Aug. 5, 1958 J. B. SIDEBOTHAM 2,845,959

BIFURCATED TEXTILE TUBES AND METHOD OF WEAVING THE SAME

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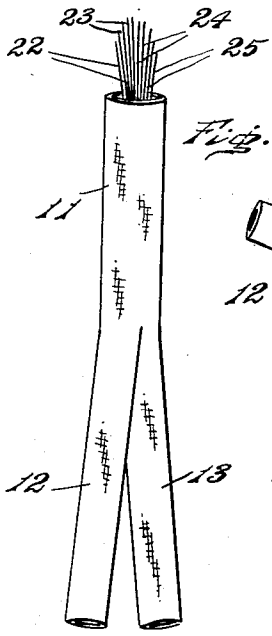

Fig. 1.

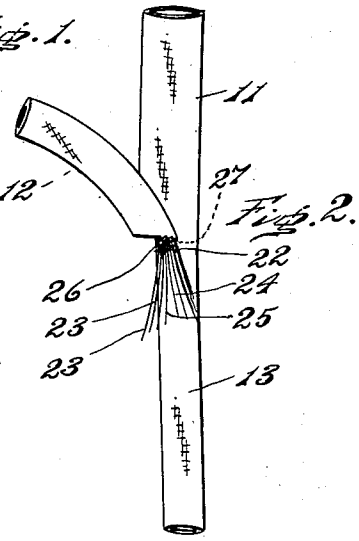

Fig. 2.

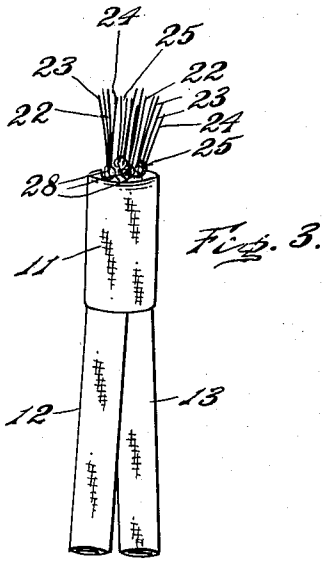

Fig. 3.

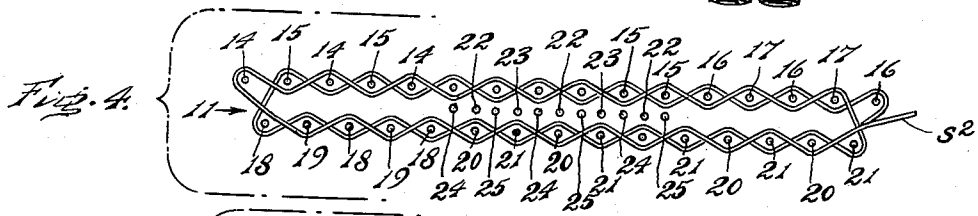

Fig. 4.

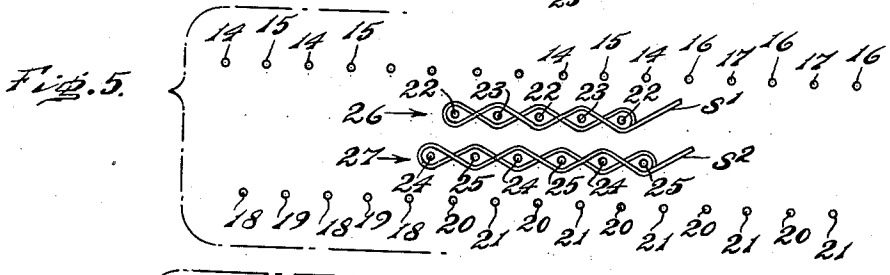

Fig. 5.

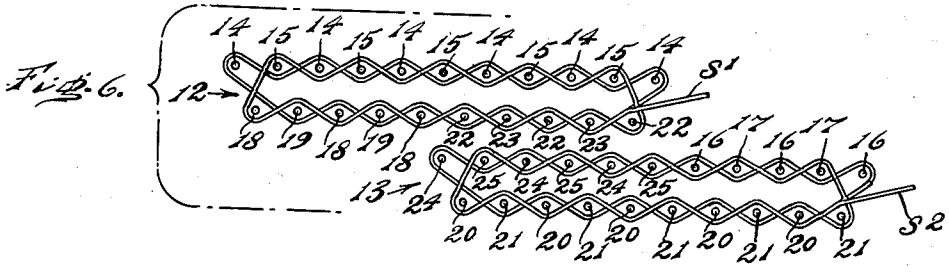

Fig. 6.

