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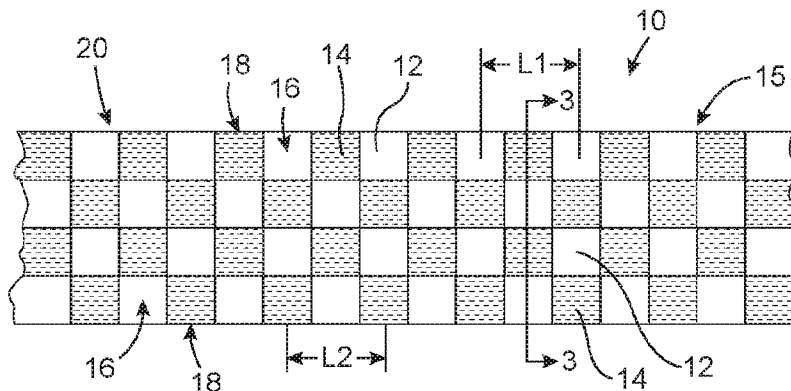
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM,  
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,  
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,  
KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
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TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,  
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,  
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,  
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, KM, ML, MR, NE, SN, TD, TG).

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(54) Title: LOW FRICTION FLAT BRAID



**FIG. 1**

(57) Abstract: A dry sliding low friction suture having an undulated surface is provided. The suture includes: a first end; and a second end braided with the first end to form the suture having an undulated surface having high portions and low portions, and wherein the first end and the second end are of different Denier thereby causing the first and second end to have different diameters which forms the high portion and low portions when all of the ends are braided together. A method of forming a suture having an undulated surface is also described.

WO 2017/074905 A1

## LOW FRICTION FLAT BRAID

[0001] This application is a Non-Provisional Application and claims priority to pending provisional U.S. patent application entitled, Low Friction Flat Braid, filed October 27, 2015, having a serial number 62/246,775, the disclosure of which is hereby incorporated by reference in its entirety.

## FIELD OF THE DISCLOSURE

[0002] The present disclosure relates generally to a flat braid suture. More particularly, the present disclosure relates to a low friction flat braid having an undulated surface.

## BACKGROUND OF THE INVENTION

[0003] Sutures are used within the human body during surgical operations. Sometimes flat braided sutures are used and sometimes they may cause post-operative irritation when the suture is implanted in a place or manner where repetitive sliding occurs. Sutures having higher coefficients of friction may sometimes lead to higher loads on the anchor sites as well as irritation where the suture is sliding, particularly if the suture is sliding on bone or cartilage.

[0004] Lower friction surfaces may be sought after in sutures in order to reduce irritation. One approach is to find more lubricious materials to use in the suture. Sutures that slide on hard surfaces are subject to wear and the resulting wear debris causes plowing and causes an increased frictional force. This can sometimes cause an undesirable amount of irritation for the patient and higher loads on anchor sites of the suture.

[0005] Accordingly, it is desirable to provide a method and apparatus that provides a suture having a relatively low amount of sliding friction and therefore be less irritable to patients and reduced anchor sites of the suture.

## SUMMARY OF THE DISCLOSURE

[0006] The foregoing needs are met, to a great extent, by the present disclosure, wherein in one aspect an apparatus is provided that in some embodiments a suture having a relatively low amount of sliding friction and

- 2 -

therefore be less irritable to patients and/or reduced loads at anchor sites of the suture.

**[0007]** In accordance with one embodiment of the present invention, a dry sliding low friction suture having an undulated surface is provided. The suture includes: a first end; and a second end braided with the first end to form the suture having an undulated surface having high portions and low portions, and wherein the first end and the second end are of different Denier thereby causing the first and second end to have different diameters which forms the high portion and low portions when all of the ends are braided together.

**[0008]** In accordance with another embodiment of the present invention, a dry sliding low friction suture having an undulated surface is provided. The suture includes: a first end; and a second end braided with the first end to form the suture having an undulated surface having high portions and low portions wherein the first end and the second end were braided at different tensions form each other causing the undulated surface.

