Oct. 18, 1960 W. D. ENGELHARDT 2,956,754

COMB WINDING GUIDE

Filed May 14, 1957

Fig. 1.

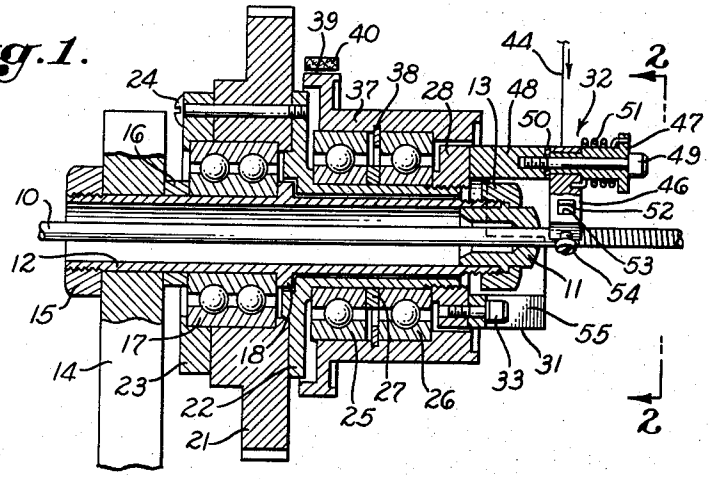


Fig. 2.

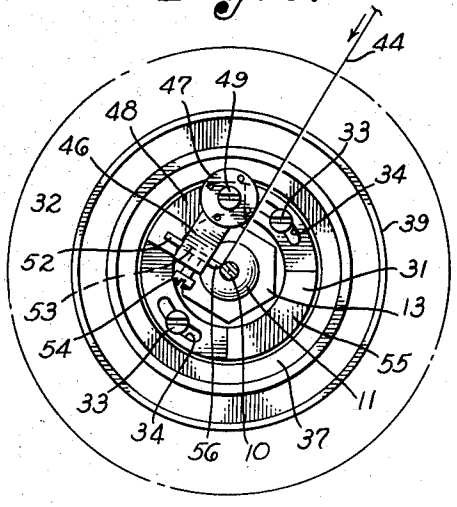


Fig. 3.

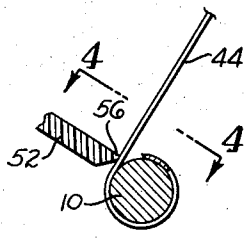


Fig. 6.

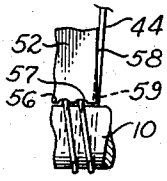


Fig. 5.

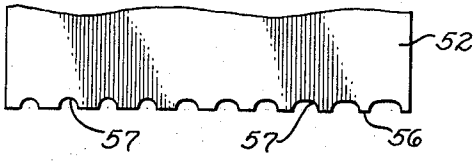
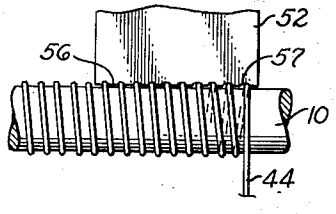


Fig. 4.



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COMB WINDING GUIDE

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7 Claims. (Cl. 242—9)

This invention relates to a guide for a winding machine and a method of making same, and, more particularly, to a comb-type guide especially suited for winding very small wire with very close and accurate spacing of turns.

When turns of wire are being wound on a mandrel in a winding machine, the average spacing between turns is constant because of the structure of the winding machine, the pitch of the winding being set in the winding machine. However, an occasional turn is misplaced due to variations in the surface of the mandrel, variations in tension on the wire being wound and other factors. It is desirable to have the turn spacing as uniform as possible so that the average space between turns can be made very small and thereby permit an increased number of turns per unit length of mandrel. Furthermore, uniform spacing improves the linearity of the wound unit, such as when a wire wound resistor is being produced for use in a potentiometer.

It is an object of this invention to provide a comb winding guide for use with a winding machine to produce uniform spacing of turns of the completed winding. A further object of the invention is to provide such a winding guide which does not have to be preset to a desired pitch of winding. A further object of the invention is to provide such a comb winding guide which may be used with very small wire and very small spacing of turns, for instance, wire of eight ten-thousandths of an inch with three and one-half ten-thousandths of an inch spacing between turns.

