This invention relates to collapsible mandrels especially adapted for use with apparatus for winding strip material or the like in contiguous helical convolutions.

In helically winding strip material for certain purposes, it is necessary to retain the dimensions of the convolutions as wound upon the mandrel of the winding machine. To this end, it becomes necessary to collapse the mandrel in order to move it from within the completely wound element and at the same time prevent the element from changing its wound dimensions axially or radially, due to elasticity of the material or otherwise.

One class of work, in which the use of collapsible mandrels is necessary in order to retain wound dimensions, is the manufacture of helically wound hollow cylindrical foraminous elements which are particularly adapted for the surface tension dialysis of commingled liquid masses. Such elements are formed from a strip of metal transversely grooved or knurled on one flat surface thereof and wound edgewise helically, so that the contiguous flat knurled and smooth surfaces of the strip form a surface of foramina extending from wall to wall of the resulting hollow cylindrical element. A foraminous element of this type is illustrated and described in my copending application, Serial No. 638,329, filed October 13, 1932.

The mandrel of the present invention is particularly adapted for use with a winding machine for the production of such elements.

In accordance with the invention, the mandrel consists of a substantially cylindrical sleeve provided with a slot which extends longitudinally along the entire length thereof. The slotted sleeve is adapted to be removable secured at one end to the headstock of the winding machine. The sleeve is also provided at spaced intervals on its inner surface on either side of the longitudinal slot therein, with a series of abutments which cooperate with a wedge member having a plurality of correspondingly spaced wedge portions. Each of the wedge portions cooperates with a corresponding abutment to expand the sleeve uniformly to the desired circumference when the wedge member is properly adjusted within the sleeve.

The preferred means for adjusting the wedge member to expand the sleeve comprises a tapered key adapted to be inserted in a slot arranged in an extension of the wedge member. The key is also adapted to engage the sleeve cap in such a way that, when the key is driven into the slot in the wedge member, the wedge portions of the latter are forced into contact with the abutments on the sleeve and the slotted sleeve is expanded to the proper predetermined circumferential dimension of the inner cylindrical surface of the element which is to be wound and formed thereon. Removal of the key from its slot in the wedge member permits the sleeve cap to be removed and the wedge member to be released from the abutments of the slotted sleeve of the mandrel. Thereupon the sleeve collapses and it may be withdrawn from within the wound element, or the element may be withdrawn from the collapsed sleeve.

In a modified form of the collapsible mandrel of this invention, it is not necessary to remove the sleeve from the headstock of the winding machine in order to remove the completely wound element therefrom. This advantage is obtained by securing the sleeve on a projection provided on the headstock, which projection supports the slotted sleeve at a point substantially diametrically opposite to the slot therein. The headstock is reduced in diameter adjacent the projection thereon so that, when the wedge member is moved from contact with the abutments of the sleeve, the latter collapses about the reduced diameter portion of the headstock in a manner which will be readily understood. Other portions of the modified collapsible mandrel are preferably arranged in a manner identical to those described hereinbefore.

For a more complete understanding of the construction and operation of the collapsible mandrel of this invention, reference may be had to the following description of a preferred embodiment of the invention illustrated by the accompanying drawing, in which:

Fig. 1 is an elevation of a winding machine including the collapsible mandrel of this invention which is illustrated in axial section as seen along line 1—1 of Fig. 2;

Fig. 2 is a plan view of the collapsible mandrel with a portion broken away to illustrate the structure of the wedge member;

Fig. 3 illustrates one end of the slotted sleeve of the mandrel;

Fig. 4 is an enlarged cross section of the mandrel as seen along the line 4—4 of Fig. 1;

Fig. 5 illustrates in perspective several convolutions of a hollow cylindrical foraminous element which may be formed by helical winding on the collapsible mandrel of this invention;

Fig. 6 is a partial axial section through a modified form of the collapsible mandrel of this invention; and
Fig. 7 is a cross section thereof as seen along the line 7—7 of Fig. 6. In the drawing, numeral 10 designates the driving member 25 which engages the periphery of the shaft 11; 12 is fixed on the shaft 11 by means of a pin 13, the head of which projects therefrom as at 14. The headstock 12 is reduced in diameter to accommodate one end of the sleeve 15 which is provided with a long slot 16, when the sleeve is expanded. The sleeve 15 is provided with a notch 16' at one end which fits over pin projection 14 on the headstock 12 and secures the sleeve 15 to the headstock 12 so as to be rotated thereby when driven by the motor 16. The other end of the sleeve 15 is fitted with a removable cap 17 provided with a central opening whereby it may be placed in position over the shaft 11.

