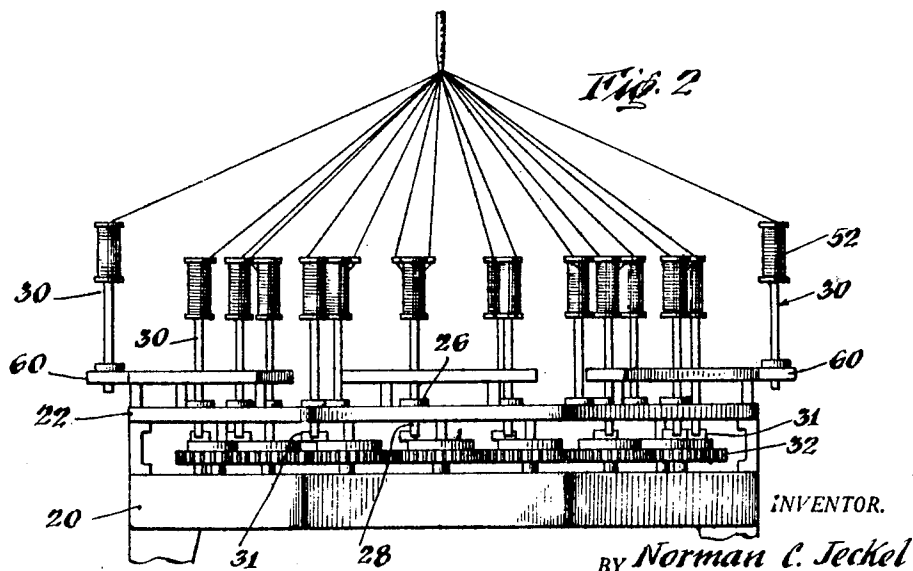
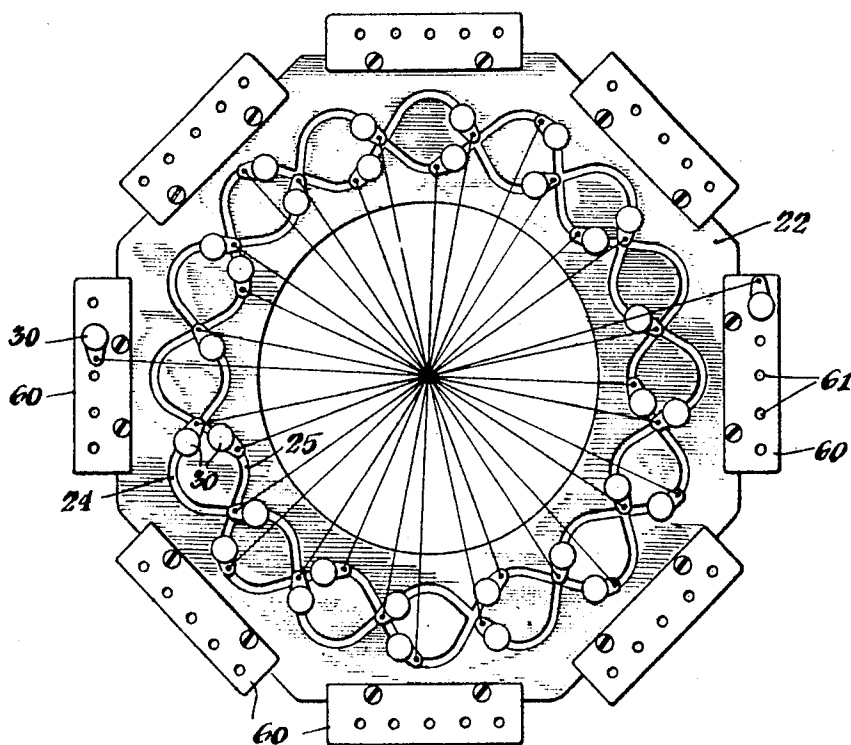




INVENTOR.

BY *Norman C. Jeckel*

Hoguet, Meary & Campbell
ATTORNEYS

11

July 25, 1944.

