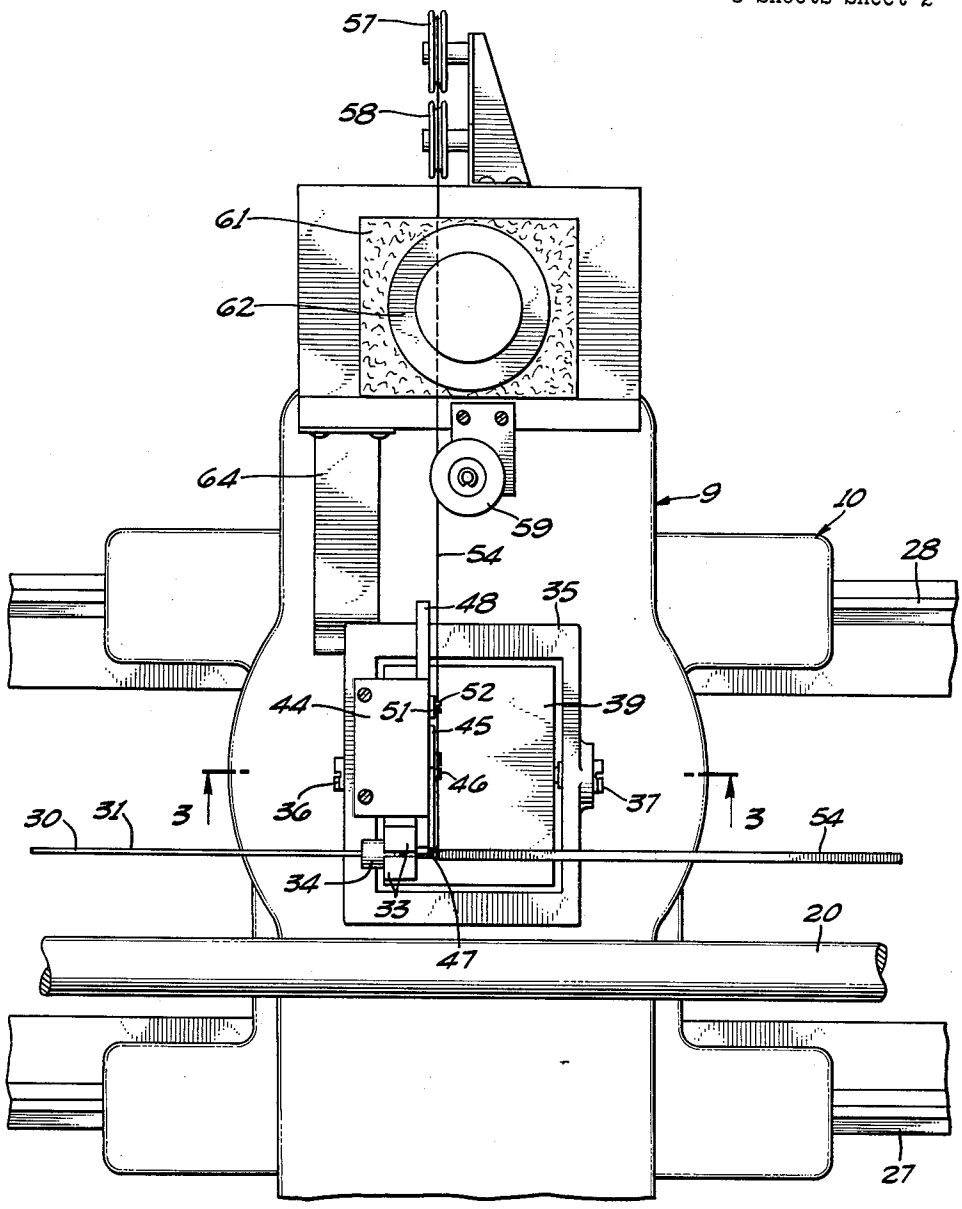


FIG. 2.

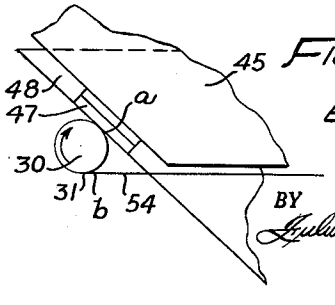


FIG. 7.