As shown particularly in Figs. 1 and 4, the interior of the sleeve 16 is provided with at least two pairs of opposite abutments 18 having integral lugs 19 to form guides. The abutments 18 are tapered longitudinally of the sleeve, as shown in Fig. 2, and conform to the taper of the two wedge portions 20 of the wedge member 21 which slides between abutments 18 on the guides 19. The wedge portions 20 of the wedge member 21 are spaced apart a distance corresponding to the spacing between the two pairs of abutments 18 on the sleeve 15.

The wedge member 21 is provided with an extension 22 which projects through an opening in the cap 17. The extension 22 is provided with a slot 23 adapted to receive a tapered key 24. One side of the key 24 engages the flat surface of cap 17, while the other or tapering side thereof engages one end of the slot 23 in wedge member 21. When the sleeve 15 is provided with an annular groove 25 which communicates with a pair of oppositely disposed longitudinal grooves 26. Cooperating with these grooves is a locking member 27 consisting of a ring having two oppositely disposed teeth 28 conforming substantially to the dimensions of slots 25 and 26. This locking member 27 may be placed on the shaft extension 11 by sliding it axially thereover with the teeth 28 registering longitudinal grooves 26 until the teeth rest in annular groove 25, whereupon the member 27 may be given a slight turn which displaces its teeth 28 from alignment with longitudinal grooves 26.

A spacer 29 extending between fastening member 27 and cap 17 serves to hold the sleeve 15 in proper contact with the headstock 12 and the pin projection 14 in engagement with slot 16' of the sleeve 15.

In utilizing the collapsible mandrel of this invention, the mandrel may be assembled in the manner previously described. For example, a metal strip which is provided with transverse grooves or knurling on one flat surface thereof may be wound edgewise on the mandrel in the form of a continuous helix, the contiguous convolutions of which form a myriad of like foramina extending from one cylindrical surface to the other of the foraminous element thus formed. Such a foraminous element is illustrated and described in the aforementioned copending application, and by way of illustration several convolutions of such an element are schematically illustrated in perspective in Fig. 5, in which the transverse grooves 30 formed on one flat surface of the metal strip 31 forms with the contiguous ungrooved or smooth surface of the strip 31 a plurality of like foramina 32.

After the element 33 has been wound on the sleeve 15 of the mandrel, the locking member 26 is removed from the shaft 11 by slightly rotating it until its tapering member is withdrawn. Then the spacer 29 is removed, the cap 17 is taken off and the sleeve removed from the headstock. To collapse the sleeve, the key 24 is withdrawn from the slot 23 in wedge member 21 and the latter is driven inwardly or toward the left as seen in Figs. 1 and 2. Wedge portions 20 of wedge member 21 accordingly disengage the corresponding abutments 18 so that the sleeve 15 may collapse. The completely wound element 33 may then be readily removed from the sleeve 15 over the end thereof, or the sleeve may be withdrawn from the element 33.

The mandrel may be reassembled for the succeeding winding operation by expanding it to the predetermined dimension, which is accomplished by driving the tapered key 24 into the slot 23 in wedge member 21 to force the wedge portions 20 thereof between the corresponding abutments 18 and consequently expand the sleeve 15. When the sleeve has been expanded to the proper dimensions, it is slipped over shaft extension 11 so that the appropriate end thereof engages the reduced diameter portion of headstock 12 with the slot 16' thereof engaging key 14. The cap 17 is replaced and it and the mandrel are held in position by the spacer 29, which is restrained against endwise movement by locking member 27.

The modified form of the collapsible mandrel of this invention, which is illustrated in Figs. 6 and 7, the sleeve 34 is permanently secured to the projection 35 on the headstock 36 diametrically opposite the sleeve 37. The headstock 36 is reduced in diameter at opposite sides of the projection 35 to provide the annular space 38 between the headstock 36 and the inner surface of the sleeve 34. A screw 39 or the like may be employed to secure the sleeve 34 to the projection 35. Other portions of the modified collapsible mandrel are constructed as illustrated in the preceding figures of the drawing.