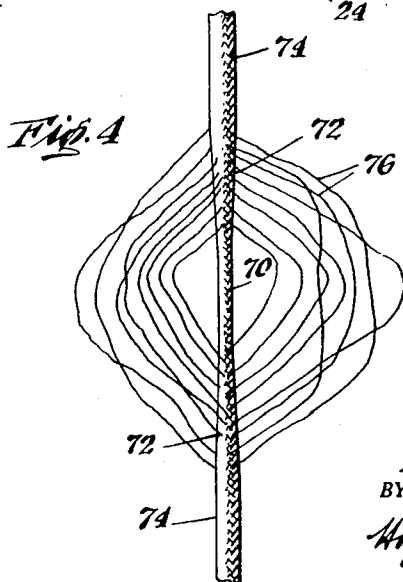
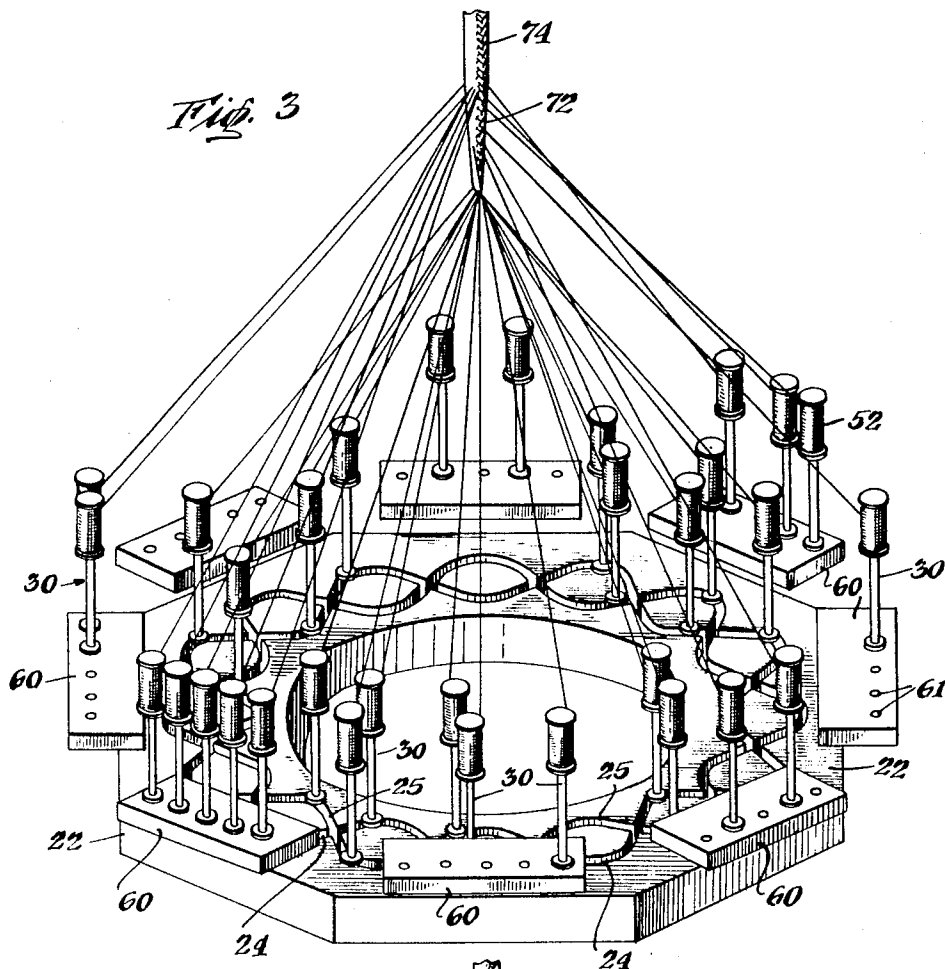
N. C. JECKEL

2,354,212

METHOD OF AND APPARATUS FOR BRAIDING

Filed Feb. 5, 1942

5 Sheets-Sheet 2



INVENTOR.
Norman C. Jeckel
 BY
Hoguet, Henry & Campbell
 ATTORNEYS

July 25, 1944.

