Feb. 9, 1960 J. B. SIDEBOTHAM 2,924,250

BIFURCATED TEXTILE TUBES AND METHOD OF WEAVING THE SAME

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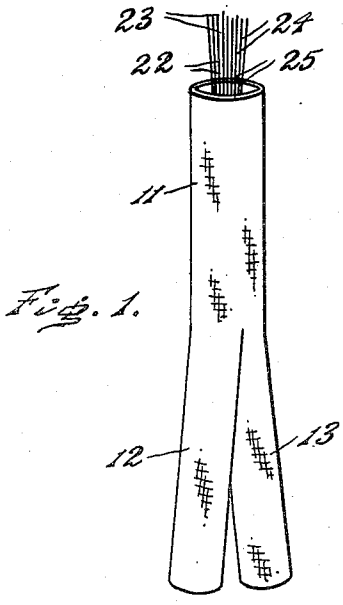


Fig. 1.

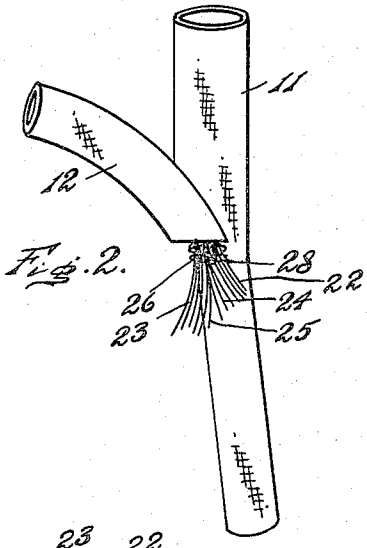


Fig. 2.

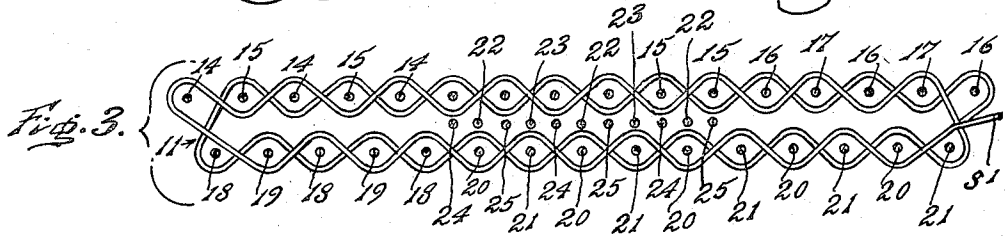


Fig. 3.

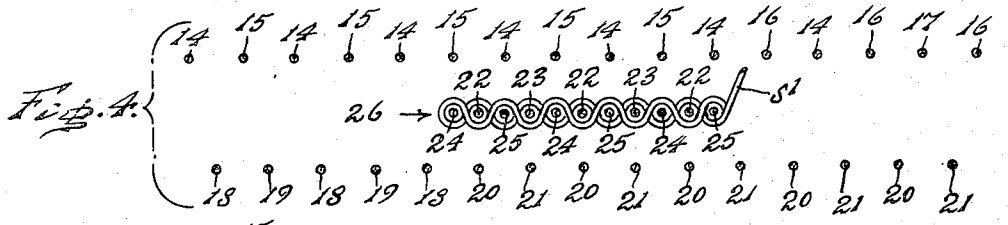


Fig. 4.

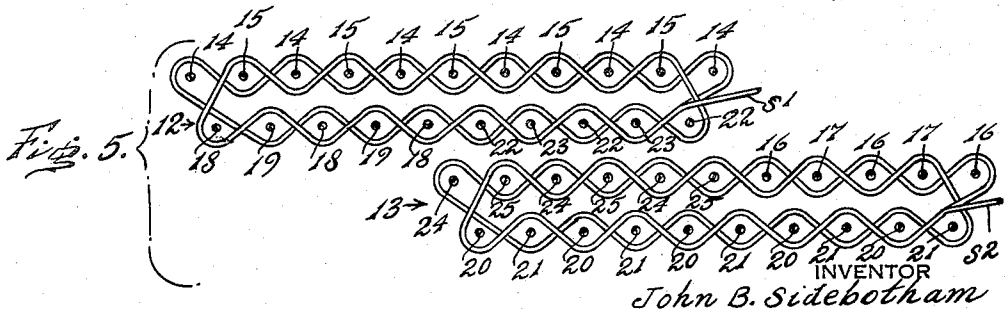


Fig. 5.

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BIFURCATED TEXTILE TUBES AND METHOD OF WEAVING THE SAME

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9 Claims. (Cl. 139—387)

This invention relates to bifurcated textile tubes and a method of weaving the same, and it relates more particularly to tubes adapted for use in surgical operations, namely, for the replacement of certain diseased or damaged blood vessels.