**[0009]** In accordance with another embodiment of the present invention, a method of forming a suture having an undulated surface is provided. The method includes: braiding a first end together with a second end to form a suture; forming with the braid an undulated surface having high and low portions in the suture; and braiding the first and second ends tightly so that the ends are firmly in place and there are no gaps when bending or twisting the suture by hand.

**[0010]** In accordance with yet another embodiment of the present invention, a suture having an undulated surface is provided. The suture includes: a first end; and a second end braided with the first end to form the suture having an undulated surface having high portions and low portions, wherein the first end and the second end are of different Denier thereby causing the first and second ends to have different diameters which forms the high portion and low portions when the first and second ends are braided together, and wherein a distance between two adjacent high portion is about 50-150 microns.

**[0011]** There has thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may

- 3 -

be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

**[0012]** In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

**[0013]** As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0014]** FIG. 1 is an enlarged, partial, top view illustrating a suture in accordance with an embodiment of the disclosure.

**[0015]** FIG. 2 is a partial side view of the suture of FIG. 1.

**[0016]** FIG. 3 is a cross-sectional view taken along the 3--3 in FIG. 1.

**[0017]** FIG. 4 is an enlarged, partial, top view illustrating a suture in accordance with another embodiment of the disclosure.

**[0018]** FIG. 5 is a partial side view of the suture of FIG. 4.

**[0019]** FIG. 6 is a cross-sectional view taken along the 6--6 in FIG. 4.

#### DETAILED DESCRIPTION

**[0020]** The various embodiments will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout. An embodiment in accordance with the present disclosure

- 4 -

provides a suture having an undulated surface. In some embodiments, the suture will be used in conditions where the suture may slide against a surface of greater or equal hardness as the suture, such as an implant, cartilage, or bone. In some embodiments, the way the suture is shaped and made may result in the design having a smaller coefficient of friction than a suture formed in a traditional manner regardless of the initial lubricity of materials used to form the suture in question.

**[0021]** An embodiment of the present inventive apparatus is illustrated in FIG. 1. FIG. 1 illustrates a partial top view of a suture 10. The suture 10 is made of two types of strands or ends 12 and 14 braided together to form a flat suture 10. The suture 10 includes a first end 12 and a second end 14.

**[0022]** In some embodiments, the ends 12 and 14 may be made of a variety of materials. For example, ultra-high-molecular-weight polyethylene (UHMWPE) may be used to make one or both of the ends 12 and 14. Alternatively one or both of the ends 12 and 14 may be made of polyester. The same suture 10 may include ends 12 and 14 of different materials such as, but not limited to UHMWPE and polyester. Using polyester in at least one of the ends 12 and 14 may give the suture 10 better knot security.

**[0023]** As shown in FIG. 1, the suture 10 has an undulated surface 15. The undulated surface 15 gives the suture 10 a lower coefficient of friction than a suture 10 of similar size and material with a flat surface in both dry and lubricated sliding conditions.

**[0024]** The undulated surface 15 has high portions 16 (shown by the lighter colored portions in FIG. 1) and low portions 18 (shown as the darker colored portions 18 in FIG. 1). The combination of the high portions 16 and the low portions 18 form a checkerboard pattern 20.

**[0025]** FIG. 2 is a side view of the portion of the suture 10 illustrated in FIG. 1. The undulated surface 15 of the suture 10 can clearly be seen. The first end 12 defines the high portions 16 and the second end 14 defines the low portions 18. The difference between the high portions 16 and the low portions 18 is illustrated by H1. In some embodiments, H1 is about 25-125 microns. Other differences in heights may also be used.

- 5 -

**[0026]** In FIGS. 1 and 2, L1 is shown to be the length between the high portions 16 and L2 is shown to be the length between the low portions 18. In some embodiments L1 is equal to L2. In other embodiments L1 and L2 are not equal. It is desirable to select the length of L1 and L2 so that they are not so long as to permit wear debris to move along with the suture 10 and cause plowing and increased friction. Keeping L1 and L2 (particularly L1) short, aids in reducing the likelihood of wear debris from being carried in the low portions 18 of the suture 10 and causing friction. In some embodiments, L1 and L2 are each in the range of 50-150 microns.