N. C. JECKEL

2,354,212

METHOD OF AND APPARATUS FOR BRAIDING

Filed Feb. 5, 1942

5 Sheets-Sheet 3

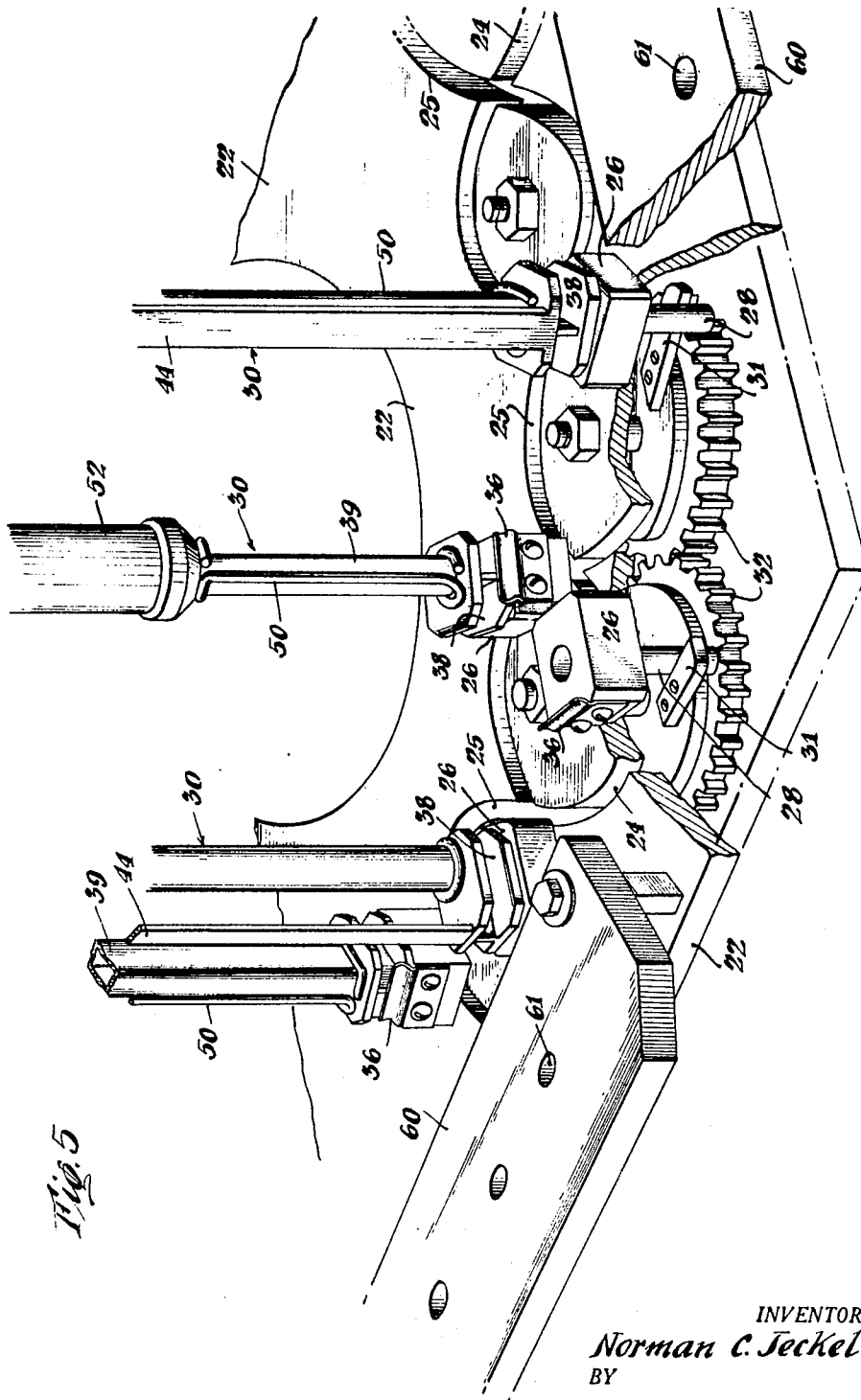


Fig. 5

INVENTOR.
Norman C. Jeckel
BY

Moguet, Henry & Campbell
ATTORNEYS

July 25, 1944.

