

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

**(43) International Publication Date
18 May 2017 (18.05.2017)**



**(10) International Publication Number
WO 2017/083645 A1**

(51) International Patent Classification:
D04C 1/02 (2006.01)

(21) International Application Number: PCT/US2016/061526

(22) International Filing Date: 11 November 2016 (11.11.2016)

(25) Filing Language: English
(26) Publication Language: English

(30) Priority Data: 62/254,800 13 November 2015 (13.11.2015) US
15/348,682 10 November 2016 (10.11.2016) US

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(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, 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, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, 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).

Published:

— with international search report (Art. 21(3))

(54) Title: BRAIDED TEXTILE SLEEVE WITH AXIALLY COLLAPSIBLE, ANTI-KINKING FEATURE AND METHOD OF CONSTRUCTION THEREOF

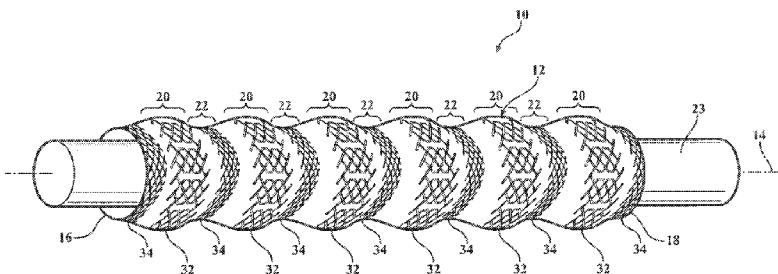


FIG. 1

(57) Abstract: A protective textile sleeve and method of construction thereof are provided. The sleeve has a tubular wall of braided yarns extending lengthwise along a central longitudinal axis between opposite ends. At least some of the braided yarns including heat-set yarns, and the wait has a plurality of annular first regions forming generally convex ridges and a plurality of annular second regions forming generally concave valleys, The first regions alternate with the second regions along the central longitudinal axis. The first regions include a plurality of twisted yarns forming a plurality of closed loops, wherein at least some of the braided yarns pass through at least some of the closed loops within the first regions to enhance the radial stiffness and resistance of the wall to kinking.

BRAIDED TEXTILE SLEEVE WITH AXIALLY COLLAPSIBLE, ANTI-KINKING
FEATURE AND METHOD OF CONSTRUCTION THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 62/254,800, filed November 13, 2015, and U.S. Utility Application Serial No. 15/348,682, filed November 10, 2016, which are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

[0002] This invention relates generally to textile sleeves, and more particularly to braided textile sleeves.

2. Related Art

[0003] It is known to protect elongate members in braided textile sleeves against a variety of environmental conditions and affects, or to just contain elongate members in textile sleeves for bundling and routing purposes. In the case of braided sleeves, the braided wall is commonly braided as a circumferentially continuous, seamless wall, sometimes referred to as a 'closed' wall. One known advantage of a closed, braided wall construction, in contrast to woven or knit wall constructions, is that the wall can be circumferentially expanded by pushing the opposite ends toward one another during installation to facilitate sliding the wall over an elongated member. However, a known problem with braided sleeves can arise during installation, particularly when trying to install the sleeve over relatively lengthy elongate members, such as wires and tubes, and/or about relatively sharp bends or corners. Commonly, when confronted with lengthy elongate members and sharp bends, the sleeves tend to flatten on themselves and kink, particularly within the region of a bend, thereby causing the material of the sleeve to bunch-up axially on itself, and thus, the sleeve ceases to

continue along the length of the elongate member, thereby complicating the installation process.

SUMMARY OF THE INVENTION

[0004] In accordance with one aspect of the invention, a protective textile sleeve is provided. The sleeve has a tubular wall of braided yarns extending lengthwise along a central longitudinal axis between opposite ends. At least some of the braided yarns including heat-set yarns. The wall has a plurality of annular first regions forming generally convex ridges and a plurality of annular second regions forming generally concave valleys. The first regions alternate with the second regions along the central longitudinal axis. The first regions including a plurality of twisted yarns forming a plurality of closed loops, wherein at least some of the braided yarns pass through at least some of the closed loops within the first regions.

[0005] In accordance with another aspect of the invention, the first regions can be provided having a first stiffness and the second regions can be provided having a second stiffness, with the first stiffness being greater than the second stiffness. Accordingly, the relatively increased stiffness first regions resist the wall from being circumferentially compressed and flattened, while the relatively decreased stiffness second regions provide axial flexibility and axial compressibility to facilitate routing the sleeve about bends without kinking.

[0006] In accordance with another aspect of the invention, the first regions can include heat-set yarns.

[0007] In accordance with another aspect of the invention, the heat-set-yarns can be provided as monofilaments.

[0008] In accordance with another aspect of the invention, the second regions can include non-heat-settable yarns.

[0009] In accordance with another aspect of the invention, the non-heat-settable yarns can be provided as relatively soft multifilaments to enhance the coverage protection offered by the sleeve and to enhance axial compressibility and flexibility of the wall to resist kinking.

[0010] In accordance with another aspect of the invention, at least some of the heat-set yarns can be braided in bundles, with each of the bundles including a plurality of yarns twisted with one another and forming closed loops, with at least some of the closed loops of one bundle being interlinked with at least some closed loops of another bundle in the first regions.

[0011] In accordance with another aspect of the invention, the second regions can be formed to include non-heat-set yarns, with the non-heat-set yarns extending through closed loops of the bundles to enhance the structural integrity of the sleeve.

[0012] In accordance with another aspect of the invention, a plurality of the yarns can be braided to pass through each of the closed loops.

[0013] In accordance with another aspect of the invention, the first regions can include yarns braided in a first pattern and the second regions can include yarns braided in a second pattern, wherein the first pattern is different from the second pattern, such that the first pattern has an increased stiffness against axial and radial compression relative to the second pattern, which in turn can provide enhanced flexibility.

[0014] In accordance with another aspect of the invention, the wall can be formed entirely of heat-set monofilaments.

[0015] In accordance with another aspect of the invention, a method of constructing a tubular protective textile sleeve is provided. The method includes braiding a plurality of yarns with one another to form a tubular wall extending lengthwise along a central longitudinal axis between opposite ends, with at least some of the yarns being provided as heat-settable yarns. Further, compressing the opposite ends of the tubular wall axially toward

one another to a compressed state. Next, heat-setting the heat-settable yarns while the wall is in the compressed state to form a plurality of annular first regions and a plurality of annular second regions alternating with one another along the central longitudinal axis, wherein the first regions form generally convex ridges and the second regions form generally concave valleys.

[0016] In accordance with another aspect of the invention, the method can include braiding the wall on a lace-braiding machine.