After the element 33 has been helically wound upon the sleeve 34, the latter may be collapsed by removing the taper key 24 and driving the wedge member 21 inwardly, or to the left as seen in Fig. 6, which permits the sleeve 34 to collapse in the annular space 38 about the headstock 36. After removing the key 24, the locking member 27 and spacer 29, the cap 17 may be slipped off of shaft 11 and the completely wound element 33 removed from the collapsed mandrel. The mandrel may be again expanded as will be readily understood upon replacing the cap 17, the spacer 29 and the locking member 27.

It will be seen that the collapsible mandrel of this invention is very simple and effective for use on a winding machine for forming helically wound cylindrical elements whose wound dimensions are to be retained and, although it has been described in connection with a winding of cylindrical foraminous elements, it is to be understood that it may be used for other purposes in which a collapsible mandrel is of advantage.

I claim:

1. A collapsible mandrel comprising, a shaft, a headstock mounted thereon and adapted to be rotatably driven thereby, a substantially cylindrical hollow sleeve supported by the headstock and adapted to be rotated therewith, said sleeve being provided with a slot extending longitudinally therethrough.
entire length thereof, a plurality of tapered abutments provided with extensions forming guides affixed to the inner surface of said sleeve at spaced intervals along the slot and adjacent opposite edges thereof, a plurality of tapered abutments provided with extensions forming guides affixed to the inner surface of said sleeve at spaced intervals along the slot and adjacent opposite edges thereof, a wedge member slidably arranged in said guides and provided with an extension, said wedge member having a plurality of spaced wedge portions adapted to cooperate with said tapered abutments, an end cap for said sleeve having openings therein to accommodate the shaft and said wedge member extension means for locking said end cap on the sleeve and on the shaft.

2. A collapsible mandrel comprising, a shaft, a headstock mounted thereon and adapted to be rotatably driven thereby, a substantially cylindrical hollow sleeve supported by the headstock and adapted to be rotated therewith, said sleeve being provided with a slot extending longitudinally the entire length thereof, a plurality of tapered abutments provided with extensions forming guides affixed to the inner surface of said sleeve at spaced intervals along the slot and adjacent opposite edges thereof, a wedge member slidably arranged in said guides and provided with an extension, said wedge member having a plurality of spaced wedge portions adapted to cooperate with said tapered abutments, an end cap for said sleeve having openings therein to accommodate the shaft and said wedge member extension, means for locking said end cap on the sleeve and on the shaft.

3. A collapsible mandrel comprising, a shaft, a headstock having a cylindrical surface mounted on said shaft and adapted to be rotatably driven thereby, a projection on said cylindrical surface of the headstock, a substantially cylindrical hollow sleeve having an inside diameter greater than the diameter of the said cylindrical surface of the headstock affixed to said headstock at the projection thereon and adapted to be rotated therewith, said sleeve being provided with a slot extending longitudinally the entire length thereof, a plurality of tapered abutments provided with extensions forming guides affixed to the inner surface of said sleeve at spaced intervals along the slot and adjacent opposite edges thereof, a wedge member slidably arranged in said guides and provided with an extension, said wedge member having a plurality of spaced wedge portions adapted to cooperate with said tapered abutments, an end cap for said sleeve having openings therein to accommodate the shaft and said wedge member extension, means for locking said end cap on the sleeve and on the shaft.

4. A collapsible mandrel comprising, a shaft, a headstock having a cylindrical surface mounted on said shaft and adapted to be rotatably driven thereby, a projection on said cylindrical surface of the headstock, a substantially cylindrical hollow sleeve having an inside diameter greater than the diameter of the said cylindrical surface of the headstock affixed to said headstock at the projection thereon and adapted to be rotated therewith, said sleeve being provided with a slot extending longitudinally the entire length thereof, a plurality of tapered abutments provided with extensions forming guides affixed to the inner surface of said sleeve at spaced intervals along the slot and adjacent opposite edges thereof, a wedge member slidably arranged in said guides and provided with an extension, said wedge member having a plurality of spaced wedge portions adapted to cooperate with said tapered abutments, an end cap for said sleeve having openings therein to accommodate the shaft and said wedge member extension, means for locking said end cap on the sleeve and on the shaft.

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