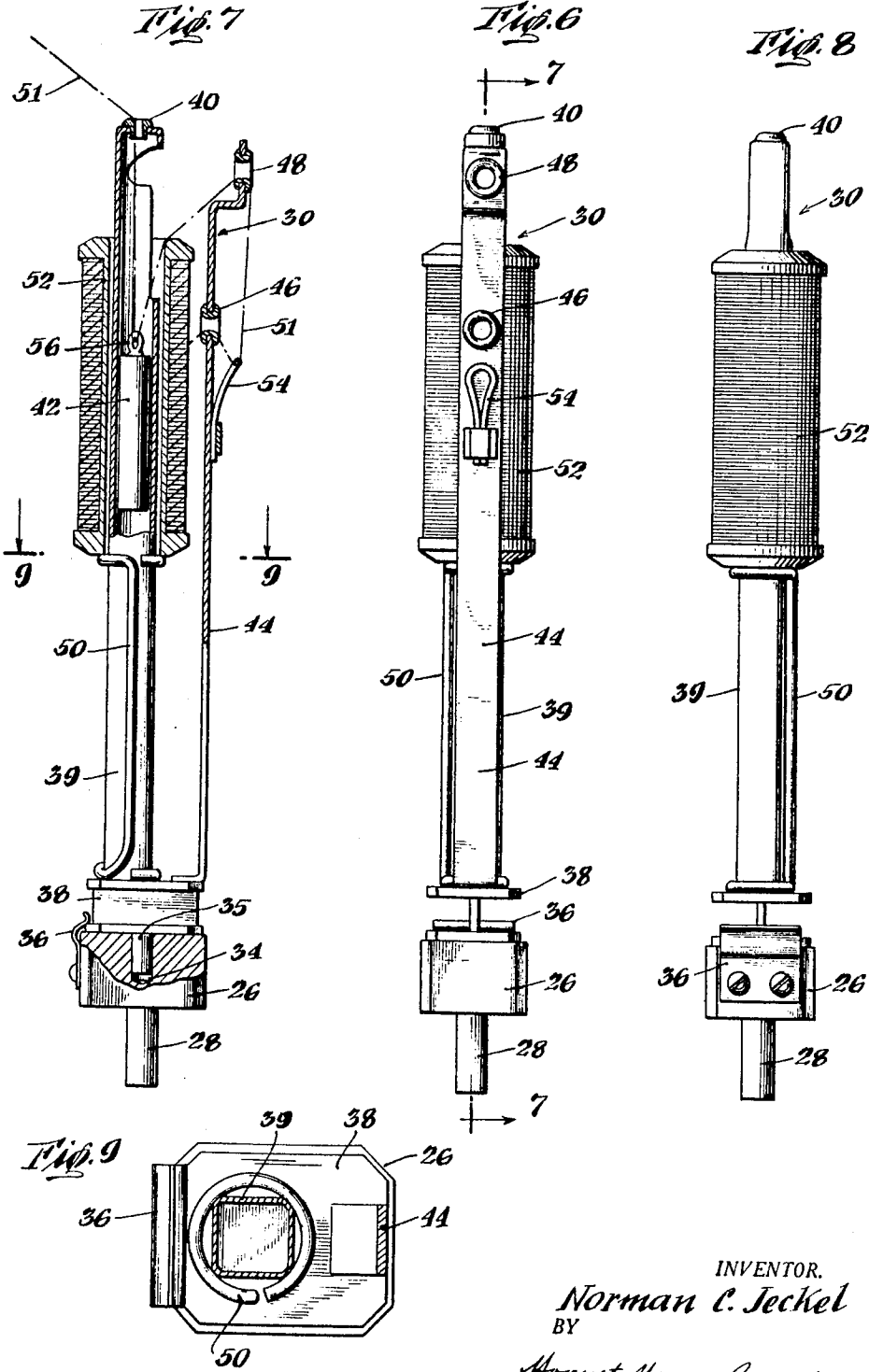
N. C. JECKEL

2,354,212

METHOD OF AND APPARATUS FOR BRAIDING

Filed Feb. 5, 1942

5 Sheets-Sheet 4



INVENTOR.
Norman C. Jeckel
 BY
August, Henry & Campbell
 ATTORNEYS

July 25, 1944.

N. C. JECKEL

2,354,212

METHOD OF AND APPARATUS FOR BRAIDING

Filed Feb. 5, 1942

5 Sheets-Sheet 5

Fig. 13

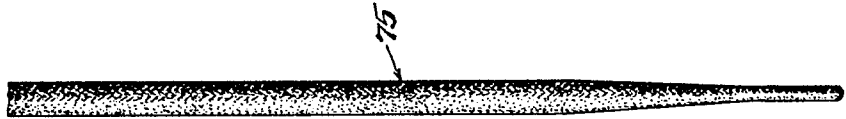


Fig. 12

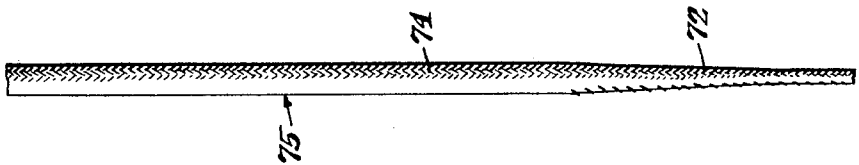


Fig. 11

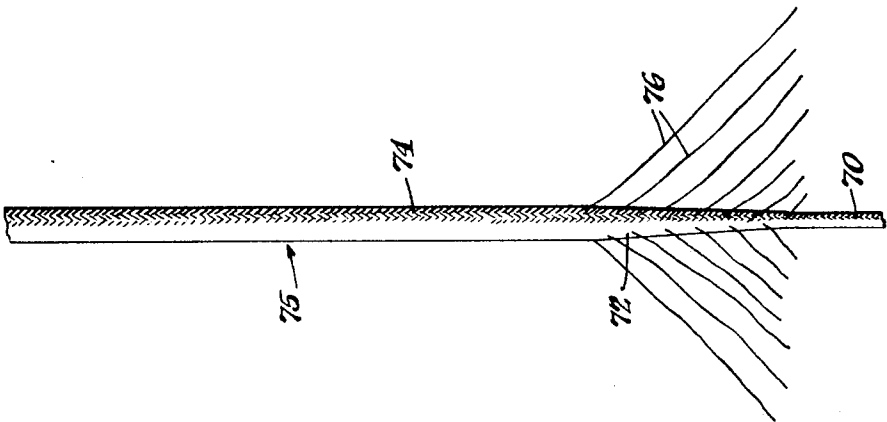
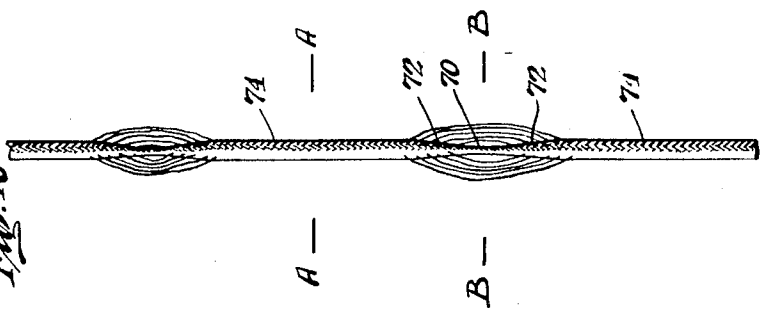


Fig. 10



INVENTOR.