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APPARATUS FOR CONSTRUCTING WIRE-WOUND RESISTANCE ELEMENTS

Filed March 29, 1956 3 Sheets-Sheet 3

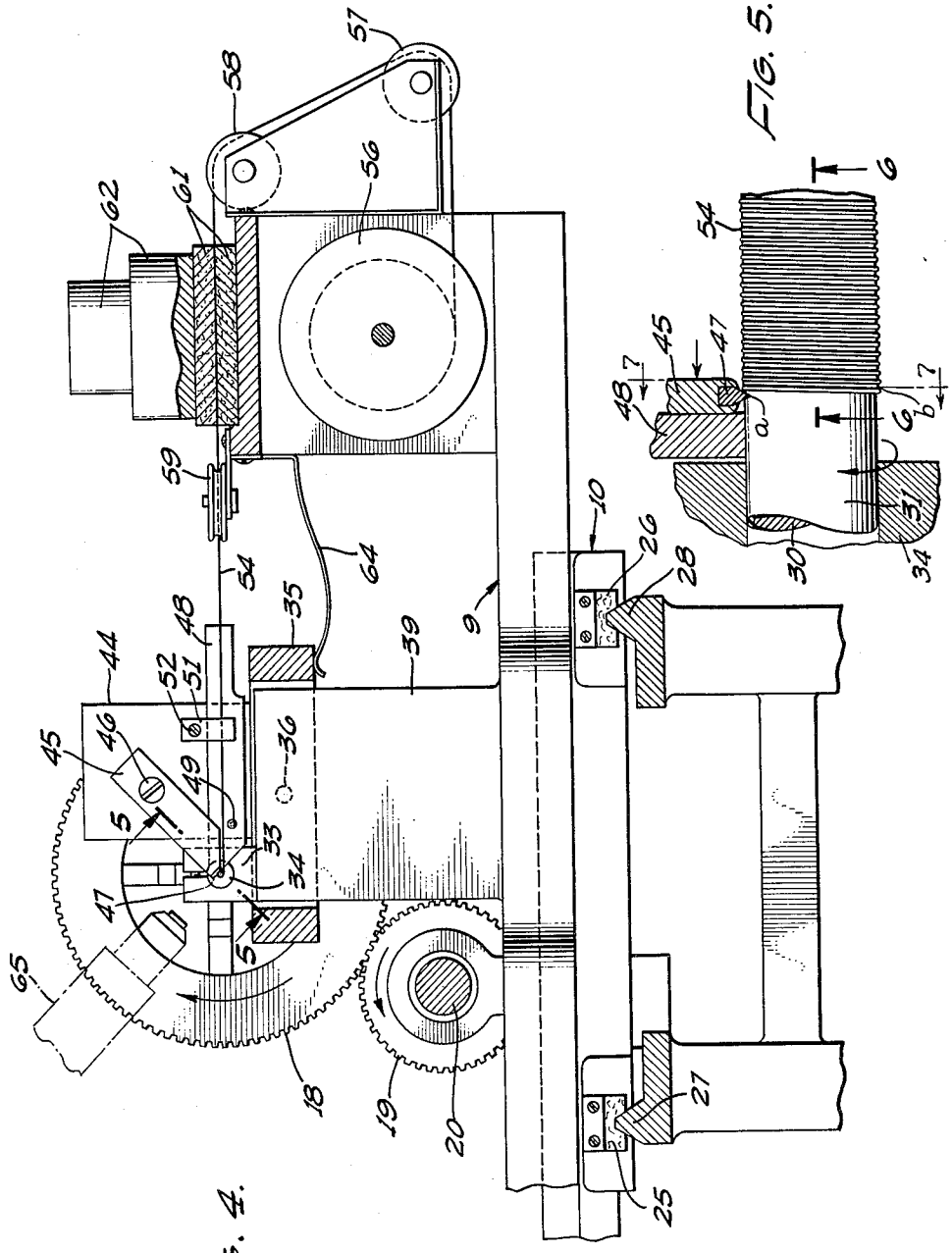


FIG. 4.

FIG. 5.

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United States Patent Office 3,034,542 Patented May 15, 1962

3,034,542

APPARATUS FOR CONSTRUCTING WIRE-WOUND RESISTANCE ELEMENTS

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Filed Mar. 29, 1956, Ser. No. 574,860
8 Claims. (Cl. 140—71.5)

This invention relates to electrical element construction and particularly to the construction of wire-wound resistance elements for resistors, potentiometers, and the like.