[0017] In accordance with another aspect of the invention, the method can include braiding the wall as a seamless, circumferentially continuous wall.

[0018] In accordance with another aspect of the invention, the method can include forming the second regions including non-heat-settable yarns.

[0019] In accordance with another aspect of the invention, the method can include providing the non-heat-settable yarns as multifilaments.

[0020] In accordance with another aspect of the invention, the method can include providing the heat-settable yarns as monofilaments.

[0021] In accordance with another aspect of the invention, the method can include braiding at least some of the heat-settable yarns in twisted bundles having loops, and further including interlinking at least some of the loops of one bundle with at least some of the loops of another bundle in the first regions.

[0022] In accordance with another aspect of the invention, the method can include extending non-heat-settable yarns through at least some of the loops of the bundles.

[0023] In accordance with another aspect of the invention, the method can include braiding yarns in the first regions in a first pattern and braiding the second yarns in the second regions in a second pattern, the first pattern having an increased axial and radial stiffness relative to the second pattern.

[0024] In accordance with another aspect of the invention, the method can include braiding the wall entirely of heat-settable yarns.

[0025] In accordance with another aspect of the invention, the method can include braiding the first regions having a first stiffness and braiding the second regions having a second stiffness, with the first stiffness being greater than the second stiffness, such that the first regions provide the sleeve with enhanced hoop strength and anti-kinking properties and the second regions provide the sleeve with enhanced flexibility and coverage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] These and other aspects, features and advantages of the present invention will become more readily appreciated when considered in connection with the following detailed description of presently preferred embodiments and best mode, appended claims and accompanying drawings, in which:

[0027] Figure 1 is a schematic perspective view of a tubular braided sleeve constructed in accordance with one aspect of the invention shown disposed about an elongate member to be protected;

[0028] Figure 2A is an enlarged fragmentary view showing the braid pattern of a wall of the sleeve of Figure 1 in accordance with one aspect of the invention;

[0029] Figure 2B is an enlarged fragmentary view showing the braid pattern of a wall of the sleeve of Figure 1 in accordance with another aspect of the invention;

[0030] Figure 2C is an enlarged fragmentary view showing the braid pattern of a wall of the sleeve of Figure 1 in accordance with another aspect of the invention;

[0031] Figure 2D is an enlarged fragmentary view showing the braid pattern of a wall of the sleeve of Figure 1 in accordance with another aspect of the invention;

[0032] Figure 3A is a fragmentary view of the sleeve of Figure 1 constructed via the braid pattern of Figure 2A shown in a braided, pre-compressed, pre-heat-set state;

[0033] Figure 3B is a view of the sleeve of Figure 3B shown in an axially compressed, heat-set state;

[0034] Figure 3C is a view of the sleeve of Figure 3B shown being routed about a sharp bend without kinking;

[0035] Figure 4A is a fragmentary view of the sleeve of Figure 1 constructed via the braid pattern of Figure 2D shown in a braided, pre-compressed, pre-heat-set state;

[0036] Figure 4B is a fragmentary view of the sleeve of Figure 4A shown in an axially compressed state;

[0037] Figure 4C is a fragmentary view of the sleeve of Figure 4B shown in an axially compressed, heat-set state; and

[0038] Figure 4D is a fragmentary view of the sleeve of Figure 4C shown being routed about a sharp bend without kinking.

DETAILED DESCRIPTION OF PRESENTLY PREFERRED EMBODIMENTS

[0039] Referring in more detail to the drawings, Figure 1 illustrates generally a braided protective textile sleeve, referred to hereafter as sleeve 10, constructed in accordance with one aspect of the invention. The sleeve 10 has a braided, circumferentially continuous, seamless tubular wall 12 extending lengthwise along a central longitudinal axis 14 between opposite open ends 16, 18. The wall 12 has a plurality of annular first regions 20 and a plurality of annular second regions 22 alternating with one another along the central longitudinal axis 14 to provide the wall 12 with axially collapsible features in the form of a corrugated or convoluted profile. The first regions 20 form generally bulbous, convex ridges having a first axial and radial stiffness and the second regions 22 form generally contracted, concave valleys having a second axial and radial stiffness, wherein the first stiffness is greater than the second stiffness. As a result of the differing region configurations and stiffness between the first and second regions 20, 22, the wall 12 is able to readily collapse

and expand axially while retaining its structural integrity, including outer peripheral shape, during assembly and while in use, thereby making assembly of the sleeve 10 about an elongate member 23 to be received and protected therein easy, even over long elongate members 23 and about meandering paths and corners.

[0040] The wall 12 is preferably braided on a lace-braiding machine, though other braiding mechanisms are contemplated herein. In accordance with one aspect of the invention, the yarns forming or substantially forming the first regions 20 can be provided as heat-settable yarns 24 (substantially forming is meant to mean that a majority, such as greater than 75% content, by way of example and without limitation, of the yarn is heat-settable yarn 24) and the yarns forming or substantially forming the second regions 22 can be provided as non-heat-settable yarns 26 (substantially forming is meant to mean that a majority, such as greater than 75% content, by way of example and without limitation, of the yarn is non-heat-settable yarn 26). The heat-settable yarns 24 are preferably provided as monofilaments, while the non-heat-settable yarns are preferably provided as multifilaments, though it is contemplated herein the heat-settable multifilaments and non-heat-settable monofilaments could be used, depending on the application performance requirements. Regardless, the heat-settable yarns 24, particularly after being heat-set, as discussed below, are relatively stiff and rigid in comparison to the non-heat-settable yarns 26, while the non-heat-settable yarns 26 are relatively soft and flexible in comparison to the heat-settable yarns 24. Accordingly, the heat-settable yarns 24 can be provided as a heat-settable monofilament or a heat-settable multifilament, such as from, for example, nylon, polyphenylene sulfide (PPS), polyethyleneterephthalate (PET), or polypropylene (PP), having a diameter between about 0.1-0.40mm, by way of example and without limitation, or being generally flat, having a thickness between about 0.15-0.25mm and a width between about 1.0-3.5mm, by way of example and without limitation. The non-heat-settable yarns 26 can be provided from any

suitable non-heat-settable material, including, by way of example and without limitation, a mineral fiber, e.g. basalt, silica, or ceramic or fiberglass.