**[0027]** In FIG. 3 is a cross-section of the suture 10 illustrated in FIG. 1. The first group of ends 12 is shown to have a greater diameter than the second group of ends 14. The high portions 16 corresponds with the first end 12 and the low portion 18 corresponds with the second end 14. It is the difference in the diameters between the first ends 12 and the second end 14 which creates the undulated surface 15 which, as shown in FIG. 1, is in a checkerboard pattern 20.

**[0028]** In some embodiments, the Deniers of the two ends 12 and 14 are different which results in the two ends 12 and 14 having different diameters. In some embodiments, the first end 12 may have a Denier of 100 and the second end 14 may have a Denier of 55. In other embodiments, end 12 may be sized at 215 Denier and end 14 may be sized at 100 Denier. In other embodiments, the ends 12 and 14 may be sized to have other Deniers. In some embodiments, the difference of the two sets of ends 12 and 14 may be 40 to 115 Denier.

**[0029]** FIGS. 4, 5, and 6 illustrate a second embodiment having similar views as those shown in FIGS. 1 - 3. FIG. 4 illustrates a partial enlarged top view of a suture 10 having a first end 12 and second end 14. The suture 10 has an undulated surface 15 comprised of high portions 16 and low portions 18 which are represented by light and dark surfaces respectively. The light and dark surfaces representing the high portion 16 low portion 18 are set out in a checkerboard pattern 20 that is slightly different than that shown in the embodiment of FIG. 1.

**[0030]** As can be seen in FIG. 4, the low portions 18 are smaller in size compared to the high portions 16. For example, L3 as shown in FIG. 4 represents

- 6 -

the length of the low portion 18. L4 represents the length of the high portion 16. As shown in FIG. 4, L4 is longer than L3. In other embodiments, L4 may be longer than L4 or, alternatively, L3 and L4 may be similar in length. As a result, the embodiment shown in FIG. 4 is checkerboard like, but the “squares” of the checkboard are rectangular not square. For the reasons set forth above with respect to L1 and L2 in Figs. 1 and 2, it is desired to keep the length of L3 and L4 from being too long. In some embodiments L3 is in the range of 25-75 microns and L4 is in the range of 50-150 microns.

**[0031]** FIG. 5 is a partial side view of the suture 10 shown in FIG. 4. As can be seen in FIG. 5, the first end 12 corresponds with the high portion 16 and the second end 14 corresponds with the low portion 18. The high 16 and low portions 18 together form the undulated surface 15. The difference between the high portions 16 and the low portions 18 is illustrated by H2. In some embodiments, H2 is about 25-125 microns. In other embodiments, other differences in heights may also be used.

**[0032]** FIG. 6 is a cross-sectional view of the suture 10 taken along the line 6 – 6 in FIG. 4. The first end 12 and second end 14 are shown lined up next to each other. As can be seen in FIG. 6 the first end 12 and the second end 14 are roughly the same diameter. In such an embodiment, the first end 12 and the second end 14 may have the same Denier.

**[0033]** The ends 12 and 14 may be made of a variety of materials. For example, ultra-high-molecular-weight polyethylene (UHMWPE) may be used to make one or both of the ends 12 and 14. Alternatively one or both of the ends 12 and 14 may be made of polyester. The same suture 10 may include ends 12 and 14 of different materials such as, but not limited to UHMWPE and polyester. Using polyester in at least one of the ends 12 and 14 may give the suture 10 better knot security.

**[0034]** The undulated surface 15 illustrated in FIG. 4 is created where the two ends 12 and 14 are the same size fibers but the tightness of the braid has been altered. In some embodiments the two ends 12 and 14 may not exceed about 100 microns in diameter.