It is well known that resistance elements of various types are used in variable resistors and potentiometers wherein a slider is adapted to be moved along either a straight smooth wire or along the turns of a wire-wound resistance element. With the advent of miniature and subminiature electrical units, particularly for use in airborne equipment, accurate and stable resistor elements are required. The present invention is directed to a method of and system for obtaining wire-wound resistor units which are suitable for use in precision resistors and potentiometers and particularly subminiature units of the type embodied in airborne equipment.

The invention features a process and machine for continuously embossing or forming a groove in a comparatively soft insulating material surrounding a core and in which groove a resistance wire, preferably bare, is continuously wound as the core is rotated. By use of a predetermined accurate tension on the resistance wire, guiding means for the core and a predetermined positioning of the embossing tool on the insulating material, an accurate resistance element may be constructed rapidly and economically. The spacing between turns of the resistance wire is accurate, while the entire unit of core, insulating material, and resistance wire may be formed into various shapes to accommodate the device in which it is to be used. By substantially immediately following the formation of the groove in the insulating material with the resistance wire, there is no opportunity for dirt or other matter to get into the groove under the resistance wire.

The principal object of the invention, therefore, is to facilitate the manufacture of precision resistance elements.

Another object of the invention is to provide an improved method of economically constructing wire-wound precision resistance elements.

A further object of the invention is to provide an improved apparatus for constructing an accurate wire-wound resistance element.

A still further object of the invention is to provide an accurate and precision resistance element.

The novel features which are believed to be characteristic of this invention, both as to the manner of its organization and the mode of its operation, will be better understood from the following description when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevational view of the apparatus embodied in the invention;

FIG. 2 is a plan view of the embossing and winding elements taken along the line 2—2 of FIG. 1;

FIG. 3 is a detail cross sectional view of the embossing unit supporting plate taken along the line 3—3 of FIG. 2;

FIG. 4 is an end elevational view taken along the line 4—4 of FIG. 1;

FIG. 5 is a detail view of a resistance element showing the positioning shoe and embossing element;

FIG. 6 is a detail view of the resistor element as produced by the apparatus shown in the other figures and taken along the line 6—6 of FIG. 5; and

FIG. 7 is an enlarged view diagrammatically illustrating the winding operation and showing the interrelationship of the cooperable parts during such operation, taken substantially on line 7—7 of FIG. 5.

Referring now to the drawings in which the same reference numerals identify the same elements, a lathe, supported on standards 5 and 6, includes a driving motor within a housing 7, a carriage shown generally at 10 with its feed lever 8, and transverse carriage 9. The lathe mechanism also includes a feed screw 12 driven from the motor in housing 7, a tail stock 13 with its adjusting wheel 14 and a head stock collet 15, a collet 16 being provided for the tail stock 13. The head stock collet 15 is driven by the motor in housing 7, and through meshed gears 18 and 19 drives a counter shaft 20 to rotate meshed gears 21 and 22 attached to the tail stock collet 16. As shown in FIG. 4, the carriage 10 is mounted on grooved carriage guide blocks 25 and 26 slidable on tapered runners 27 and 28, respectively.

As shown in the drawings, a core rod 30, which may be of copper or similar material and which is coated with a plastic insulating material 31 (see FIG. 6) has one end mounted in the head collet 15, and its other end in tail stock collet 16. Both ends of the core rod are thus rotated through the shaft 20 and respective gears to minimize the torsion therein. The core rod is held in position in the hole of a sleeve guide 34 in a holder 33 mounted on a block plate 35 pivoted on adjustable screws 36 and 37 in a standard 39 by means of balls 41 and 42 (see FIG. 3).

Mounted on the plate 35 is a vertical panel 44 to which is attached an embossing unit 45 by screw 46 which has in the end thereof the actual pointed embossing element 47, which may be a diamond or similarly hard element. Also mounted on the panel 44 is a groove depth determining shoe 48, this shoe being pivoted at 49 and held in any adjusted position by a clamp 51 and screw 52. As shown in FIGS. 5 and 7, the edge of the shoe 48 rides against the surface of the plastic material 31 alongside of the unit 45 carrying the embossing element. Since the shoe 48 and embossing element 45—47 are both mounted on the standard 44, which in turn is mounted on the pivoted plate 35 biased by a spring 64, the shoe 48 will determine the depth of the embossing groove which is progressively made as the rod 30—31 rotates.