[0041] During the braiding process, the heat-settable yarns 24 are braided to form the substantial majority of, or the entirety of the first regions 20, while non-heat-settable yarns 26 are braided to form the substantial majority of, or the entirety of the second regions 22. Accordingly, the heat-settable yarns 24 are interlaced with one another to form or substantially form the first regions 20 and the non-heat-settable yarns 26 are interlaced with one another to form or substantially form the second regions 22. In Figures 2A and 2B, different braid patterns are shown in accordance with different aspects of the invention, while it should be recognized that other braid patterns providing relatively stiff first regions 20 and relatively soft, flexible second regions 22 are contemplated herein. The heat-settable yarns 24 in Figure 2A and 2B are shown as being braided as twisted bundles 28, wherein each bundle 28 includes a plurality of heat-settable yarns 24, shown as a pair of heat-settable yarns 24, by way of example and without limitation, twisted with one another to form closed loops 30. At least a portion or the entirety of the closed loops 30 within the first regions 20 are interlinked with one another such that the twisted bundles 28 are locked together. In Figure 2A, within the second regions 26, the non-heat-settable yarns 26 are not only interlaced with one another in generally standard braided fashion, undulating over-and-under one another in alternating relation, but they also extend through closed loops 30 of the twisted bundles 28, while in Figure 2B, the second regions 22 are formed entirely of the non-heat-settable yarns 26.

[0042] Upon braiding the wall in accordance with the braid pattern of Figure 2A, as shown in Figure 3A, with the same process applying to that for the braid pattern of Figure 2B, the opposite ends 16, 18 of the wall 12 are axially compressed toward one another, wherein during the compressing process, the first regions 20, being relatively stiff, form

radially outwardly extending, bulbous convex ridges 32, while the second regions 22, being relatively soft and flexible, collapse radially to form radially inwardly extending, contracted concave valleys 34. While in the compressed state, the wall 12 is heat-set via application of a suitable degree of heat to cause the heat-settable yarns 24 to take on a heat-set configuration. Upon being heat-set, the wall 12 retains a corrugated or convoluted configuration while in a relaxed, unbiased state, as shown in Figures 3B. It should be recognized the wall 12 can be axially compressed to the desired reduced length, whether fully compressed or partially compressed, and further, the wall 12 can be compressed in sections and heat set prior to cutting the sleeve to its finished length, or the wall 12 can be cut to length, then compressed to the desired length, and then heat-set. While compressing the wall 12, it is contemplated that the wall 12 can be disposed about a central mandrel to facilitate uniform compression of the wall 12 without buckling. Further, the mandrel could be heated to facilitate heat-setting the wall 12 while in its fully or partially compressed state.

[0043] Upon being heat-set, the wall 12 retains the radially outwardly extending, relatively stiff first regions 20 and the radially inwardly extending, relatively soft and flexible second regions 22, and as a result, the sleeve 10 is readily able to be installed over relatively long, meandering elongate members 23, including around bends and corners, as shown in Figure 3, without kinking or losing its "as constructed" outer peripheral shape, whether circular or non-circular, as viewed in lateral cross-section.

[0044] In Figures 2C and 2D, different braid patterns of the wall 12 in accordance with further embodiments of the sleeve 10 of Figure 1 are shown, wherein the same reference numerals as above are used to indicate like features, while it should be recognized that other braid patterns providing relatively stiff first regions 20 and relatively soft, flexible second regions 22 are contemplated herein. The braid patterns shown in Figures 2C and 2D include solely heat-settable yarns 24, wherein the heat-settable yarns 24 are interlaced with

themselves in a first standard braid pattern, undulating over-and-under one another in opposite helical S and Z directions throughout the second regions 22, while the heat-settable yarns 24 are interlaced with each other in a second braid pattern in the first regions 20, with the second braid pattern being formed by pairs 36 of the heat-settable yarns 24 looping about intermediate heat-settable yarns 24 and each other to change helical directions relative to one another. Accordingly, one of the yarns 24 in the pair of yarns 36 changes from an S or Z helical direction to the opposite S or Z direction with the first region 20, while the other of the yarns 24 in the pair of yarns 36 changes from an S or Z helical direction to the opposite S or Z direction with the first region 20, thereby forming closed loops 30. Extending through the closed loops 30 is a plurality, shown as a pair of heat-settable yarns 24, by way of example and without limitation, extending opposite helical directions to one another. The main difference between the braid patterns of Figures 2C and 2D is with regard to the axial length of the second, relatively flexible regions 22, wherein the second regions 22 of Figure 2C are shown as being the same or substantially the same axial length as the relatively stiff first regions 20, and in contrast, the second regions 22 of Figure 2D are shown as having an increased axial length relative to the relatively stiff first regions 20, shown as being about twice as long, by way of example and without limitation. It should be recognized that the first and second regions 20, 22 can be braided having any suitable axially extending length, wherein the first and second regions can all be about the same length, or they can vary in length individually or relative to one another over the length of the sleeve 10, as desired for the intended application.

[0045] Upon braiding the wall in accordance with the braid patterns of Figures 2C and 2D, as shown in Figure 4A for the braid pattern of Figure 2D, though the same process applies to the braid pattern of Figure 2C, the opposite ends 16, 18 of the wall 12 are axially compressed toward one another, wherein during the compressing process, the first regions 20,

being relatively stiff, form radially outwardly extending, convex ridges 32, while the second regions 22, being relatively flexible, form radially inwardly extending, concave valleys 34, with the wall 12 taking a generally bellowed or convolute shape, as shown in Figure 4B. While in the compressed state, the wall 12 is heat-set via application of a suitable degree of heat to cause the heat-settable yarns 24 to take on a heat-set configuration. Upon being heat-set, the wall 12 retains a corrugated or convoluted configuration while in a relaxed, unbiased state, as shown in Figure 4C. It should be recognized the wall 12 can be axially compressed to the desired reduced length, whether fully compressed or partially compressed, and further, the wall 12 can be compressed in sections and heat set prior to cutting the sleeve to its finished length, or the wall 12 can be cut to length, then compressed to the desired length, and then heat-set. While compressing the wall 12, it is contemplated that the wall 12 can be disposed about a central mandrel to facilitate uniform compression of the wall 12 without buckling. Further, the mandrel could be heated to facilitate heat-setting the wall 12 while in its fully or partially compressed state.

[0046] Upon being heat-set, the wall 12 retains the radially outwardly extending, relatively stiff first regions 20 and the radially inwardly extending, relatively soft and flexible second regions 22. As a result, the sleeve 10 is readily able to be installed over relatively long, meandering elongate members 23, including around bends and corners, as shown in Figure 4D, without kinking or losing its "as constructed" outer peripheral shape, such as round, by way of example and without limitation. As the sleeve 10 is being routed around bends, the flexible, softer second regions 22 are able to collapse axially, while the first regions 20 maintain the peripheral profile of the wall 12, whether circular or non-circular, as viewed in lateral cross-section, thereby maintaining or substantially maintaining the "as constructed" outer peripheral shape of the wall 12. Accordingly, assembly of the sleeve 10 over the length of generally long, meandering elongate members 23 is greatly simplified.