Norman C. Jeckel

BY

Hoguet, Henry & Campbell

ATTORNEYS

UNITED STATES PATENT OFFICE

2,354,212

METHOD OF AND APPARATUS FOR
BRAIDING

Norman C. Jeckel, Glens Falls, N. Y., assignor to
United States Catheter & Instrument Corp., a
corporation of New York

Application February 5, 1942, Serial No. 429,603

8 Claims. (Cl. 87—11)

The present invention relates to the braiding art and more particularly to a method of and apparatus for braiding improved, tubular and tapered products, such as may be used for catheter tubes, various forms of ducts, wire and line coverings, etc.

Braided tubes have heretofore been made with tapered portions but in most instances the resulting product is not entirely satisfactory or the cost of production is unduly high. In one of the methods heretofore proposed the taper is effected by braiding a plurality of threads over a tapered core or other object to be covered. In this core covering method the mesh of the braided material is coarse and much looser over the larger portions of the core than over the smaller portions thereof. This coarser mesh at the larger portions tends to spread apart, especially if the product is bent, thereby exposing the core and sometimes even permitting the core to bulge out between the threads of the braided covering.

According to another method heretofore proposed the taper or different sizes of the braided tubing was formed by utilization of a tapered mandrel over which the braiding is effected. To produce different sizes of tubing or tapered tubing the position of the mandrel is varied at the point where the threads come together in the braiding operation. In this way the size and taper of the braided tube is controlled by the relative positioning of the mandrel. The tapered tubing produced by the mandrel method, however, has the objectionable feature of producing for the larger portions of the tubing a much coarser or looser mesh than that produced at the smaller portions of the tubing.

This feature of the mandrel produced tubing is particularly objectionable where such tubing is used for catheter purposes. Fabric tubing of coarse mesh is capable of considerable stretching and, when the tubing is coated with a thin layer of varnish or other lacquer, the coating alone must resist any longitudinal tension placed upon the tube. A small amount of longitudinal tension on such a construction is apt to cause the varnish to rupture, thereby permitting the tube to elongate and break away parts of the coating.

Another method heretofore proposed for producing a taper during the braiding of tubes involves the substitution of heavier for lighter threads, or vice versa, as the case may be. This interchanging of threads of different size not only requires the close attention of a skilled at-

tendant but also involves considerable machine stoppage over a period of time.

It is one of the objects of the present invention, therefore, to provide a method of producing tubular and tapered products which overcomes the objectionable features of the prior art methods hereinbefore discussed.

Another object of the invention is to provide a new method of producing braided products of varying diameter with a consistently tight or close mesh for the different sizes of the braided products.

Another object of the invention is to provide a method of making by a continuous operation a braided product having alternate cylindrical and tapered portions in which the mesh is substantially the same for both portions.

A further object of the invention is to provide a machine by which the method of my invention may be practiced.

Still another object of my invention is to provide an improved braided tubular and tapered product having hollow, cylindrical and tapered portions wherein the cylindrical portion is adapted to resist longitudinal tension substantially the same as the tapered or smaller portion of the tube.

An additional object of the invention is to provide an improved braided tubing for catheter tubes.

The above and additional objects and advantages of the invention are obtained by making the tapered and smaller portions of the braided tubing by changing in step-like order the number of threads entering into the braiding operation. This changing of the number of threads is carried on without stopping the machine and does not require as close attendance by the operator as is required by the existing types of machines.

More particularly the method comprises an operation wherein a braided product is produced having hollow cylindrical and tapered portions by withholding in step-like order a number of the threads used in the braiding of the larger cylindrical portion until the desired small size is reached and thereby insuring a substantially equal degree of tightness of braiding or mesh throughout the length of the tube. Advantageously, the process is carried out as a continuous operation and with the production of a continuous length of braided tubing made up of alternate cylindrical and tapered portions. When the process is so conducted, the braiding of

the tubing back to the desired larger cylindrical diameter following a reducing tapering operation will be effected by returning the withheld threads, in step-like order, into the braiding operation. In this way a taper or portion flaring in the opposite direction as compared with the reducing taper is formed until the former cylindrical size of the tubing is reached, or, if desired, the operation may be stopped when a cylindrical size of intermediate diameter is attained. The braiding is then continued with the same number of threads until the desired cylindrical length is obtained and then the cycle is repeated.

The resulting tubing having alternate cylindrical and tapered portions is then cut into desired lengths. In the case of catheter tubes, the cutting may be performed in the mid-sections of the cylindrical tubular portion and at the mid-sections between the adjacent tapered portions. The unbraided portions of the threads which were withheld are then trimmed and the resulting tubular lengths can be coated by a suitable lacquer and used for catheter purposes.

