May 12, 1953 B. B. SCOTT 2,638,278

WINDING MACHINE WITH MINIMUM TURN SPACING DEVICE

Filed June 18, 1949

Fig. 1.

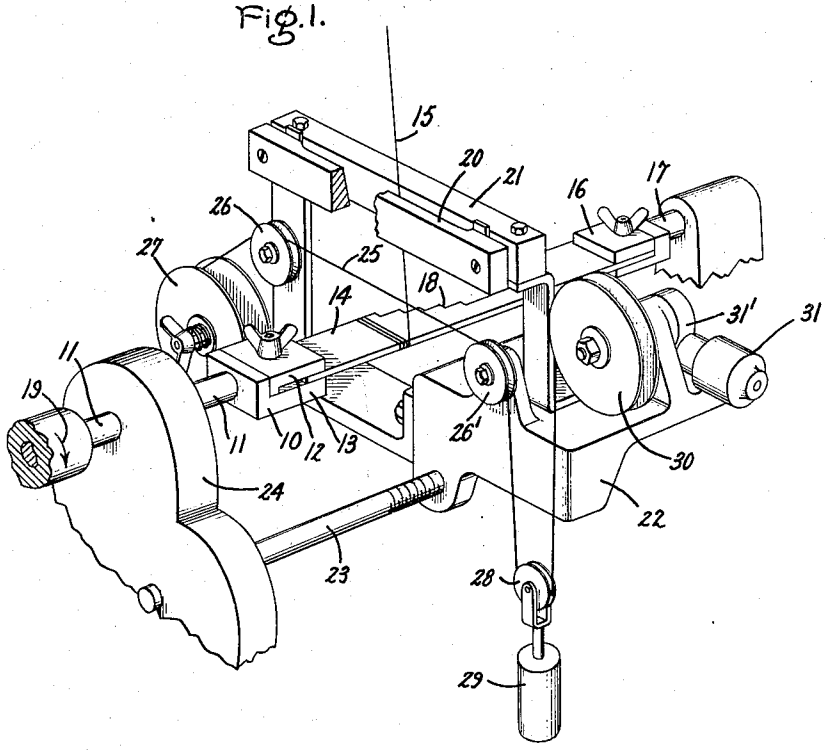
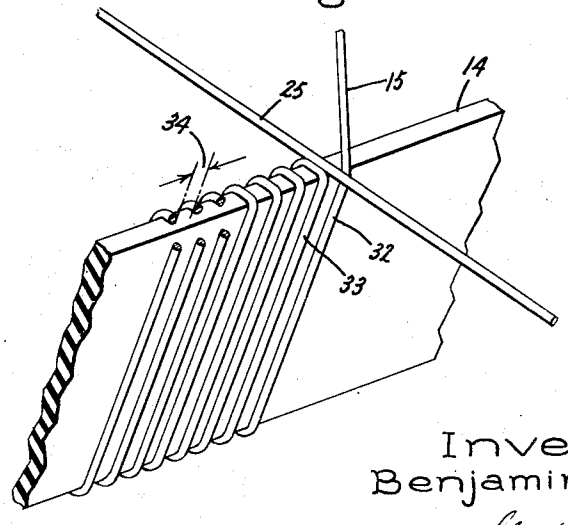


Fig. 2.



Inventor:
Benjamin B. Scott,
by Chas. H. Watt
His Attorney.

Patented May 12, 1953 2,638,278

UNITED STATES PATENT OFFICE

2,638,278

WINDING MACHINE WITH MINIMUM TURN SPACING DEVICE

Benjamin B. Scott, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application June 18, 1949, Serial No. 100,043

12 Claims. (Cl. 242—9)

1

My invention relates to winding machines and more particularly to machines for winding precision variable resistance units, and has for its object simple and reliable means for assuring a predetermined minimum spacing between the turns of the resistance conductor.

My invention has particular application in the winding of variable resistance units with fine wire on flat card suports, which resistance units are constructed to vary the amount of resistance in an electric circuit as an electric contact or brush is moved over bared edge portions of the resistance turns. The resistance may be constructed to give a resistance variation which is either a linear or non-linear function of the movement of the electric contact. In order to obtain very close limits in the predetermined linear or non-linear relationship between resistance change and movement of the contact it is necessary that the turns be spaced apart very accurately in predetermined relative positions on the card.