[0047] Many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that the invention may be practiced otherwise than as specifically described, and that the scope of the invention is defined by any ultimately allowed claims.

What is claimed is:

1. A protective textile sleeve, comprising:
a tubular wall of braided yarns extending lengthwise along a central longitudinal axis between opposite ends, at least some of said braided yarns including heat-set yarns; and
said wall having a plurality of annular first regions forming generally convex ridges and a plurality of annular second regions forming generally concave valleys, said first regions alternating with said second regions along said central longitudinal axis, said first regions including a plurality of twisted yarns forming a plurality of closed loops, wherein at least some of said braided yarns pass through at least some of said closed loops within said first regions.
2. The protective sleeve of claim 1 wherein said second regions are free of said closed loops.
3. The protective sleeve of claim 2 wherein the entirety of said braided yarns include heat-set yarns.
4. The protective sleeve of claim 2 wherein a plurality of said yarns pass through each of said closed loops.
5. The protective sleeve of claim 1 wherein said first regions have a first stiffness and said second regions have a second stiffness, said first stiffness being greater than said second stiffness.

6. The protective sleeve of claim 5 wherein said first regions include said heat-set yarns.
7. The protective sleeve of claim 6 wherein said heat-set-yarns are monofilaments.
8. The protective sleeve of claim 5 wherein said second regions include non-heat-set yarns.
9. The protective sleeve of claim 8 wherein said non-heat-set yarns are multifilaments.
10. The protective sleeve of claim 9 wherein at least some of said multifilaments pass through at least some of said closed loops.
11. The protective sleeve of claim 1 wherein at least some of said heat-set yarns are braided in bundles, each of said bundles including a plurality of said closed loops, at least some of said closed loops of one bundle being interlinked with at least some of said closed loops of another bundle in said first regions.
12. The protective sleeve of claim 11 wherein said second regions include non-heat-set yarns, said non-heat-set yarns extending through said closed loops.
13. The protective sleeve of claim 11 wherein said second regions are free of said closed loops.

14. The protective sleeve of claim 1 wherein said first regions include yarns braided in a first pattern and said second regions include yarns braided in a second pattern, said first pattern being different from said second pattern.

15. The protective sleeve of claim 1 wherein said wall is formed entirely of heat-set monofilaments.

16. A method of constructing a textile sleeve, comprising:

braiding a plurality of yarns with one another to form a tubular wall extending lengthwise along a central longitudinal axis between opposite ends with at least some of said yarns being provided as heat-settable yarns;

compressing said opposite ends of said tubular wall axially toward one another; and

heat-setting said heat-settable yarns while said wall is in said compressed state to form a plurality of annular first regions and a plurality of annular second regions alternating with one another along said central longitudinal axis, said first regions forming generally convex ridges and said second regions forming generally concave valleys.

17. The method of claim 16 further including braiding said wall with a lace-braiding machine.

18. The method of claim 16 further including braiding said wall as a seamless, circumferentially continuous wall.

19. The method of claim 16 further including braiding said second regions including non-heat-settable yarns.

20. The method of claim 19 further including providing said non-heat-settable yarns as multifilaments.
21. The method of claim 16 further including braiding at least some of said heat-settable yarns in twisted bundles with each of said twisted bundles including a plurality of closed loops, and further including interlinking at least some of said closed loops of one twisted bundle with at least some of said closed loops of another twisted bundle in said first regions.
22. The method of claim 21 further including providing at least some of the yarns as non-heat-settable yarns and extending at least some of the non-heat-settable yarns through at least some of said closed loops.
23. The method of claim 22 further including providing the heat-settable yarns as monofilaments and providing the non-heat-settable yarns as multifilaments.
24. The method of claim 22 further including extending a plurality of the non-heat-settable yarns through each of said closed loops.
25. The method of claim 16 further including braiding yarns in said first regions in a first pattern and braiding said second yarns in said second regions in a second pattern, said first pattern being different from said second pattern.
26. The method of claim 25 further including braiding said wall entirely of heat-settable yarns.

27. The method of claim 26 further including braiding at least some of said heat-settable yarns forming a plurality of closed loops in the first regions.
28. The method of claim 26 further including braiding the second regions being free of the closed loops.
29. The method of claim 16 further including braiding the first regions having a first stiffness and braiding the second regions having a second stiffness, with the first stiffness being greater than the second stiffness.