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BIFURCATED TEXTILE TUBES AND METHOD OF WEAVING THE SAME

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13 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 arteries.

It frequently happens that arteries of human beings and other animals become diseased or injured whereby replacement of the same becomes necessary. It has been found particularly difficult to replace such arteries with artificial tubing at locations such, for example, as where the aorta branches into the iliac arteries, or in similar conditions in a living body wherever a larger artery branches into two smaller ones.

In such locations, where the branching of the arteries occurs, it is desirable that the cross-sectional area of the two tubes beyond the branching shall be substantially equal 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 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 attempts to make woven bifurcated tubes for arterial replacements arises out of the desirability of the elimination of distortion, such as bulging or constriction, at the place of branching from a larger tube into two smaller ones.

The principal object therefore of the present invention is to provide seamless woven textile bifurcated tubes which are particularly adaptable for use as artificial arteries employed by surgeons for the replacement of diseased or damaged arteries at places where a larger tube branches into two smaller ones.

A further object of the invention is to provide woven bifurcated tubes to serve as arterial replacements in which there will be no objectionable bulging or constriction at the place where an artery branches from a single larger tube to two smaller tubes.

A further object of the invention is to provide bifurcated arterial replacements of the character aforesaid, in which the cross-sectional area of the small tubes beyond the branch will be substantially equal to that of the cross-sectional area of the main tube when said tubes are distended in use.

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 made in accordance with the present invention;

Fig. 2 is a view somewhat similar to Fig. 1, but with a portion of a branch tube raised at the place of bifurcation for the purpose of illustrating a preferred manner of sealing at the bifurcation to prevent leakage at that location;

Fig. 3 is a view also somewhat similar to Fig. 1, illustrating another form of sealing means at the place of branching;

Fig. 4 is a schematic or diagrammatic cross section illustrating the manner of weaving the main tube;

Fig. 5 is a similar view illustrating the manner of weaving at the place where the bifurcation occurs; and

Fig. 6 is a similar view illustrating the manner of weaving the branch tubes beyond the bifurcation.

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 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 be substantially equal to that of 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 in the larger tube will be proportioned to the number of warp ends of each of the smaller tubes in a ratio of approximately 10 to 7.

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 during the weaving.

In the weaving of the present product, at least two shuttles are required, which are used in a manner to be presently explained. While both shuttles could 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 another closure tab **27**, and the other branch tube.

Each of the branch tubes is thus woven by a separate shuttle as indicated in Fig. 6 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 duing the weaving of the main tube **11**.

During the weaving of the tubes it is preferable for the

manipulation of the warp to use at least twelve harness frames, although it is possible to use a different or larger number.

A careful consideration of Figs. 4, 5 and 6 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 subdivided to form two separate sheds, each interwoven with filling threads S^1 and S^2 supplied by the several shuttles, this being done for the purpose of more effective sealing, and for preventing leakage. The feed of the loom is stopped for about ten picks at the time the floating threads above referred to are being interwoven with the filling at the branching.

Referring now more particularly to Fig. 4 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. 6, 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** 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 portion 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. 5 of the drawing, there is there shown diagrammatically a preferred manner of weaving at the place where the branching occurs. Upon referring to Fig. 5 of the drawing it will be noted that at this place the warp ends **22** and **23** are interwoven with the filling S^1, whereas the warp ends **24** and **25** are interwoven with the filling S^2, thereby providing two separate woven tabs **26** and **27** for a purpose to be presently explained, which tabs are initially disposed interiorly and tightly woven. During the weaving of the tabs **26** and **27**, the cloth feed of the loom may be stopped and the tabs **26** and **27** 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 4 of the drawing. However, in the form of the invention in which the tabs **26** and **27** are woven as aforesaid, the yarns used are preferably of the heat-fusible or sealable type, whereby the tabs **26** and **27** may be subsequently fused or joined to each other.