The resistance wire, as shown at 54, and which is laid in the spiral groove 55 made by element 47, is fed into the last turn of the groove as indicated at (*b*) substantially immediately after and following the formation of the groove at point (*a*), as shown in FIGS. 5, and 7, the wire being obtained from a supply reel 56 and passed around guide pulleys 57, 58 and 59 to the core 30—31. To maintain a predetermined tension in the resistance wire 54 and to clean it, it passes between two felt-like pads 61 upon which a predetermined pressure is applied by a weight member 62, the wire first contacting the core member 30—31 on its under side as shown in FIG. 4. That is, the resistance wire is placed in the groove within substantially 90 degrees of rotation of the core.

The operation of the apparatus will now be explained: The core 30—31 has its ends attached to the two collets, as mentioned above, and with the carriage 5 moved to the right in FIG. 1, the wire is attached to the core member in any suitable manner. The groove embossing unit 46, 47, and 48 is then adjusted to provide the depth of groove desired in accordance with the size of the resistance wire. The lever 8 then engages the carriage by means of the feed screw 12. The motor is then energized, and the core 30—31 and feed screw 12 are rotated, the screw moving the entire carriage, which includes the resistance wire and its supply reel, and other elements described

above to the left along the core 30—31. As the rod is rotated, the spiral groove 55 is embossed in the insulating material 31 and the resistance wire substantially immediately wound therein. The pitch of the groove controlled by the ratio between the rotation of the core and of the screw 12 determines the amount of separation between the turns of the wire. The spring 64 provides a predetermined loading so that the shoe 48 and embossing element 47 follows any irregularities in concentricity of the core 30—31 and insures a groove of uniform depth. This is accomplished by having the plate 35 carrying the embossing and wire directing elements pivoted as shown at 36 and 37.

To inspect the embossing and winding operation and to check on adjustments, particularly when resistance wire as small as .0004 of an inch used, a microscope, shown in phantom lines 65, is used. Different diameters of resistance wire down to .0002 of an inch may be wound on the machine and the core can have practically any diameter which may be accommodated in the machine. By winding the resistance elements in this manner, the resistance wire itself may be bare since the turns are accurately separated from each other by the spiral groove which is accurately embossed in the insulating material. By substantially immediately laying the resistance wire in the groove as it is embossed, the wire is always placed in a clean groove to obtain a more uniform diameter to the resistance unit. Thus, a highly reliable and maximum capacity unit is provided for resistors and potentiometers, particularly useful in subminiature equipment.

I claim:

1. Apparatus for producing wire-wound resistance elements on a core having an outer surface of insulation, comprising: means for rotating said core, a tool movable axially of said core for forming a single groove in said insulation as said core is rotated, an adjustable depth control member secured in fixed relationship with and adjacent said groove forming tool for engaging a non-grooved surface portion of said insulation for controlling the groove depth, means for urging said control member and said groove forming tool into working engagement with said insulation, means for simultaneously moving the control member and groove forming tool axially of said core at a substantially uniform rate to cause the groove to progress in a spiral path, and means for feeding a wire under tension into the groove substantially immediately following said groove forming tool, the feed point of said wire being moved axially of said core at substantially the same rate as the groove forming tool.

2. Apparatus for producing precision bare wire wound resistance elements on a core having an insulating covering, comprising: means for rotating said core; a movable support; a tool carried by said support for progressively forming a single groove in said insulation covering; an adjustable depth shoe carried by said support for engaging a non-grooved surface portion of said covering for controlling the groove depth; means biasing said support in a direction to press the shoe and tool against the surface of said covering; means including a feed screw having connection with said support for moving the shoe and tool as a unit axially of said core at a uniform rate to cause the groove to progress in a spiral path; and means for feeding a wire under tension into the finished groove substantially immediately following said tool, the feed point of said wire being moved axially of said core at the same rate as the tool.

3. Apparatus for winding extremely fine bare resistance wire, which may have a diameter of the order of .0002 of an inch, on a core surface of insulating material, which comprises: means for rotatably supporting said core; a movable support positioned laterally of said core; a groove forming tool carried by said support adapted to engage the outer surface of said core; a shoe carried by said support adapted to ride on the surface of said core closely adjacent the point of engagement of said tool

therewith, said shoe being adjustable to control the depth of groove formed by said tool; means biasing said support in a direction of movement to carry the tool and shoe to a working position with respect to said core surface; means including a feed screw for moving the support at a uniform rate axially of the core in a direction such that the shoe precedes the tool along the core surface to cause the tool to progressively form a single spiral groove of uniform depth in the core surface; and means for feeding a wire under tension into the last groove turn as it is being formed.