- 7 -

**[0035]** In some embodiments, the checkerboard like pattern 15 shown in FIG. 4 having high portions 16 and low portions 18 may be achieved by braiding ends 12 and 14 of same or similar diameter or Denier at a low braid angle with respect to the braiding machine bobbin. For example the braid may be formed tight enough so that the ends 12 and 14 are firmly in place and those are no gaps when handling bending or twisting the suture 10 by hand. Alternatively, the high portions 16 and low portions 18 forming the checkerboard like pattern 15 of FIG. 4 may be achieved by having the all ends braided under different tensions.

**[0036]** While the illustrated figures only show two ends 12 and 14 and show the suture to only be four ends 12 and 14 wide, it should be understood that this has been simplified to better explain the various embodiments. It will be appreciated that some embodiments will use more or fewer ends 12 and 14 in the suture 10. Many sutures 10 will incorporate many more ends 12 and 14 than four in the braid of the suture 10. It may be appreciated that end 12 may represent all of the ends having the Denier or diameter of end 12 and end 14 may represent all of the ends having the Denier or diameter of end 14.

**[0037]** The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.



- 8 -

What is claimed is:

1. A dry sliding low friction suture having an undulated surface comprising:  
a first end; and  
a second end braided with the first end to form the suture having an undulated surface having high portions and low portions, and  
wherein the first end and the second end are of different Denier thereby causing the first and second end to have different diameters which forms the high portion and low portions when all of the ends are braided together.
2. The suture of claim 1, wherein the suture is a flat braid.
3. The suture of claim 1, wherein at least one of the ends is made of ultra-high-molecular-weight polyethylene (UHMWPE).
4. The suture of claim 1, wherein at least one of the ends is made of polyester.
5. The suture of claim 1, wherein the two ends are made of the same material.
6. The suture of claim 1, wherein the two ends are made of different materials.
7. The suture of claim 1, wherein the first end has a Denier of about 100-215.
8. The suture of claim 1, wherein the second end has a Denier of about 55-

- 9 -

100.

9. The suture of claim 1, wherein a distance between the high portions is between about 50-150 microns.

10. The suture of claim 9, wherein the first and second ends are no greater than 100 microns in diameter.

11. The suture of claim 1, wherein the first and second ends are braided tightly so that the ends are firmly in place and there are no gaps when bending or twisting the suture by hand.

12. A dry sliding low friction suture having an undulated surface comprising:  
a first end; and  
a second end braided with the first end to form the suture having an undulated surface having high portions and low portions wherein the first end and the second end were braided at different tensions from each other causing the undulated surface.

13. The method of claim 12, wherein the first end and second end are braided tightly so that there are no gaps in the suture when the suture is bent or twisted.

14. The method of claim 13, further comprising forming the high and low portions by using a first end having a different diameter than the second end.

15. The method of claim 14, wherein the difference in size between the first and second ends is about 40-115 Denier.

- 10 -

16. The method of claim 14, wherein the difference in height between the high and low portions is about 10-15 microns.
17. A method of forming a suture having an undulated surface comprising:  
braiding a first end together with a second end to form a suture;  
forming with the braid an undulated surface having high and low portions in the suture; and  
braiding the first and second ends tightly so that the ends are firmly in place and there are no gaps when bending or twisting the suture by hand.
18. The method of claim 13, further comprising using ultra-high-molecular-weight polyethylene (UHMWPE) as the first end.
19. The method of claim 13, further comprising using polyester as the second end.
20. A suture having an undulated surface comprising:  
a first end; and  
a second end braided with the first end to form the suture having an undulated surface having high portions and low portions,  
wherein the first end and the second end are of different Denier thereby causing the first and second ends to have different diameters which forms the high portion and low portions when the first and second ends are braided together, and wherein a distance between two adjacent high portion is about 50-150 microns.