More specifically considered, this application relates to certain improvements in the tubes, and a method of weaving the same, described and shown in my previous application for Letters Patent of the United States, filed March 23, 1956, Serial No. 573,744, now U.S. Patent No. 2,845,959.

As pointed out in my aforesaid previous application for letters patent, it frequently happens that blood vessels become diseased or injured whereby replacement of the same becomes necessary, and it has been found particularly difficult to replace such blood vessels with artificial tubing at locations such, for example, as where the aorta branches into the iliac arteries, or under similar conditions in a living body wherever a larger blood vessel branches into two smaller ones.

In such locations, where the branching of the arteries or veins occurs, it is desirable that the total cross-sectional area of the two tubes, beyond the branching, shall bear a certain relationship to the cross-sectional area of the large or main tube, as otherwise differences in pressure and flow would occur in the tubes.

It has also been found, by actual experimentation, that woven tubes may be used in which the warp and weft are made of certain of the modern plastics, the various surgical operators, however, preferring yarns of different materials, and it therefore follows that the particular yarn employed in the carrying out of the present invention is not an essential feature thereof, although in the use of certain of the plastic yarns which are available and adaptable, advantage may be taken of the inherent characteristics thereof such, for example, as the known heat-fusibility of nylon and various other plastic yarns.

The principal difficulty encountered in attempting to make seamless woven bifurcated tubes for blood vessel replacements arises out of the desirability of the elimination of distortion, such a bulging or constriction, as well as leakage, at the place of branching from a larger tube into two smaller ones.

The principal object therefore of the present invention is to provide a further improvement in seamless woven textile bifurcated tubes for use as artificial blood vessels employed by surgeons for the replacement of diseased or damaged blood vessels at places where a larger tube branches into two smaller ones.

A further object of the present invention is to provide woven bifurcated tubes to serve as blood vessel replacements in which there will be no objectionable bulging or constriction, or likelihood of leakage, at the places where such a tube branches from a single larger tube into two smaller tubes.

A further object of the present invention is to provide, in bifurcated tubular replacements of the character aforesaid, improved means for interweaving and sealing,

at the place of branching of the tubes, the additional warp ends required in the smaller tubes to obtain the proper sizes thereof.

The nature and characteristic features of the present invention will be more readily understood from the following description, taken in connection with the accompanying drawing forming part hereof, in which:

Figure 1 is an elevational view of a portion of a bifurcated woven textile tube, showing the initial step in the formation of the same, in accordance with the present invention;

Fig. 2 is a view somewhat similar to Fig. 1, but with the tubes reversed to operative condition, a portion of a branch tube being raised at the place of branching to illustrate the interweaving of the additional warp ends required in the smaller tubes, and the sealing thereof to prevent leakage at that location;

Fig. 3 is schematic or diagrammatic cross-section illustrating the manner of weaving the main tube;

Fig. 4 is a similar view illustrating the manner of weaving at the place where the branching occurs; and

Fig. 5 is a similar view illustrating the manner of weaving the branch tubes beyond the branching.

It should, of course, be understood that the description and drawing herein are illustrative merely, and that various modifications and changes may be made in the structure and method disclosed without departing from the spirit of the invention.

Referring now more particularly to Fig. 1 of the drawing, there is there shown a portion of bifurcated tubing as initially woven in accordance with the present invention, which consists of a larger or main tube **11**, branching into two smaller tubes **12** and **13**. It should be understood that, for the best results, the cross-sectional area of the larger tube **11**, when distended, should bear a certain relationship to the combined cross-sectional area of the branch tubes **12** and **13**, when distended, and for this purpose it will be found that the number of warp ends required for weaving the main tube will be less than that required for the weaving of the tubes.

As the warp ends in the main tube **11** are necessarily less than the number used in the branch tubes **12** and **13**, there will, during the weaving of the main tube **11**, be an excess of warp ends which may be internally floated during the weaving of the main tube.

The main tube **11**, as well also as the branch tubes **12** and **13**, are each woven in a manner similar to that used for weaving pillow cases and other tubular fabrics. In the simple form of such weaving, it is well known that at least two sheds must be formed, and one shed contains one more warp end than the other shed, thereby to avoid inclusion of two warp ends between the successive crossings of the filling at one side from one shed to the other during the weaving.

In the weaving of the present product, as well as that shown and described in my previous application at least two shuttles are required, which are used in a manner to be presently explained. While both shuttles can be used in the weaving of the main tube **11**, it is preferable to use but a single shuttle for that purpose, as otherwise the controls would be more complicated.