For the purpose of effecting the sealing by uniting the tabs **26** and **27** to each other, the terminal portions of the warp ends **22**, **23**, **24** and **25** at the upper end of the tube **11** are tied to each other, whereupon a hook (not shown) may be inserted through the opening between the tabs **26** and **27**, and the said warp ends may then be pulled through at the branch to a location between the branch tubes **12** and **13** on the outside thereof, together with the tabs **26** and **27**, as shown in Fig. 2 of the drawing. When in this condition the tabs **26** and **27** may be secured to each other by heat-fusing or, if preferred, the tabs **26** and **27** may be joined by a suitable adhesive, or any other means may be used to close the fabric at the place of branching.

After the sealing has been effected, the loose warp ends **22**, **23**, **24** and **25** may be severed from the tabs, as they are of no use and would be objectionable in the finished structure.

In Figure 3 of the drawing there is illustrated another manner of closing the fabric at the branching place which consists in first turning the main tube **11** inside out, down to the branching and then pairing and separating a number of the loose or floating yarn ends and tying the same, after which the free ends may be severed adjacent the knots **28**.

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

I claim:

1. A seamless woven bifurcated tubular device in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube when distended.

2. A seamless woven bifurcated tubular device in which the number of interwoven warp ends in the main tube is less than the total number of warp ends in the smaller tubes.

3. A seamless woven bifurcated tubular device in which the number of interwoven warp ends in the main tube is less than the total number of warp ends in the smaller tubes, and in which the excess ends are interwoven with filling at the place of the branching of the smaller tubes from the main tube.

4. A seamless woven bifurcated tubular device in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube, when distended, in which the

number of interwoven warp ends in the main tube is less than the total number of warp ends in the smaller tubes, and in which the excess ends are interwoven with filling at the place of the branching of the smaller tubes from the main tube, and in which certain of the yarns are of the heat-sealable type and are fused at the place of branching.

5. A seamless woven bifurcated tubular device in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube, when distended, in which the number of warp ends in the main tube is proportioned to the number of warp ends in each of the smaller tubes in a ratio of approximately 10 to 7, and in which the excess ends are interwoven with filling at the place of branching of the smaller tubes from the main tube to provides tabs which are secured to each other.

6. A seamless woven bifurcated tubular device in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube, when distended, in which the number of warp ends in the main tube is proportioned to the number of warp ends in each of the smaller tubes in a ratio of approximately 10 to 7, and in which the excess ends are interwoven with filling at the place of the branching of the smaller tubes from the main tube, to provide tabs which are secured to each other at the place of branching.

7. A seamless woven bifurcated tubular device in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube, when distended, in which the number of warp ends in the main tube is proportioned to the number of warp ends in each of the smaller tubes in a ratio of approximately 10 to 7, and in which the excess ends are interwoven with filling at the place of branching of the smaller tubes from the main tube to provide tabs in which certain of the yarns are of heat-sealable type and are fused to provide a closure at the place of branching.

8. The method of weaving seamless bifurcated tubes which consists in using, for the weaving of the main tube, a number of warp ends less than the total number of warp ends in the smaller tubes, and floating the excess ends internally during the weaving of the main tube.

9. The method of weaving seamless bifurcated tubes in which the total cross-sectional area of the branch tubes, when distended, is substantially the same as the cross-sectional area of the main tube, when distended, which consists in using, for the weaving of the main tube, a number of warp ends proportioned to the number of warp ends in each of the smaller tubes in a ratio of approximately 10 to 7, and floating the excess ends internally during the weaving of the main tube.

10. The method of weaving seamless bifurcated tubes which consists in floating a plurality of pairs of warp ends during the weaving of the main tube, utilizing certain of the ends which have been floated as aforesaid to form portions of the fabric of each of the branch tubes.

11. The method of weaving seamless bifurcated tubes which consists in floating a plurality of pairs of warp ends during the weaving of the main tube, utilizing certain of the ends 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 warp ends which are floated as aforesaid, to form tabs for sealing the tubes at the branching.

12. The method of weaving seamless bifurcated tubes which consists in floating a plurality of pairs of warp ends during the weaving of the main tube, utilizing certain of the ends 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 warp ends which are floated as aforesaid to provide tabs, securing the tabs to each other, and cutting off the loose portions of the floating ends beyond said tabs.

13. The method of weaving seamless bifurcated tubes which consists in floating a plurality of pairs of warp ends during the weaving of the main tube, utilizing certain of the ends 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 warp ends which are floated as aforesaid to form sealing tabs, certain of the yarns employed having heat-sealable qualities, heat-sealing the tabs to each other, and cutting off the loose portions of the floating ends beyond said tabs.

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