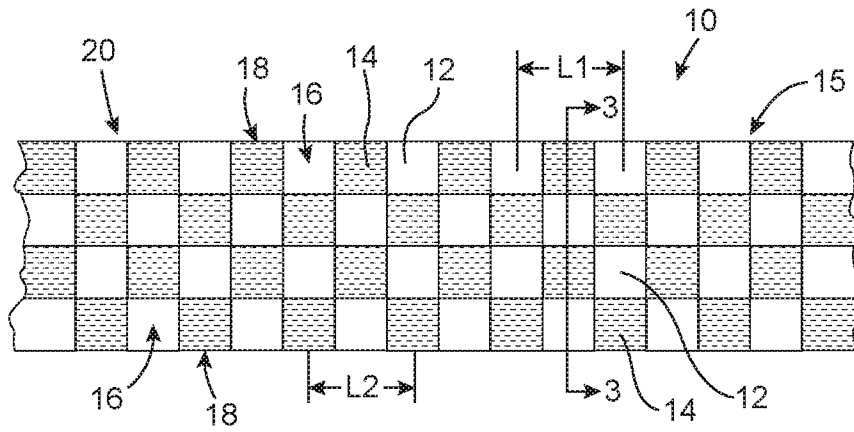


FIG. 1

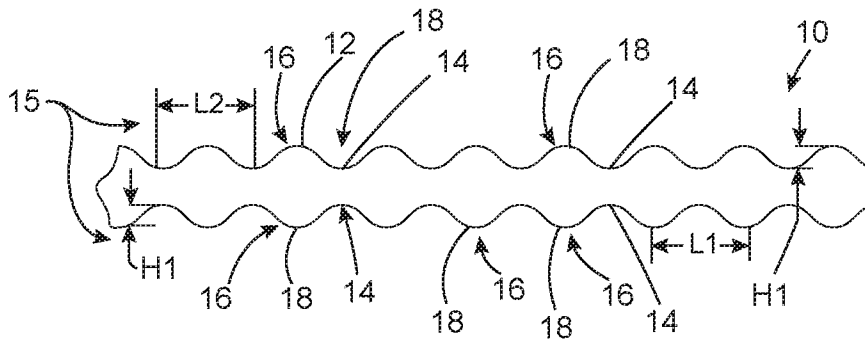


FIG. 2

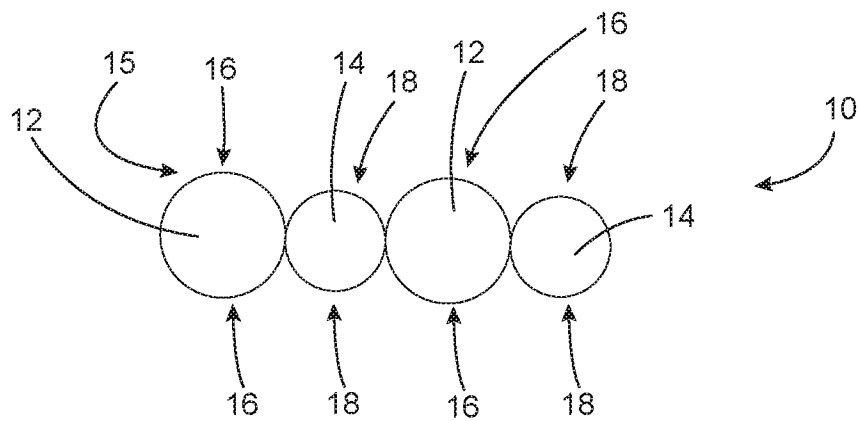


FIG. 3

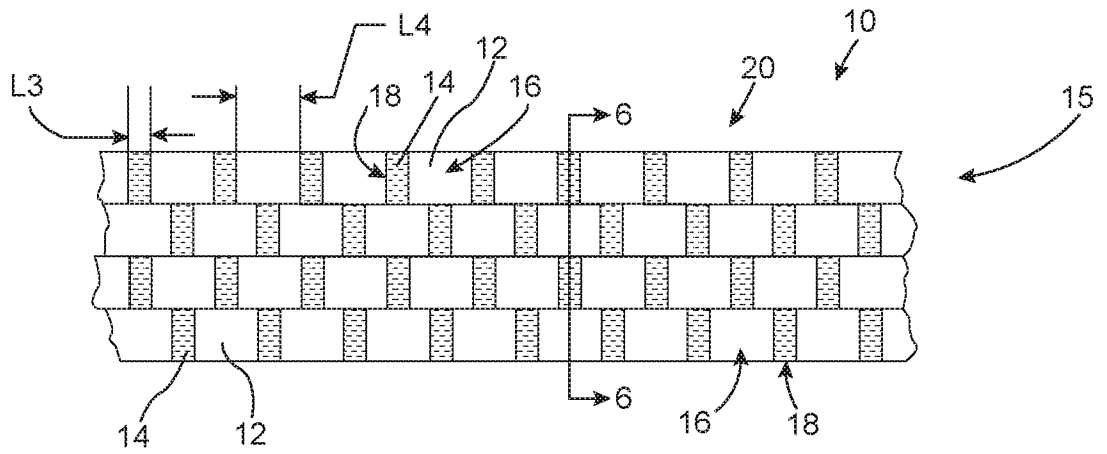


FIG. 4

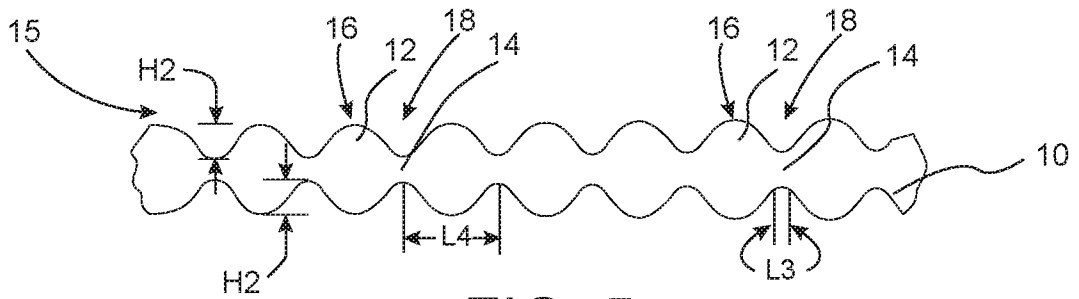


FIG. 5

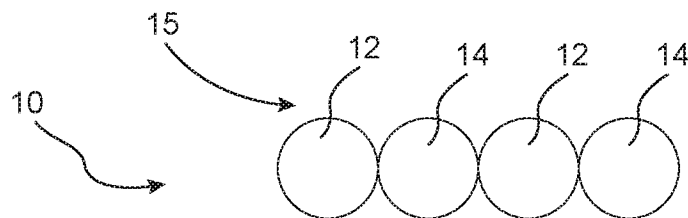


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/58596

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC(8) - A61B 17/06, A61B 17/04, A61L 17/00 (2017.01)  
 CPC - A61B 2017/06176, A61B 17/06166, A61B 17/04, A61B 17/0401, A61F 2220/0075  
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
 CPC - A61B 2017/06176; USPC - 606/230

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
 CPC - A61B 17/06166, A61B 17/04, A61B 17/0401, A61F 2220/0075, A61F 2220/0008, A61L 17/00; IPC(8) - A61B 17/06, A61B 17/04, A61L 17/00 (2017.01); USPC - 606/231, 606/228, 606/154, 606/155, 606/151 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
 PatBase; Google (Web, Patents, Scholar) Search Terms Used: Suture ligature stitch Dry low friction undulated wavy curve uneven high low Braid flat filaments threads Ultra high molecular weight polyethylene UHMWPE Polyester Denier different varying Diameter