It is an object of the invention to provide a comb winding guide using a tough, smooth cornered material, such as nylon or polyethylene, as a comb with an edge of the comb contacting the newly wound turns in such a manner that regularly spaced grooves are made in the edge with the wider grooves adjacent the winding point so that the turns are shifted to a uniform spacing by contact with successive grooves. It is a further object of the invention to provide a method for making such comb winding guides.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. The drawing merely shows and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

In the drawing:

Fig. 1 is a sectional view of a portion of a winding machine having a preferred embodiment of the invention mounted thereon;

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

Fig. 3 is an enlarged sectional view of a portion of Fig. 2 showing the engagement of the comb winding guide with the turns of a winding;

Fig. 4 is a view taken along the line 4—4 of Fig. 3;

Fig. 5 is an enlarged view of the comb of Fig. 4; and

Fig. 6 is a view similar to that of Fig. 4 showing an alternative embodiment of the invention.

The comb winding guide of the invention may be used with any winding machine in which a wire is wound on a mandrel and is described and illustrated herein in conjunction with a machine for making wire wound resistors in which the wire and the guide are revolved around the mandrel which advances axially at a fixed rate. A portion of such a winding machine is shown in Figs. 1 and 2, no attempt being made to show the entire machine since its construction and operation are conventional.

A mandrel **10**, which may be a rod or a tube and which may be covered with an insulating tape or varnish, is advanced to the right at a fixed, predetermined rate through a nozzle **11**. The nozzle **11** is clamped in a sleeve **12** by a nut **13** and the sleeve is fixed to a frame **14** by a nut **15**, with a spacer **16** and bearing **17** clamped between a shoulder **18** of the sleeve **12** and the frame **14**. A gear **21** is mounted on the bearing **17** and is clamped to a collar **22** by a ring **23** with screws **24**. Bearings **25**, **26** and a bearing spacer **27** are mounted on the collar **22** with a lock ring **28**. A guide mounting block **31** carrying a guide assembly **32** is attached to the lock ring **28** by screws **33**, the mounting block **31** having arcuate slots **34** permitting rotational adjustment of the block relative to the lock ring. A spool support sleeve **37** is mounted on the bearings **25**, **26** and is positioned axially by a retainer ring **38**. An enlarged diameter **39** is provided on the support sleeve **37** for engagement by a wire tension brake **40**.

In the operation of the winding machine of Figs. 1 and 2, a spool of wire is mounted on the spool support sleeve **37** with the wire running off to a winding head (not shown) and returning at **44** for winding on the mandrel **10**. The gear **21** is rotated in synchronism with the winding head so that as the wire is wrapped around the mandrel by the winding head, the guide assembly **32** is also rotated around the mandrel. The pitch of the winding is set by controlling the rate of axial advance of the mandrel and the rate of rotation of the winding head.

Referring to the guide assembly **32**, a guide arm **46** is pivotally mounted on an arm bearing **47** which in turn is clamped to a boss **48** on the guide mounting block **31** with a screw **49**, the guide arm **46** being spaced from the boss **48** with a washer **50**. A coil spring **51** is mounted on the arm bearing **47** with one end engaging the arm bearing and the other end engaging the guide arm **46** for urging the guide arm in a counterclockwise direction as viewed in Fig. 2. A comb **52** is clamped in a slot **53** in the guide arm **46** by a screw **54**. Another boss **55** on the guide mounting block **31** serves as a counterbalance for the boss **48**.

The comb **52** is made of a tough, slightly flexible, wire wearable material which does not develop sharp corners or edges. Examples of suitable materials are nylon, Teflon, polyethylene, medium rubber and even close grain wood. When the term "comb material" is used in the specification and claims, a material having the above described characteristics is being referred to.

The comb **52** is provided with a thin, preferably wedge-shaped edge **56** which is urged into engagement with the wire wound on the mandrel **10** (Figs. 2, 3 and 4). The edge **56** is initially straight; however, as the winding operation proceeds, the wound turns soon wear grooves **57** into the edge of the comb. The average spacing between turns is constant because the winding machine winds at a uniform pitch and, therefore, the centers of the grooves **57** are uniformly spaced and correspond to the desired pitch of the winding. The

spacing between each turn at the winding point will vary slightly because of variations in the winding operation as previously discussed and, therefore, the grooves adjacent the winding point will be wider than the grooves remote from the winding point. The engagement of the comb with the winding is shown in Fig. 4 and an enlarged view of the comb is shown in Fig. 5. As the winding operation continues, the occasional misplaced turn is shifted on the mandrel toward the correct spacing by engagement with the sides of the progressively narrowing grooves. Hence, it is seen that the turns which may have random spacing at the winding point will be slightly corrected with each revolution of the winding machine until they emerge from contact with the comb having substantially uniform spacing. The comb winding guide of the invention has been successfully used with mandrels which are two tenths of an inch in diameter and with resistance wire which is eight ten-thousandths of an inch in diameter wound with three and one-half ten-thousandths of an inch spacing.