4. Apparatus for winding extremely fine bare resistance wire, which may have a diameter of the order of .0002 of an inch, on a core surface of insulating material, which comprises: means for rotatably supporting said core; a carriage; a pivotally mounted tool supported on said carriage positioned laterally of the core axis; a groove forming tool carried by said support adapted to engage the outer surface of said core; a shoe carried by said support adapted to ride on the surface of said core closely adjacent the point of engagement of said tool therewith, said shoe being adjustable to control the depth of groove formed by said tool; means biasing said support in a direction of movement to carry the tool and shoe to a working position with respect to said core surface; a sleeve guide mounted on said carriage for supporting the core adjacent said working position of said tool and shoe; means including a feed screw for moving said carriage longitudinally of said core at a uniform rate, the sleeve guide, shoe and tool being carried as a unit longitudinally of the core, and the tool operating to form a single progressively advancing spiral groove controlled to uniform depth by said shoe; and means for feeding a wire into the last turn of the groove as it is formed.

5. Apparatus for winding extremely fine bare resistance wire, which may have a diameter of the order of .0002 of an inch, on a core surface of insulating material, which comprises: means for rotatably supporting said core; a carriage; a pivotally mounted tool support on said carriage positioned laterally of the core axis; a groove forming tool carried by said support adapted to engage the outer surface of said core; a shoe carried by said support adapted to engage the surface of the core on the same side as the tool at a position closely adjacent the engagement of its working end on said core surface, said shoe being adjustable to control the depth of groove formed by said tool; means biasing said support in a direction of movement to carry the tool and shoe to a working position with respect to said core surface; a sleeve guide mounted on said carriage for supporting the core adjacent said working position of said tool and said shoe; means including a feed screw for moving said carriage longitudinally of said core at a uniform rate, the sleeve guide, shoe and tool being carried as a unit longitudinally of the core, and the tool operating to form a single progressively advancing spiral groove controlled to uniform depth by said shoe; and means for feeding a wire into the last turn of the groove as it is formed.

6. Apparatus for producing wire-wound resistance elements on a core having an insulating plastic coating thereon comprising: means for rotating said core, an embossing means including a pivoted support and an embossing element carried by said support and adapted for swinging movement therewith, means biasing said support in a direction to move the embossing element into engagement with the surface of said plastic coating, an adjustable depth shoe carried by said support to engage the surface of the plastic coating adjacent the embossing element for controlling the depth of said embossing element with respect to the surface of said plastic coating, means for moving said embossing element and said adjustable depth shoe axially of said core at a constant predetermined rate to thereby form a single spiral groove of uniform depth in said coating, the pitch of said groove providing a predetermined separation between the turns of said

spiral, and means having synchronized movement axially of said core with said embossing means for feeding a resistance wire into the last turn of said groove at a point substantially immediately following the embossing means in the direction of rotation of said core.

7. Apparatus for producing wire-wound resistance elements on a core having an insulating plastic coating thereon comprising: means for rotating said core, a support, a tool carried by said support for forming a continuous groove in said coating as said core is rotated, an adjustable depth control member also carried by said support and secured in fixed relationship with and immediately adjacent said groove forming tool to engage a non-grooved surface portion of said coating for controlling the groove depth, means for engaging the surface of said coating with said control member and said groove forming tool, means for simultaneously producing relative motion between said core and said control member and groove forming tool in a direction axially of said core to cause the groove to progress in a spiral path, and means for feeding a wire into said groove substantially immediately following said groove forming tool.

8. Apparatus for producing precision bare wire-wound resistance elements on a core having an insulating covering, comprising: means for rotating said core; a swingable support; an embossing tool carried by said support for progressively embossing a single groove in said insulation covering; an adjustable depth shoe carried by said support for engaging a non-grooved surface portion of said covering for controlling the groove depth; means

biasing said support in a direction to press the shoe and embossing tool against the surface of said covering; means for simultaneously moving the shoe and embossing element axially of said core at a uniform rate to cause the groove to progress in a spiral path; and means for feeding a wire under tension into the finished groove substantially immediately following said tool, the feed point of said wire being moved axially of said core at the same rate as the embossing tool.

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