variable Linear density thickness tight gaps openings spaces remove eliminate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0298872 A1 (Berndt et al.), 25 November 2010 (25.11.2010), entire document, especially Fig. 1A and 7; para [0020]-[0021], [0029]-[0034], [0040], [0060]	1-2, 4-10 and 20
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Y		3
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A		11
Y	US 8,414,612 B2 (Kirsch et al.), 09 April 2013 (09.04.2013), entire document, especially Fig. 3A; col 2, ln 32-34; col 3, ln 64 to col 4, ln 16; col 5, ln 62 to col 6, ln 26	3
A	US 8,641,732 B1 (Goraltchouk et al.), 04 February 2014 (04.02.2014), entire document	1-11 and 20
A	US 2015/0173753 A1 (Spivey et al.), 25 June 2015 (25.06.2015), entire document	1-11 and 20
A	US 2013/0317545 A1 (Gross et al.), 28 November 2013 (28.11.2013), entire document	1-11 and 20
A	US 2014/0081295 A1 (Lau et al.), 20 March 2014 (20.03.2014), entire document	1-11 and 20
A	US 2009/0105753 A1 (Greenhalgh et al.), 23 April 2009 (23.04.2009), entire document	1-11 and 20
A	RO 123135 B1 (INSTITUTUL NATIONAL DE CERCETARE-DEZVOLTARE PENTRU TEXTILE SI PIELARIE), 30 December 2010 (30.12.2010), Abstract	1-11 and 20