The comb of the invention does not have to be preset for the particular pitch being wound. It is only necessary that the edge **56** be straight at the beginning of the winding operation and the grooves will be worn into the edge at the exact pitch of the winding, thereby eliminating the requirement of a large number of combs for different pitch windings and eliminating setup time for adjusting a comb to a particular pitch. In effect, the forming of the grooves in the comb by engagement of the comb edge with the turns of wire is analogous to taking a statistical average of the turn spacing and applying this result to linearlizing the winding spacing.

It is preferred to have the edge of the comb wedge shaped, such as shown in Fig. 3, although, of course, it could be blunt. The thin, wedge-shaped edge wears in more rapidly, yet provides more material at the bottom of the groove. It has been found that optimum results are obtained by having the comb positioned relative to the mandrel and the incoming wire so that the line of force applied by the comb is at approximately 90° to the line of travel of the incoming wire, and further, to have the point of engagement of the edge of the comb with the incoming wire slightly ahead of the point of engagement of the incoming wire with the mandrel. This particular arrangement is shown in enlarged form in Fig. 3. However, it is understood that this particular arrangement is not essential to the invention and that the relative positions of the incoming wire, the comb and mandrel may be varied.

An alternative position for the comb is shown in Fig. 6 wherein the comb is mounted substantially parallel to the incoming wire with the wire engaging an edge **58** of the comb for controlling the positioning of the wire at the winding point. The edges **56** and **58** are at right angles to each other and the incoming wire wears a groove **59** in the edge **58** similar to the grooves **57** in the edge **56**.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

I claim as my invention:

1. In an apparatus for controlling the spacing of turns of wire wound on a mandrel in a winding machine, the combination of: a length of comb material having a wedge-shaped edge; and means for urging said edge against the turns on the mandrel adjacent the winding point with the line of application of the force exerted by said edge on the winding and the line of the wire being fed onto the mandrel lying in a plane substantially perpendicular to the axis of the mandrel with said lines being approximately at right angles to each other.

2. An apparatus as defined in claim 1 in which said line of application of said force lies in a first plane which is parallel to a second plane passing through the axis of the mandrel, said first plane being spaced from said second plane toward the wire being fed onto the mandrel.

3. In an apparatus for controlling the spacing of turns of wire wound on a mandrel in a winding machine, the combination of: a length of comb material having a thin edge; a plurality of grooves in said edge, the centers of said grooves being substantially equally spaced along said edge, said grooves progressively decreasing to a minimum width in a direction away from the winding point; and means for urging said edge against the turns on the mandrel adjacent the winding point.

4. In a guide for a winding machine having a mandrel and means for winding a wire on the mandrel at a pitch controlled by the winding machine, the combination of: a length of comb material having a thin edge; support means pivotally mounted on the winding machine for supporting said edge in engagement with the turns on the mandrel adjacent the winding point, the pivotal axis of said support means being spaced from and substantially parallel to the axis of the mandrel; and means for engaging said support means and the winding machine for resiliently urging said edge against the turns and wearing grooves in said edge with a center to center spacing corresponding to the winding machine pitch.

5. In an apparatus for controlling the spacing of turns of wire wound on a mandrel in a winding machine, the combination of: a length of comb material having a straight edge; and means for urging said straight edge against the turns on the mandrel adjacent the winding point for forming grooves of equal spacing and progressively decreasing width in said edge, with said edge substantially parallel to the axis of the mandrel.

6. A method of making a comb for a winding guide, including steps of: winding a length of wire on a mandrel at a predetermined pitch; bringing an edge of comb material into engagement with the wire on the mandrel adjacent the winding point with the edge substantially parallel to the axis of the mandrel; and pressing the edge of the comb material against the wire for forming a plurality of grooves in the edge by the wearing action of the wire on the comb material with the grooves having equally spaced centers and progressively decreasing width.

7. In a guide for precisely aligning turns of wire previously wound on a mandrel at a preset pitch, the combination of: a length of comb material having a thin, straight edge for engaging the turns on the mandrel, with the comb material being wearable by frictional engagement with the turns forming grooves in the edge; and means for urging said edge against the turns on the mandrel adjacent the winding point with said edge positioned substantially parallel to the axis of the mandrel.

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