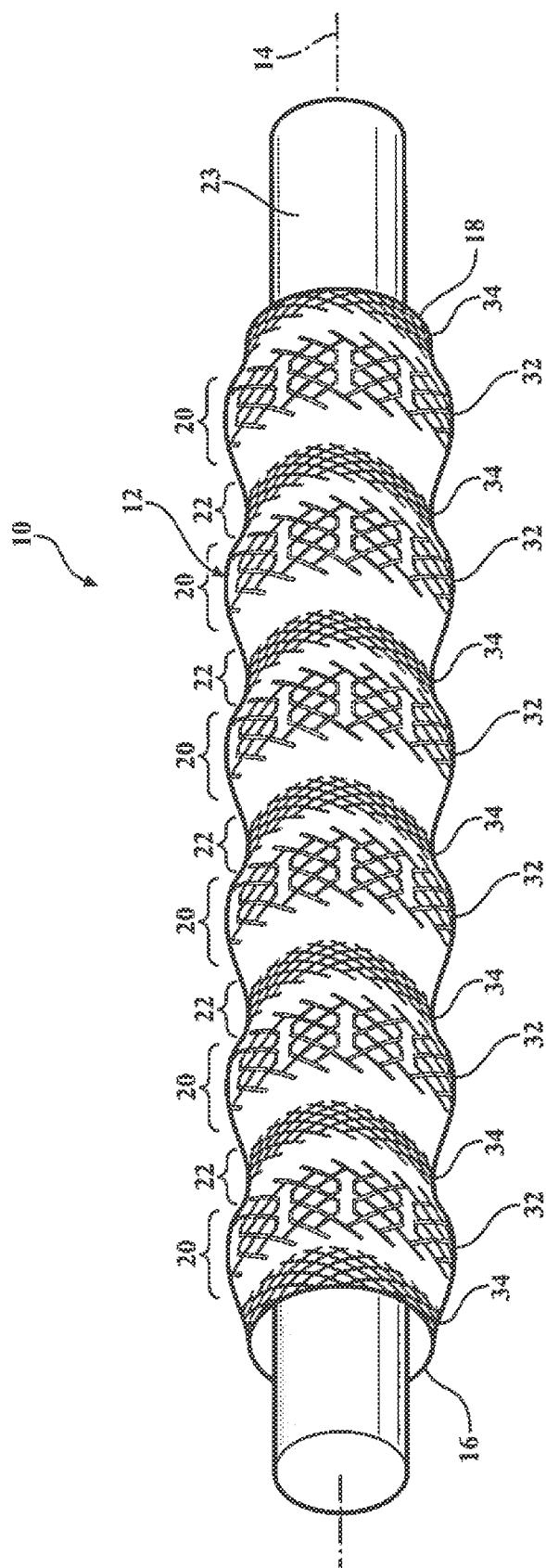


FIG. 1

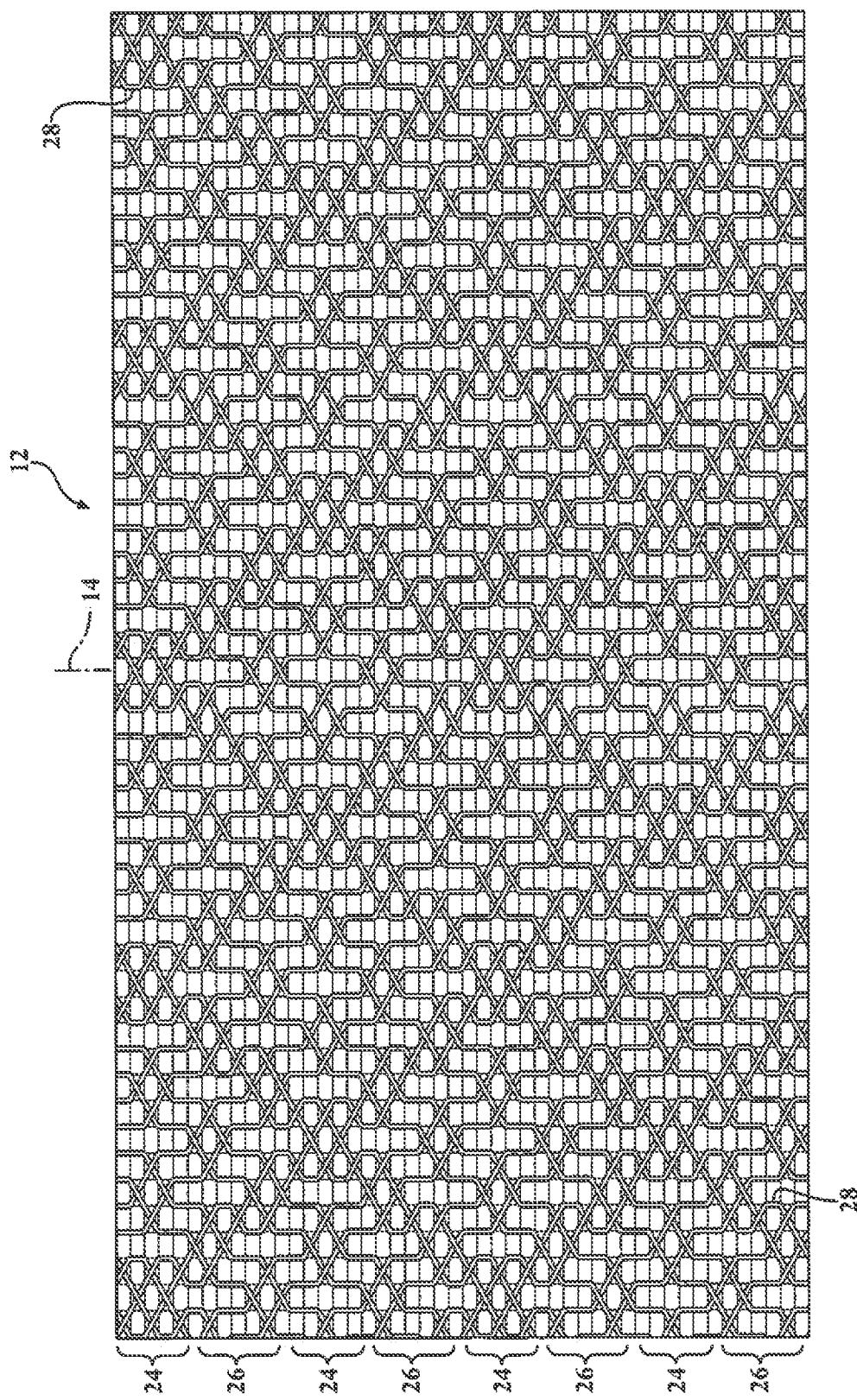


FIG. 2A

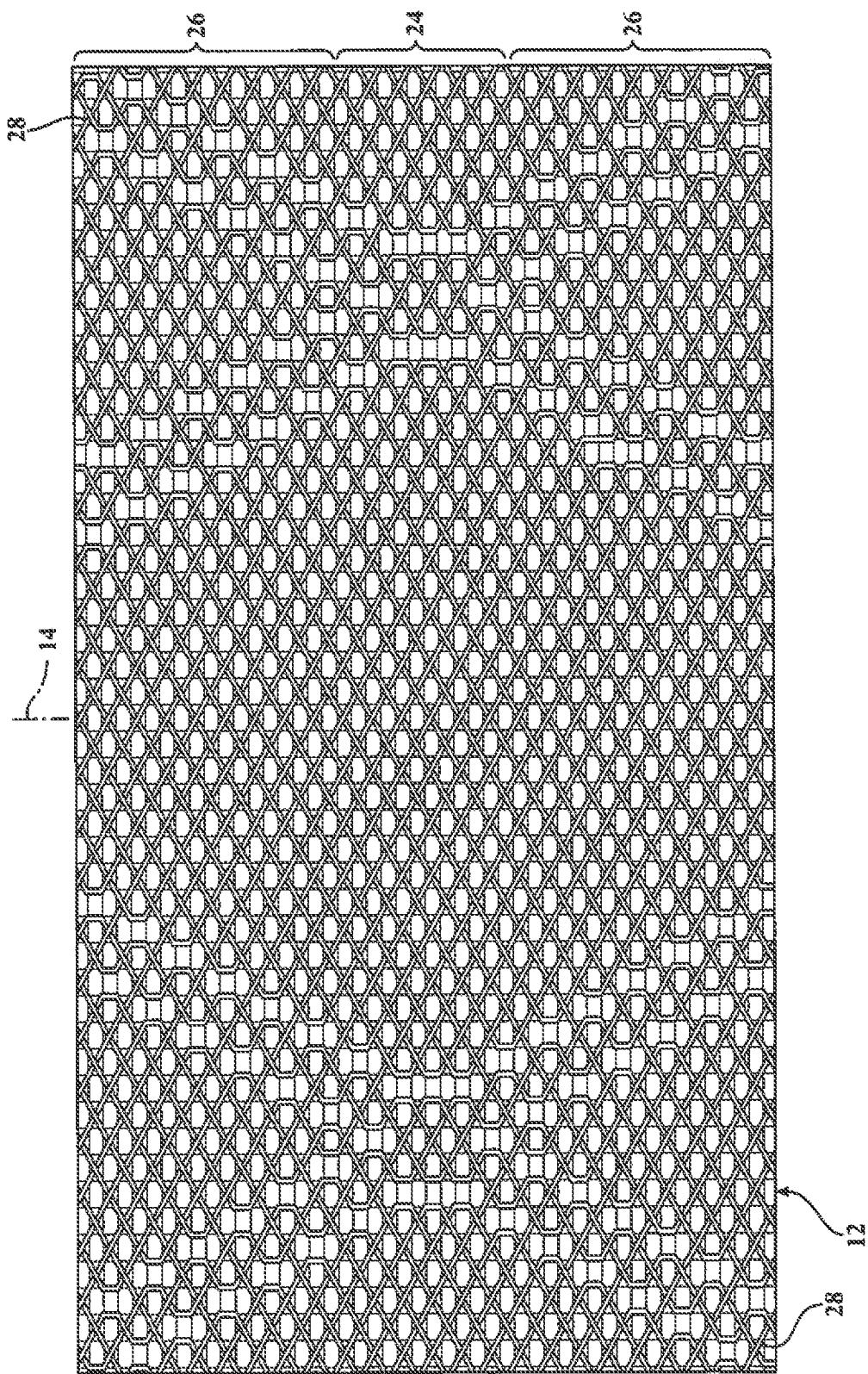


FIG. 2B

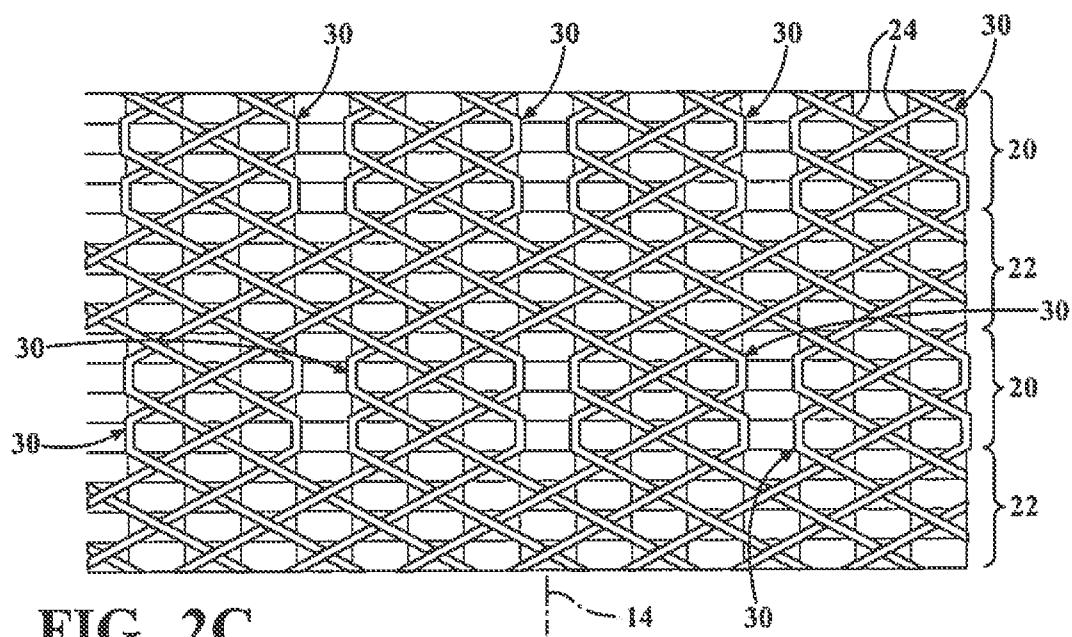


FIG. 2C

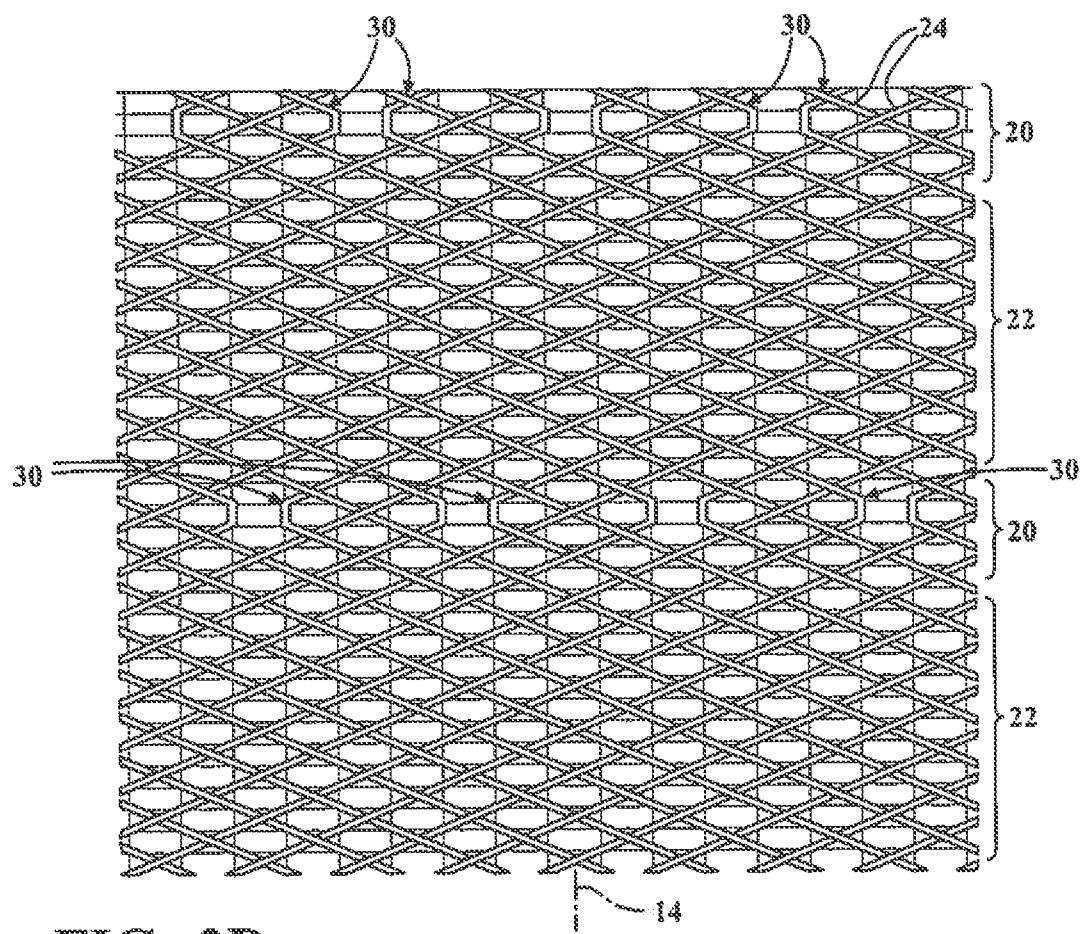


FIG. 2D

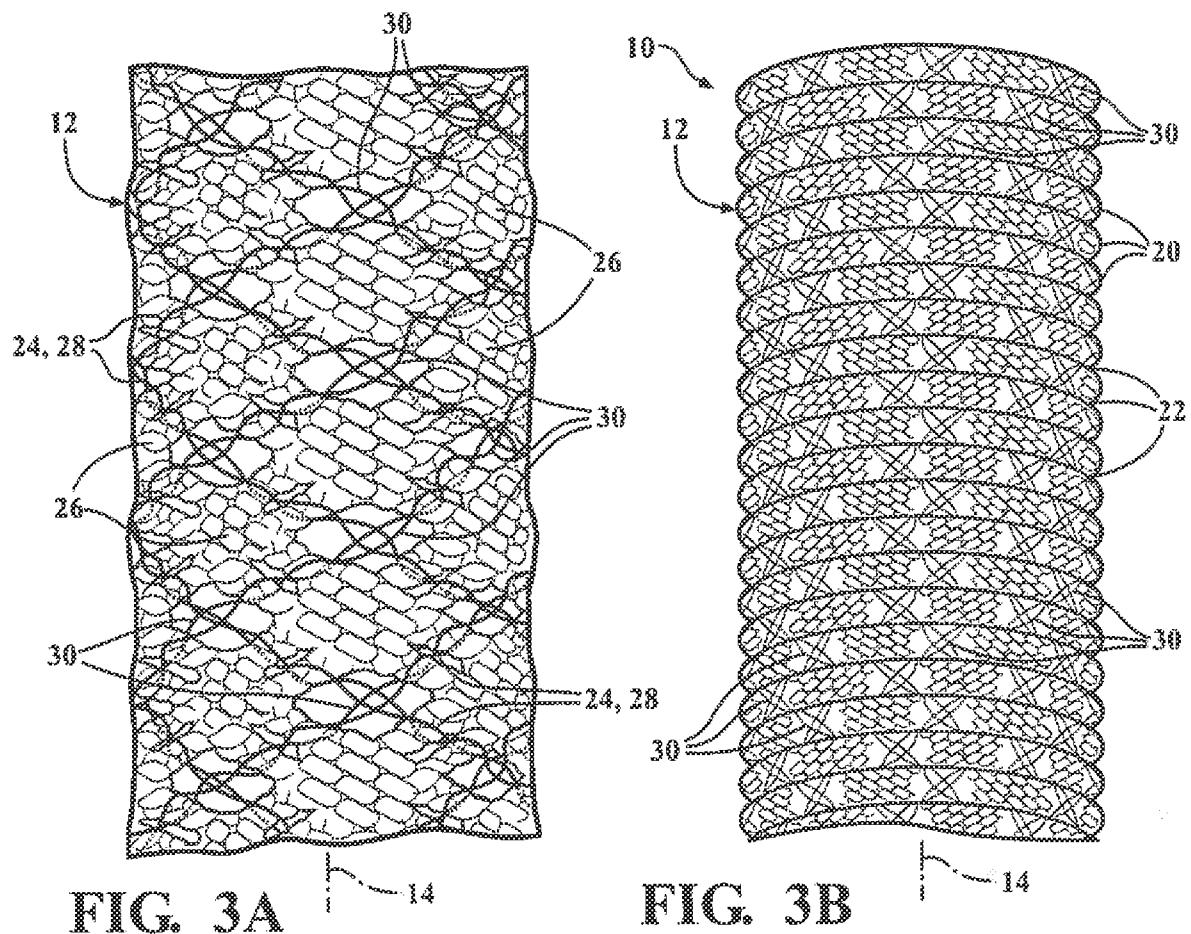


FIG. 3A

FIG. 3B

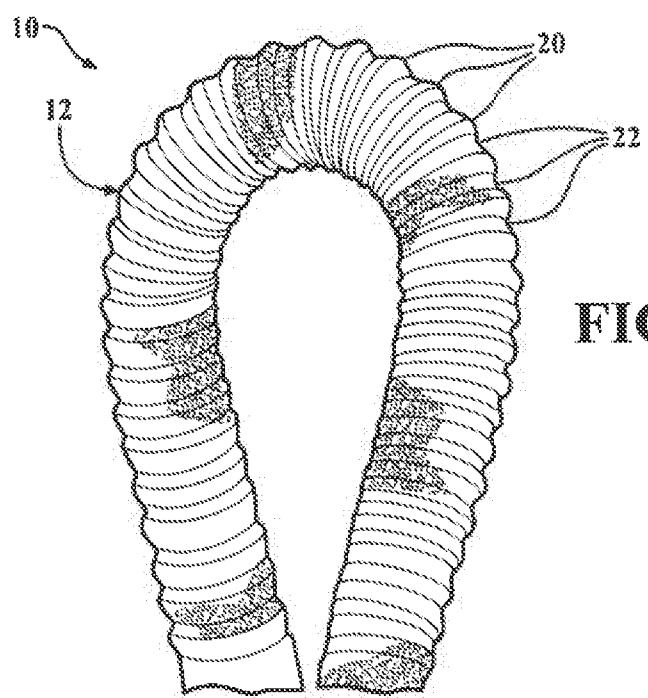


FIG. 3C

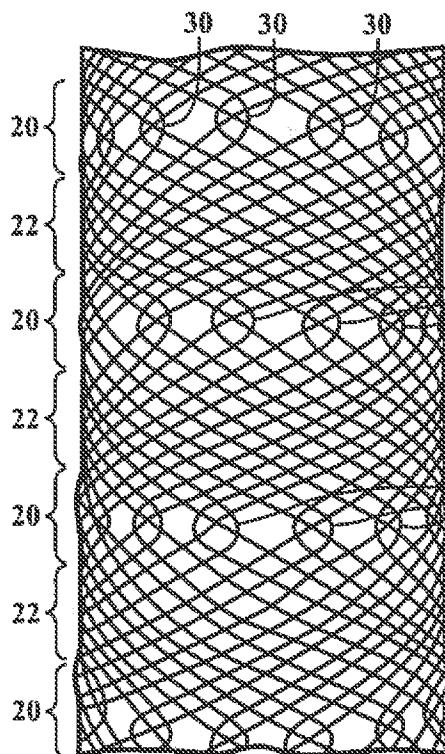


FIG. 4A

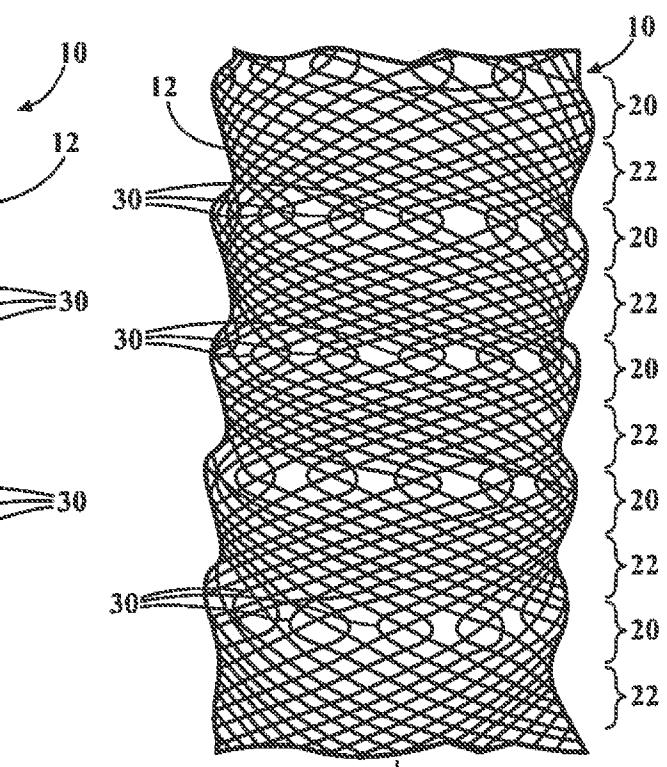


FIG. 4B

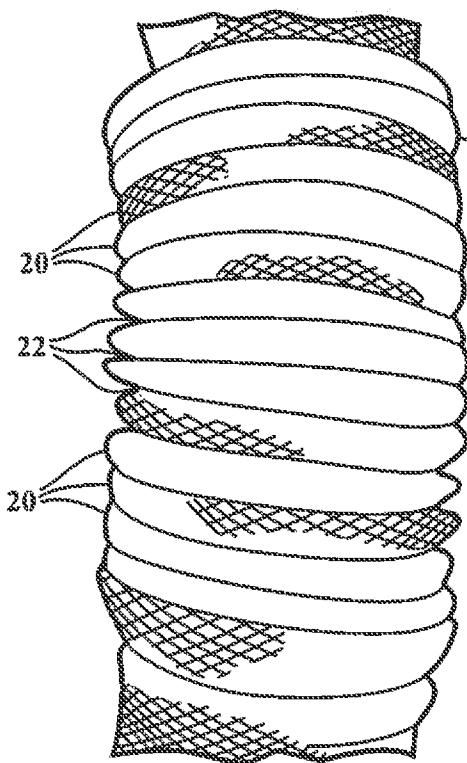


FIG. 4C