Moreover, although the spacing between the turns may not be uniform and may be varied during the winding operation, it is essential that there be at least a predetermined minimum amount of spacing between turns to prevent turn short circuiting by gradual flattening of the resistance wire under brushing action, to prevent turn short circuiting because of small physical displacement of turns under brushing action, to eliminate electrical brushing noise difficulties associated with high bond between turns arising from incomplete drying of the varnish applied to secure surface tension effects during application of the bonding agent, and to eliminate electrical brushing noise arising from wire enamel on the sides of the brush edge turns following normal wear by providing mechanical clearance for brush edge cleaning to an appropriate depth.

I have found that the best obtainable commerical round resistance wire for use in the manufacture of precision variable resistance units is not perfectly circular because of manufacturing limitations, and particularly in very fine wire, the out-of-round variation assumes very perceptible proportions such that the wire has a pronounced tendency to roll over on a flat side when a narrow edge engages the card. This rolling action, when it occurs in a direction toward the preceding turn, results in decreased spacing. Also, microscopic machining imperfections in the edges of card type winding forms used in the manufacture of precision variable resistance units have a tendency to produce additional wire displacement during winding operations, this condition becoming more pronounced and of increasing importance as wire sizes are reduced.

2

In carrying out my invention in one form, I provide a spacing member which is interposed between the incoming wire and the preceding turn at critical parts of the turn to assure a minimum spacing, the wire being secured against rolling action after the spacing member is removed by reason of the fact that the wire is bent around the supporting card. More specifically, I provide a wire having a diameter sufficient to provide the required minimum spacing between the turns, which wire is mounted on the resistance wire feeding means so as to be movable therewith and extends in a direction perpendicular to the axis of rotation of the card and in position to engage the last turn at critical points on the card and thus separate it from the turn being wound a distance at least as great as the predetermined required minimum spacing.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a fragmentary view in perspective of a potentiometer resistance winding machine embodying my invention, while Fig. 2 is an enlarged fragmentary view showing the card in engagement with the spacing wire.

Referring to the drawing, I have shown my invention in one form as applied to a potentiometer resistance winding machine comprising a winding head-stock 10 secured to shaft 11 and comprising clamping jaws 12 and 13 between which is secured one end of a support or card 14 made of electrical insulating material on which a resistance wire 15 is wound. The opposite end of the card 14 is secured by a second clamp 16 mounted on a shaft 17 in axial alignment with the shaft 11. The card 14 is shown as a strip of electrically insulating material having one straight edge, which is the electric contact brushing edge of the completed resistance, and one edge of irregular shape provided with steps 18 to give a varying turn length in accordance with the desired resistance characteristic. It has a noncircular cross section, shown as rectangular. To prevent axial twist and bending of cards which are not extremely stiff and consequent turn spacing irregularity, a rotating slot type of card holder may be used, such as disclosed in a copending application of John R. Moore, Serial No. 664,471, filed April 24, 1946, for Variable Resistor Winding Machine, which

application is assigned to the same assignee as this application.

By means of a suitable driving motor connected to the shaft **11**, the shaft is turned in a clockwise direction, as indicated by the arrow **19**, thereby to wind the wire **15** on the card **14**, the wire being pulled from a suitable reel (not shown) provided with a drag tension means such as an electric torque motor (not shown). For the purpose of guiding the wire **15** so as to obtain the desired turn spacing, a guide is provided comprising two strips, **20** and **21**, secured together in spaced parallel relation between which the wire **15** is passed, the spacing between the strips **20** and **21** being just slightly greater than the normal diameter of the wire **15**. This wire guide is preferably of the type described and claimed in my copending application Serial No. 82,112, filed March 18, 1949, for Wire Guide. The two strips **20** and **21** are carried by a carriage member **22** mounted for slidable movement in a direction parallel with the axis of rotation of the card **14**. The carriage is advanced with the winding of the wire on the card in a predetermined spaced relation with the speed of the card by means of a lead screw **23** connected to the shaft **11** through suitable drive gearing (not shown) indicated by the gear enclosure **24**, whereby the turns are wound in a predetermined relation of minimum spacing.

In accordance with my invention, I provide positive turn spacing means comprising a wire **25** mounted on the carriage **22** and extending across and above the card **14** in a direction perpendicular to the axis of rotation of the card. As shown, the wire extends across two positioning pulleys **26** and **26'** mounted on the carriage **22**. One end of the wire is secured to a supply reel **27** mounted on the carriage **22** and secured against rotation, while its other end after passing over the guide wheel **26'** extends downward in a loop and around a tension pulley **28** provided with a weight **29** and then around an adjacent pulley **30** to which it is secured. By means of a knob **31** connected to the pulley **30** through a worm and worm wheel gearing **31'**, the pulley **30** may be turned to shorten or lengthen the wire loop and thereby adjust the height of the weight **29** so that it is free to rise and fall during the winding operation without engaging the frame or other parts of the machine, whereby a predetermined tension is maintained in the wire.