The method of my invention is further characterized by maintaining the threads under tension during the braiding operation. The large or cylindrical portions of the tubing are formed with a tight or fine mesh and this mesh is continued into and throughout the tapered portions. The taper is effected by the step by step withholding of a number of the threads from entering into the braiding operation and by maintaining tension on the withheld threads. When the withheld threads are returned to the braiding operation, lengths of threads corresponding to the length of the tubing braided during the withholding of the threads extend from the points of their removal from the braiding operation to the points where they are returned. These unbraided thread portions will normally lie alongside the tubing. Advantageously, the unbraided threads are trimmed closely adjacent the tubing after the tubing is cut into lengths of desired size.

The method may be considerably varied, depending on the product desired. The cylindrical portions of the tubing may be of any desired length and the degree of taper as well as the length thereof may be varied, as desired. The taper may be continued until the tubing reaches solid cord size and the cord size continued for any desired length. From cord size the product may be flared into the tubing by returning in step-like order the threads previously withdrawn from the braiding operation.

A form of machine suitable for carrying out the method of my invention may comprise a base structure defining intersecting paths along which a plurality of bobbin carriers are adapted to travel. The machine may be provided with any suitable power driven means to drive the bobbin carriers along the paths to perform the braiding operation. Adjacent the paths of travel I provide stationary supporting means for the bobbin carriers when the threads supported thereby are to be withheld from the braiding operation. The bobbin carriers are provided with foot members which are maintained in the base structure for continuous travel along the paths provided therefor and the bobbin carriers are removable from the foot members and may be placed on the stationary supporting means when it is desired to withhold the threads carried by them from the braiding operation. The foot members, however, may be formed as parts of

the driving means or they may comprise separate elements adapted to ride upon the base plate and be guided therealong by slots in the base plate or in slots defined by guides secured to the base plate.

Thus, when it is desired to produce a taper in the tubular product being braided, the bobbin carriers are selectively withdrawn in step-like order from the foot members and held stationary on the stationary supporting means without, however, severing the thread carried thereby. As the tubular product is gradually withdrawn by a draw spool or equivalent means, not shown, as the braiding proceeds, the thread tensioning means of the bobbin carriers cooperate therewith in maintaining under tension all of the threads that are still participating in the braiding operation as well as those that have been withdrawn therefrom. In this way a tight and uniform mesh is insured.

The product produced by my invention is superior to those products wherein the same threads are utilized in both the large and small or tapered portions of the product. Further, the product of my invention is less expensive to produce than the tapered products wherein threads are interchanged for other threads of heavier or lighter weights, as the case may be. The manufacture of the improved braided article of my invention does not require as close attention or as highly skilled operators, nor does it involve frequent stoppage of the machine for rethreading or tying-in of threads of different weights.

When the tubular product of my invention is cut into desired lengths for catheter tubes and the unbraided threads trimmed, the resulting tubing is strong, retains its shape and resists longitudinal tension with a minimum of stretching. The cut and trimmed lengths each of which, according to the embodiment described, comprises a cylindrical portion and a tapered portion may then be coated with a varnish, lacquer or other suitable coating. The resulting product has the smooth and flexible characteristics desired for catheter tubes.

It will be understood that my method of braiding tubular products having tapered portions is not to be limited to the manufacture of catheter tubes, the catheter tube product being selected for the purposes of illustrating my invention. Besides catheter tubes, the tubing, tapered in accordance with my invention, may be used for many other purposes.

For a further understanding of my invention, reference may be had to the following detailed description which is to be read in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a braiding machine by which my method of braiding may be performed;

Fig. 2 is a vertical elevational view of the machine shown in Fig. 1;

Fig. 3 is a perspective view of the braiding machine illustrating the manner by which the taper is effected in accordance with my invention;

Fig. 4 is a view of the braided product of my invention with the unbraided threads spread apart;

Fig. 5 is a fragmentary perspective view of a part of the machine showing the driving means by which the bobbin carriers are moved;

Fig. 6 is a view in vertical elevation of a bobbin carrier and a foot member associated therewith;

Fig. 7 is a sectional view of the bobbin carrier and associated foot member taken substantially along line 7—7 of Fig. 6;

Fig. 8 is a view in vertical elevation of the backside of the bobbin carrier and associated foot member shown in Fig. 6;

Fig. 9 is a horizontal sectional view of the bobbin carrier taken along line 9—9 of Fig. 7 with the bobbin removed.

Fig. 10 shows a portion of the tubular product before it is cut into short lengths;

Fig. 11 shows a larger view of a portion of one of the lengths after it has been cut and before the unbraided threads have been trimmed;

Fig. 12 shows the tubular product of Fig. 11 with the unbraided threads trimmed; and

Fig. 13 shows the trimmed product coated with a suitable lacquer.

Referring to Figs. 1 to 6 of the drawings, a machine is illustrated according to my invention and by which the method of my invention may be performed. The machine comprises a frame or base plate 20 upon which is mounted a platen 22 having a pair of complementary sinuous grooves 24 and 25, constituting endless sinusoidal paths disposed about a common axis. Supported in these grooves are a plurality of foot members 26 (Figs. 5 and 6 to 9), each of which has a depending element 28 adapted to be engaged by lugs 31 carried by gears 32 or other suitable driving means disposed below the platen.