Further documents are listed in the continuation of Box C.

\* Special categories of cited documents:  
 "A" document defining the general state of the art which is not considered to be of particular relevance "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
 "E" earlier application or patent but published on or after the international filing date "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
 "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art  
 "O" document referring to an oral disclosure, use, exhibition or other means  
 "P" document published prior to the international filing date but later than the priority date claimed "&" document member of the same patent family

Date of the actual completion of the international search  
 06 February 2017  
 Date of mailing of the international search report  
 23 FEB 2017

Name and mailing address of the ISA/US  
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 Lee W. Young  
 PCT Helpdesk: 571-272-4300  
 PCT OSP: 571-272-7774

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 16/58596

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:  
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-11 and 20, directed to a suture wherein the first end and second end are of different Denier.

Group II: Claims 12-16 and 18-19 directed to a suture wherein the first end and second end were braided at different tensions from each other.

Group III: Claim 17, directed to a method of forming a suture.

-\*-Continued in Supplemental Box-\*-

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1-11 and 20

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

-\*- Continuation of Box III - Observations where Unity of Invention is Lacking -\*-

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

#### SPECIAL TECHNICAL FEATURES

The invention of Group I includes the special technical feature of wherein the first end and the second end are of different Denier thereby causing the first and second end to have different diameters which forms the high portion and low portions when all of the ends are braided together, not required by the claims of Groups II-III.

The invention of Group II includes the special technical feature of wherein the first end and the second end were braided at different tensions from each other causing the undulated surface, not required by the claims of Groups I and III.

The invention of Group III is related to Groups I-II in that it is a method of forming the product claimed in Groups I-II. Group III also includes the special technical feature of braiding the first and second ends tightly so that the ends are firmly in place and there are no gaps when bending or twisting the suture by hand, not required by the claims of Groups I-II.

#### COMMON TECHNICAL FEATURES

Groups I-III share the common technical features of a first end; a second end braided with the first end to form the suture having an undulated surface having high portions and low portions. However, these shared technical features do not represent a contribution over prior art as being anticipated by US 2010/0298872 A1 to Berndt et al. (hereinafter 'Berndt'), which discloses a suture (suture 10, Fig. 1A) comprising a first end (a first filament of the filaments 18/19, Fig. 1A; para [0060]); a second end braided with the first end (a second filament of the filaments 18/19, braided together to form braid 12, para [0060]; Fig. 1A) to form the suture (suture 10 is composed of the filamentary braid 12, para [0060]) having an undulated surface (suture 10 has filamentary loops 16 extending therefrom, Fig. 1A and 7 - thus creating a wavy or undulating surface; see also para [0060]) having high portions (peaks of filamentary loops, Fig. 1A and 7) and low portions (valleys of filamentary loops, Fig. 1A and 7).

Groups I-II further share the common technical feature of the suture being a dry sliding low friction suture. However, this shared technical feature does not represent a contribution over prior art as being anticipated by Berndt, which further discloses a dry sliding low friction suture (suture is formed from materials such as polyethylene compounds or polytetrafluoroethylene, para [0034] - which are low friction and thus suture is low friction and allows sliding for insertion; see also para [0021] - while liquids may be used, they are cured or hardened).

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-III lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.