The spacing wire **25**, moreover, is positioned on the carriage **22** by the pulleys **26** and **26'** so as to be engaged particularly by the brushing-edge of the card, i. e. its straight edge, as the card rotates and lie against the preceding turn as shown in Fig. 2 and thus positively space the turn **32** being wound from the preceding turn **33** a distance **34** at least as great as the diameter of the spacing wire. It will be observed that the spacing wire extends between the incoming wire **15** and the preceding turn. Moreover, the spacing wire is of such height with respect to the card **14** that it engages the straight edge of the card preferably at approximately 10 angular degrees of card rotation before the incoming wire **15** engages the flat side of the card **14** and is disengaged by the card approximately 25 degrees of card rotation thereafter. As the card turns under the spacing wire the card pushes the spacing wire upward at the point of engagement, the required additional length of wire being supplied from the loop by raising of the weight **29** which maintains the wire under a predetermined tension. In the event of excessive wear of the wire **25**, it is moved between

the reel **27** and pulley **30** to bring a different portion into engagement with the card. If desired, the wire **25** may be moved continuously to prevent localized wear.

Preferably, the diameter of the spacing wire **25** is selected to be approximately 15 per cent less than the design minimum spacing between any turns on the card, which spacing of turns in normal practice is approximately twice the minimum spacing required for satisfactory bonding of the resistance wire to the card by means of a suitable varnish. Ordinarily, the diameter of the spacing wire will be no greater than the diameter of the wire being wound.

It will be understood that the bending of the resistance wire **15** into a loop around the edge of the card effectively prevents rolling of the wire on the card from its wound position after the card disengages the spacing wire with the result that a desired minimum spacing between turns is always assured on the brushing edge of the card and generally on the sides of cards and opposite edge although this is of lesser importance.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto, since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A winding machine comprising driving means for rotating a support, wire feeding means movable by said driving means for feeding a wire to the support so to wind the wire in spaced turns on the support, and a yieldable turn spacing member on said feeding means, means for tensioning said spacing member, said spacing member being physically oriented for interposition between the wire and the last turn on the support for spacing each turn a predetermined distance from the preceding turn.

2. A winding machine comprising driving means for rotating a support about a predetermined axis, wire feeding means movable in substantial parallel relation with said axis, a driving connection between said feeding means and said driving means for moving said feeding means in a predetermined relation with said driving means thereby to wind a wire in spaced turns on said support, and a yieldable turn spacing member on said feeding means, means for tensioning said spacing member, said spacing member being physically oriented for interposition between the incoming wire and the last turn on the support for spacing each turn a predetermined distance from the preceding turn.

3. A winding machine comprising driving means for rotating a support having a noncircular cross section, wire feeding means movable to feed a wire to the support, a driving connection between said feeding means and said driving means for moving said feeding means in a predetermined relation with said driving means thereby to wind the wire in spaced turns on said support, and a turn spacing member on said feeding means arranged to extend across the support in position to be engaged by the support and lie between the incoming wire and the last turn on the support so as to space each turn a predetermined distance from the preceding turn.

4. A winding machine comprising driving means for rotating a support having a rectangular cross section, wire feeding means movable to

feed a wire to the support, a driving connection between said feeding means and said driving means for moving into feeding means in a predetermined relation with said driving means thereby to wind the wire in spaced turns on the support, and a turn spacing member on said feeding means arranged to extend across the support in position to be engaged by at least one edge of the support and lie between the incoming wire and the last turn on the support so as to space each turn a predetermined distance from the preceding turn.

5. A winding machine comprising driving means for rotating a support about a predetermined axis, wire feeding means movable in substantially parallel relation with said axis, a driving connection between said feeding means and said driving means for moving said feeding means in a predetermined relation with said driving means thereby to wind a wire in spaced turns on the support, and a turn spacing wire on said feeding means extending substantially at right angles with said axis for interposition between the incoming wire and the last turn on the support for spacing each turn a predetermined distance from the preceding turn.

6. A winding machine comprising means for supporting a resistance card for rotation about a predetermined axis, means for turning said supporting means to wind a resistance wire on the card, wire feeding means movable in parallel relation with said axis, a driving connection between said feeding means and said driving means thereby to wind the wire in spaced turns on the card, and a spacing wire on said feeding means extending substantially at right angles with said axis in position to be engaged by at least one edge of the card and lie between the incoming wire and the last turn on the card so as to space each turn a predetermined distance from the preceding turn.