Referring more particularly to Figs. 7 to 9 of the drawings, the foot member 26 is provided with an aperture 34 which is adapted to receive the base pin 35 of a bobbin carrier 30. A spring 36 is secured to the foot member 26 and is adapted to engage the base 38 of the carrier 30 to releasably hold the carrier in position upon the foot member.

The carrier 30 is provided with a hollow rectangularly shaped standard 39 which has at the top thereof an eyelet 40. A tensioning weight 42 is also disposed for movement axially of the standard. Adjacent the standard 39 is a bracket 44 supported on the base 38 having eyelets 46 and 48 through which the thread from a bobbin 52 supported on the standard is adapted to be threaded. A bobbin base support is formed by a wire 50 suitably shaped to grip the standard 39 and to provide an upper annular base portion upon which the bobbin is adapted to rest. It will be understood, however, that any other suitable means may be provided on the standard adjustably to support the bobbin.

As shown in Fig. 7, the bobbin 52 is adapted to be received over the upper end of the standard 39 and to rest upon the upper end of the element 50. The thread 51 of the bobbin is passed through the eyelet 46 in the bracket 44, the eyelet in the looped spring element 54, and then through the upper eyelet 48 and an eyelet 56 on the tensioning weight 42, and finally through the eyelet 40 provided at the upper end of the standard 39. Thus threaded, the carrier is ready for the braiding operation.

When all of the bobbin carriers are disposed for movement along the sinusoidal paths of the machine, the threads supported thereby are interwoven into the desired braid which, with the number of threads illustrated, will produce a tubular braided article of a desired diameter. When it is desired to taper the braided tube I withdraw a number of the bobbin carriers from the foot members thereof and place them on stationary supports 60.

These supports are shown in the drawings to comprise a plurality of platforms each having five apertures 61 and are supported on the platen 22. They may, however, comprise a continuation of the platen or may be in the form of an annular or other suitably shaped member disposed adjacent the platen.

The supports as illustrated are elevated so that when the bobbin carriers are removed from the platen and held on the supports, the threads thereof are held clear of the threads of the bobbins remaining on the platen. In Figs. 1 and 2, two of the bobbin carriers 30 are shown to have been withdrawn from their corresponding foot members and placed upon diametrically disposed supports. As the braiding progresses, additional bobbin carriers are withdrawn from their foot members in step-like order and placed upon the stationary supports. The withdrawal of the bobbin carriers may be singly or in pairs or in a larger number, depending on the degree of taper desired. In Fig. 3 a number of bobbin carriers have been removed from the braiding cycle to illustrate the taper effect produced by the method of my invention. The remaining bobbins continue to weave in and out to produce a tight braid.

While the bobbins shown in removed positions in Fig. 3 are disposed unequally among the several supports, it will be understood that the carriers removed from their foot members, may be selected so as to leave the carriers remaining in the braiding cycle in evenly spaced relation about the platen, and the removed carriers may be distributed substantially equally on the supports about the platen.

After the desired number of bobbins have been removed from braiding positions, the braiding operation may be continued to produce either a small cylindrical portion or a cord-like portion 70 between the tapered portions 72. When a desired taper in one direction has been produced, the withdrawn threads may be returned in step-like order, or even at a faster rate, until the product is again built up to the former cylindrical size 74. It will be understood that the tubular product 74 is gradually withdrawn as the braiding proceeds by means of a draw spool or other conventional means not shown.

This method of producing a tubular product of cylindrical and tapered portions is particularly desirable for continuous production of alternate, hollow cylindrical and tapered portions for use in the manufacture of catheter tubes. Such a continuous tubing is shown in Fig. 10. The cutting of the product for catheter tubes may take place along lines A—A and B—B, that is to say, the cylindrical portions 74 are cut at their mid-portions and the tapered portions 72 are cut at their smallest or mid-sections 70. Each section 75, as illustrated in Figs. 11 and 12, is then trimmed of the unbraided threads 76 and the resulting sections coated with a suitable lacquer or varnish to give them a desired smooth flexible surface coating.

From the foregoing it will be clear that I have invented a new method for braiding tubular products having tapered portions and in which product the mesh is substantially the same throughout the larger and smaller portions thereof, that the product is strong and tightly braided, and that it is capable of resisting longitudinal tension with a minimum of stretching; and when coated with a suitable lacquer provides a smooth flexible tubing.

While I have shown and described my method in connection with production of tubes of cylindrical and tapered portions and but one machine by which the method may be performed, it is recognized that many changes and variations in the steps of the method and the means by which the method may be performed, as well as the different shapes of the product produced, are possible without departing from my invention. It is, therefore, to be understood that the present disclosure is to be regarded as illustrative of the invention only and not in restriction of the appended claims.