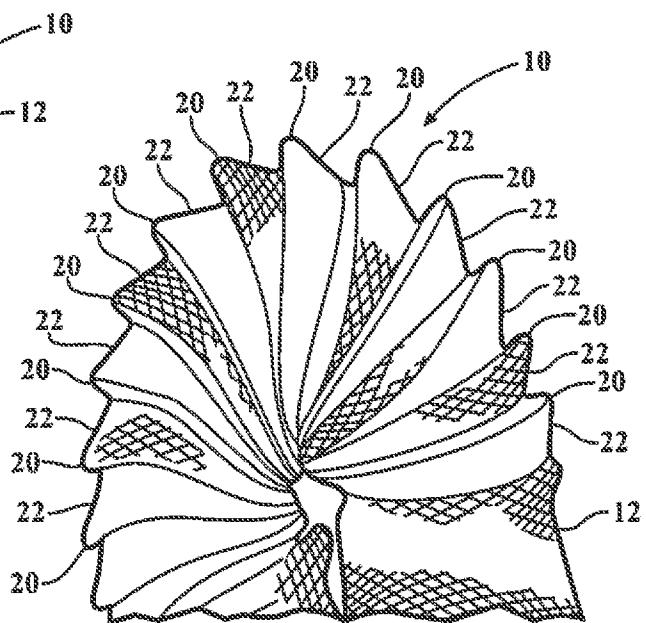


FIG. 4D

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/061526

A. CLASSIFICATION OF SUBJECT MATTER
INV. D04C1/02
ADD.

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)
D04C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95/13495 A1 (BENTLEY HARRIS MFG CO [US]; T & N PLC [GB]) 18 May 1995 (1995-05-18) page 6, line 32 - page 10, line 4; claims 1-13; figures 1-3D	1-13, 15-24, 26-29 14,25
A	----- EP 2 312 192 A1 (FEDERAL MOGUL POWERTRAIN INC [US]) 20 April 2011 (2011-04-20) abstract; figures 1-4	1-29