7. A resistance winding machine comprising driving means for supporting and rotating a flat rectangular cross section resistance card about a predetermined axis to wind a resistance wire thereon, wire feeding means movable in a direction parallel with said axis, a minimum spacing device on said feeding means comprising a spacing wire positioned for intermittent deflection by the radially outwardmost edges of the card as the card is rotated by said driving means for straddling engagement of said spacing wire by the incoming wire and the last turn on the card for maintaining a predetermined minimum spacing therebetween irrespective of the speed of movement of said wire feeding means.

8. A resistance winding machine comprising driving means for supporting and rotating a flat rectangular cross section resistance card about a predetermined axis to wind a resistance wire thereon, wire feeding means movable in a direction parallel with said axis, means for moving said wire feeding means at a speed having a predetermined relationship to the speed of rotation of said driving means to axially space turns of the wire on the card, a minimum spacing device on said feeding means comprising a tensioned spacing wire positioned for intermittent deflection by the radially outwardmost edges of the card as the card is rotated by said driving means for straddling engagement of said spacing wire by the incoming wire and the last turn on the card for maintaining a predetermined minimum spacing therebetween irrespective of the speed of movement of said wire feeding means.

9. In a resistor winding machine of the type for winding a single layer of spaced turns on a support member and including driving means for supporting and rotating the support member about a predetermined axis and a wire guide movable along the axis for establishing the spacing of the turns to be wound, a minimum turn spacing device comprising a resilient tensioned member positioned transversely to said axis within the anticipated maximum radius of rotation of the support on which the wire is to be wound mechanically connected to said guide member for axial movement therewith and having a dimension in the direction parallel to said axis corresponding to the minimum desired turn spacing.

10. A resistor winding machine comprising driving means for supporting and rotating a resistor wire support member about a predetermined axis to wind a resistance wire thereon, wire guiding means positioned beyond the maximum radius of the support to be used and movable in a direction parallel to said axis for positioning the wire as it is wound upon the support, and a spacing member for providing a minimum spacing between adjacent turns of the wire to be wound comprising a resilient spacing wire of a diameter corresponding to the minimum desired turn spacing extending transversely to said axis in a position within the maximum radius of rotation about said axis of the resistor support to be used.

11. A resistor winding machine comprising driving means for supporting and rotating a resistor wire support member about a predetermined axis to wind a resistance wire thereon, wire guiding means movable in a direction parallel to said axis for positioning the wire as it is wound upon the support, a spacing member for providing a minimum spacing between adjacent turns of the wire to be wound comprising a resilient spacing wire of a diameter corresponding to the minimum desired turn spacing, supporting means for said spacing wire attached to said guiding means for movement therewith at a distance with respect to said guiding means along said axis such that the leading edge of said spacing wire is at the intended position of the following edge of the wire being wound as it leaves said guiding means.

12. A resistor winding machine comprising driving means for supporting and rotating a resistor wire support member about a predetermined axis to wind a resistance wire thereon, wire guiding means including a guide positioned beyond the maximum radius of the support to be used and movable in a direction parallel to said axis for positioning the wire as it is wound upon the support, a spacing member for providing a minimum spacing between adjacent turns of the wire to be wound comprising a resilient spacing wire of a diameter corresponding to the minimum desired turn spacing, means including at least one pulley wheel for supporting said spacing wire attached to said guiding means for movement therewith, the separation of said spacing wire with respect to said guide in the direction parallel to said axis being such that the leading edge of said spacing wire is at the intended position of the following edge of the wire being wound as it leaves said guide, said spacing wire being positioned transversely to said axis and extending within the maximum radius of rotation about said axis of the resistor support to be used, and a yieldable tension means connected to said

spacer wire for applying a tension thereto across said pulley wheel.

BENJAMIN B. SCOTT.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,627,188	Lightfoot	May 3, 1927
2,360,960	Martindell	Oct. 24, 1944
2,364,696	Crom	Dec. 12, 1944
2,393,548	McCoy	Jan. 22, 1946
2,401,676	Weber	June 4, 1946
2,406,397	Parkinson	Aug. 27, 1946
2,406,846	Muller	Sept. 3, 1946

FOREIGN PATENTS

Number	Country	Date
143,624	Great Britain	May 25, 1920
483,356	Great Britain	Apr. 19, 1938