The filling inserted in the weaving of the main tube **11** is designated S^1, this filling also being used in the weaving of a closure tab **26**, and one of the branch tubes, whereas the filling inserted by the other shuttle is designated as S^2, the same being used for the weaving of the other branch tube. However, if desired, the filling S^2 can be used for the weaving of the closure tab **26** in lieu of the filling S^1 as shown in the drawing.

Each of the branch tubes is thus woven by a separate shuttle as indicated in Fig. 5 of the drawing, during the weaving of which the warp ends which have been floated

during the weaving of the main tube **11**, are subdivided, approximately one-half going into one of the branch tubes, and the other half going into the other of the branch tubes.

For the proper formation of the fabric as above set forth, it is necessary, in the weaving, that portions of the tubes **12** and **13** should overlap to the extent of the width in the shed of the warp ends which are internally floated during the weaving of the main tube **11**.

A careful consideration of Figs. 3, 4 and 5 of the drawing will make clear the manner in which the weaving may be accomplished.

It is, of course, well known that in the weaving of tubular fabrics such, for example, as pillow cases and the like, at least four harness frames must be employed, as two separate sheds must be successively formed for the alternate passage of the shuttle therethrough, and there should be one more warp end in one shed than in the other shed as, otherwise, there would be two warp ends included between successive crossings of the filling at one of the sides during the weaving.

As hereinbefore set forth, in the weaving of bifurcated tubes in accordance with the present invention, a greater number of warp ends are required in the branch tubes **12** and **13** than in the main tube **11**, and consequently there will be an excess of warp ends during the weaving of the main tube **11**, which warp ends are internally floated during the weaving of the main tube **11**.

The warp ends which are floated during the weaving of the main tube **11**, at the branching of the single tube into the two branch tubes, are manipulated, in the present invention, to successively form single sheds, each interwoven with filling threads S^1 supplied by the proper shuttle, this being done for the purpose of forming the tab **26** for more effective sealing, and for preventing leakage. It should, however, be understood that the filling thread S^2 may be used, if desired, in lieu of the filling S^1. The feed of the loom is preferably stopped for about ten picks at the time the floating threads above referred to are being interwoven with the filling at the branching to form the sealing tab **26**.

Referring now more particularly to Fig. 3 of the drawing, which illustrates diagrammatically the weaving of the main tube portion **11** of the fabric, at which time one set of warp ends **14** is controlled by one harness frame, and another set of warp ends **15** is controlled by another harness frame to form successive sheds for weaving the portion of the top cloth at the center and left end. Another set of warp ends **16** is controlled by another harness frame, and a corresponding set of warp ends **17** is controlled by another harness frame to complete the weaving of the top cloth of the main tube **11**.

For the purpose of weaving the bottom cloth of the main tube **11** there is provided a set of warp ends **18** and a corresponding set of warp ends **19**, each set being controlled by a harness frame for the purpose of successively shedding the same to weave the portion of the bottom cloth of the main tube **11** at the left end of Fig. 4. For weaving the remaining portion of the bottom cloth of the main tube **11**, there are provided two sets of warp ends **20** and **21**, each controlled by a separate harness frame for successively shedding said warp ends disposed at the center and right end of Fig. 4.

Passing now to a consideration of Fig. 5, which is a diagrammatic illustration of the weaving of the two tubes **12** and **13**, it will here be noted that the top cloth of the tube **12** is formed by the interweaving of the filling S^1 from one of the shuttles with the warp ends **14** and **15**. The left portion of the bottom cloth of tube **12** is formed by the interweaving of said filling with the warp ends **18** and **19**.

The remaining portion of the bottom cloth of tube **12** is formed by the interweaving of two sets of warp ends **22** and **23**, each controlled by a separate harness frame, with the filling S^1 from the first shuttle which had previously been used for the weaving of the main tube **11**.

The other tube **13** is formed in a similar manner, in this instance, the lower cloth being formed by interweaving the filling S^2 from the second shuttle with the warp ends **20** and **21** hereinbefore described as being used in connection with the weaving of the main tube **11**. The right end of the upper cloth of the tube **13** is formed by the interweaving of said filling S^2 from the second shuttle with the warp ends **16** and **17**, previously referred to, which are used in the weaving of the top cloth of tube **11**, whereas, the remaining porton of the top cloth of tube **13** at the left end thereof is formed by the interweaving of said filling S^2 with the warp ends **24** and **25** controlled by their respective harness frames.

Referring now to Fig. 4 of the drawing, there is there shown diagrammatically a preferred manner of weaving at the place whree the branching occurs. It will be noted that at this place, in the present invention, the warp ends **22**, **23**, **24** and **25** are interwoven preferably with the filling S^1, or with the filling S^2, if desired, thereby providing a woven tab **26** for a purpose to be presently explained, which tab is initially disposed interiorly and very tightly woven. During the weaving of the tab **26**, the cloth feed of the loom may be stopped and the tab **26** woven during a short run of approximately ten picks.