A	----- EP 1 775 811 A1 (RELATS SA [ES]) 18 April 2007 (2007-04-18) abstract; figures 1-4	1-29



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2017	23/02/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Braun, Stefanie

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2016/061526

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
WO 9513495	A1	18-05-1995	NONE		
EP 2312192	A1	20-04-2011	AU 2002346382 A1	26-05-2003	
			BR 0214125 A	13-10-2004	
			CA 2467355 A1	22-05-2003	
			CN 1585869 A	23-02-2005	
			EP 1453997 A2	08-09-2004	
			EP 2312192 A1	20-04-2011	
			HR P20040431 A2	31-08-2004	
			HU 0401964 A2	28-01-2005	
			JP 4317754 B2	19-08-2009	
			JP 2005509805 A	14-04-2005	
			KR 20040064706 A	19-07-2004	
			MX PA04004599 A	13-08-2004	
			US 2003089971 A1	15-05-2003	
			WO 03042440 A2	22-05-2003	
EP 1775811	A1	18-04-2007	CN 101002371 A	18-07-2007	
			EP 1775811 A1	18-04-2007	
			ES 2246716 A1	16-02-2006	
			MX PA06007645 A	01-09-2006	
			US 2007131302 A1	14-06-2007	
			WO 2006027399 A1	16-03-2006	