I claim:

1. The method of making a braided tubular product characterized by a substantially uniformly tight and closely braided weave throughout the length thereof, which comprises braiding a plurality of threads sufficient in number to form a tube, and thereafter changing in step-like order the number of threads entering into the braiding operation and thereby varying the diameter of the product, and throughout the braiding operation maintaining under tension all of the threads that are currently participating or have previously participated in the braiding operation, and thereafter cutting the product to the desired length and trimming the unbraided portions of the threads which have not entered into the braiding operation.

2. The method of making a braided catheter tube characterized by a substantially uniformly tight and closely braided weave throughout the length thereof, which comprises braiding a plurality of threads to form a cylindrical tube portion, withholding in step-like order some of the threads from entering into the braiding operation until the product is tapered from the hollow cylindrical size to a substantially solid cord size, and throughout the braiding operation maintaining all of the threads under a substantially constant tension, and thereafter cutting the product to the desired length and trimming the unbraided portions of the threads which were withheld.

3. The method of making a braided catheter tube characterized by a substantially uniformly tight and closely braided weave of the threads throughout the product, comprising braiding a plurality of threads to form a cylindrical tube portion, withholding in step-like order some of the threads from entering into the braiding operation until the product is tapered from the hollow cylindrical size to substantially cord size, then returning the withheld threads in step-like order into the braiding operation, thereby forming a tapered portion from cord size to the former cylindrical size, maintaining all of said threads constantly under substantially the same tension throughout the entire operation, cutting the product at the mid-sections of the tubular portion and at the cord sections, trimming the unbraided portions of the threads which were withheld and coating the cut lengths of the tubular and tapered portions with lacquer.

4. In a machine for braiding tubular products wherein bobbin carriers are moved along intersecting sinusoidal paths about the central axis to effect braiding operations and the resulting braided tubular product is withdrawn as the braiding proceeds in a path parallel to and adjacent said central axis, said machine including means defining said intersecting paths, bobbin carriers movable along said paths, and thread tensioning means associated with said carriers for

maintaining under tension the threads of the bobbins carried thereby; the improvement which consists in means for supporting a plurality of bobbin carriers in stationary position adjacent but sufficiently removed from the plane of said intersecting sinusoidal paths to insure that threads carried by bobbins removed from said paths to said stationary supports will be withheld from the braiding operation and maintained under tension so long as they remain on said supports, and will re-enter said braiding operation if and when said removable bobbins are returned to said sinusoidal paths.

5. The method of making a braided catheter tube characterized by a substantially uniformly tight and closely braided weave of the threads throughout the product, comprising braiding a plurality of threads to form a cylindrical tube portion, withholding in step-like order some of the threads from entering into the braiding operation by maintaining said threads outside of the tube being formed until the product is tapered from the hollow cylindrical size to substantially cord size, then returning the withheld threads in step-like order into the braiding operation, thereby forming a tapered portion from cord size to the former cylindrical size, maintaining all of said threads constantly under substantially the same tension throughout the entire operation, cutting the product at the mid-sections of the tubular portion and at the cord sections, trimming the unbraided portions of the threads which were withheld and coating the cut lengths of the tubular and tapered portions with lacquer.

6. The method of making a braided catheter tube characterized by a substantially uniformly tight and closely braided weave throughout the length thereof, which comprises braiding a plurality of threads to form a cylindrical tube portion, withholding in step-like order some of the threads from entering into the braiding operation by maintaining said threads outside of the tube being formed until the product is tapered from the hollow cylindrical size to a substantially solid cord size, and throughout the braiding operation maintaining all of the threads under a substantially constant tension, and thereafter cutting the product to the desired length and trimming the unbraided portions of the threads which were withheld.

7. The method of making a braided tubular product characterized by a substantially uniformly tight and closely braided weave throughout the length thereof, which comprises braiding a plurality of threads sufficient in number to form a tube, and thereafter changing in step-like order the number of threads entering into the braiding operation by maintaining the remaining threads outside of the tube being formed and thereby varying the diameter of the product, and throughout the braiding operation maintaining under tension all of the threads that are currently participating or have previously participated in the braiding operation, and thereafter cutting the product to the desired length and trimming the unbraided portions of the threads which have not entered into the braiding operation.

8. In a machine for braiding tubular products wherein bobbin carriers are moved along intersecting sinusoidal paths about the central axis to effect braiding operations and the resulting braided tubular product is withdrawn as the braiding proceeds in a path parallel to and adjacent said central axis, said machine including means defining said intersecting paths, bobbin

11

2,354,212

5

carriers movable along said paths, and thread tensioning means associated with said carriers for maintaining under tension the threads of the bobbins carried thereby; the improvement which consists in means for supporting a plurality of bobbin carriers in stationary position adjacent but outside and sufficiently removed from the circle defined by the points of intersection of said intersecting sinusoidal paths and sufficiently

removed away from said central axis to insure that threads carried by bobbins removed from said paths to said stationary supports will be withheld from the braiding operation and maintained under tension so long as they remain on said supports, and will re-enter said braiding operation if and when said removable bobbins are returned to said sinusoidal paths.

NORMAN C. JECKEL.