During the weaving of the main tube **11**, the warp ends **22**, **23**, **24** and **25** are floated interiorly as indicated in Figs. 1 and 3 of the drawing. However, in the present invention the tab **26** is woven as aforesaid, and the yarns used are preferably of the heat-fusible or sealable type, whereby the threads forming the tab **26** may be subsequently fused or joined to each other.

For the purpose of further effecting the sealing by uniting the threads of the tab **26** to each other, the tubes should be turned inside out in any preferred manner to the arrangement indicated in Fig. 2 of the drawing. When in this condition the threads forming the tab **26** may be secured to each other by the heat-fusing or, if preferred, may be joined by a suitable adhesive, or any other preferred means may be used to close the fabric at the place of branching.

After the sealing has been effected, the lose warp ends **22, 23, 24** and **25** may be separated into groups and tied in a series of knots, as at **28**, after which the free ends of the warps may be severed from the tab **26**, as they are of no further use and would be objectionable in the finished structure. It will be found that in some instances the knotting of the free ends of the warps will not be required, particularly if the fusing or adhesion of these warps is done properly.

By the foregoing arrangement and method of weaving there is provided an improved form of woven bifurcated tube particularly adaptable for surgical use in the replacement of diseased and damaged blood vessels. Such bifurcated tubes have been found to be very effective for their indicated purpose.

I claim:

1. A seamless woven bifurcated tubular device in which the number of interwoven warps in the main tube is less than the total number of warps in the smaller tubes, and in which the excess warps are interwoven with filling into a single closure tab at the place of branching of the smaller tubes from the main tube.

2. A seamless woven bifurcated tubular device in which the number of interwoven warps in the main tube is less than the total number of warps in the smaller tubes, and in which the excess warps are interwoven with filling into a single closure tab at the place of the branch of the smaller tubes from the main tube, and in which certain of the yarns in said closure tab are of the heat-sealable type and are fused at the place of the branching.

3. A seamless woven bifurcated tubular device in which the number of interwoven warps in the main tube is less than the number of warps in the smaller tubes, in

which the excess warps are interwoven with filling into a single closure tab at the place of the branching of the smaller tubes from the main tube, and in which certain of the yarns in said closure tab are secured to each other.

4. A seamless woven bifurcated tubular device in which the number of warps in the main tube is less than the total number of warps in the smaller tubes in which the excess warps are interwoven with filling into a single closure tab at the place of branching of the smaller tubes from the main tube, and in which certain of the yarns in said closure tab are of heat-sealable type and are fused to each other.

5. The method of weaving seamless bifurcated tubes which consists in floating a plurality of warps during the weaving of the main tube, utilizing the warps which have been floated as aforesaid to form portions of the fabric of each of the branch tubes, and at the branching of the tubes, interweaving the filling for a short run with the warps which are floated as aforesaid, to form a single tab for sealing the tubes at the branching.

6. The method of weaving seamless bifurcated tubes which consists in floating a plurality of warps during the weaving of the main tube, utilizing the warps which have been floated as aforesaid to form portions of the fabric of each of the branch tubes, and at the branching of the tubes interweaving the filling for a short run with the warps which are floated as aforesaid to provide a single closure tab, and cutting off the loose portions of the floating ends beyond said tab.

7. The method of weaving seamless bifurcated tubes which consists in floating a plurality of warps during the weaving of the main tube, utilizing the warps which have been floated as aforesaid to form portions of the fabric of each of the branch tubes, and at the branching of the tubes interweaving the filling for a short run with the warps which are floated as aforesaid to form a single closure tab, and tying the free end portions of said floating warps into a series of knots at the end of said tab.

8. The method of weaving seamless bifurcated tubes which consists in floating a plurality of warps during the weaving of the main tube, utilizing the warps which have been floated as aforesaid to form portions of the fabric of each of the branch tubes, and at the branching of the tubes interweaving the filling for a short run with the warps which are floated as aforesaid to form a single closure tab, certain of the yarns employed in weaving said tab having heat-sealable qualities, heat-sealing said yarns to each other, and cutting off the loose portions of the floating ends beyond said tab.

9. The method of weaving seamless bifurcated tubes which consists in floating a plurality of warps during the weaving of the main tube, utilizing certain of the warps which have been floated as aforesaid to form portions of the fabric of each of the branch tubes, and at the branching of the tubes interweaving the filling for a short run with the warps which are floated as aforesaid to form a single closure tab, certain of the yarns employed in weaving said tab having heat-sealable qualities, heat-sealing said yarns to each other, tying the free end portions of said floating warps into a series of knots at the end of said tab, and cutting the loose portions of said floating warps beyond said knots.

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