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(54) **SUSPENSION BANDS HAVING ENERGY ABSORBING PROPERTIES**

(57) Suspension bands (100), helmet systems, and/or the like are provided. In some embodiments, a suspension band (100) includes: a plurality of knitted loop structures (108); and a plurality of knitted inlay structures (106A-C), wherein the plurality of knitted inlay structures (106A-C) is inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures (108). In some embodiments, the suspension band (100) includes one or more inlay sections (102A, 102B) and a reinforcement section (104); a greater portion of the

plurality of knitted loop structures (108) are disposed on, beneath, or within the reinforcement section (104) than are disposed on, beneath, or within the one or more inlay sections (102A, 102B). In some embodiments, the one or more inlay sections (102A, 102B) include a first inlay section (102A) and a second inlay section (102B), wherein the first inlay section (102A) is disposed on a first side of the reinforcement section (104) and the second inlay section (102B) is disposed on a second side of the reinforcement section (104).

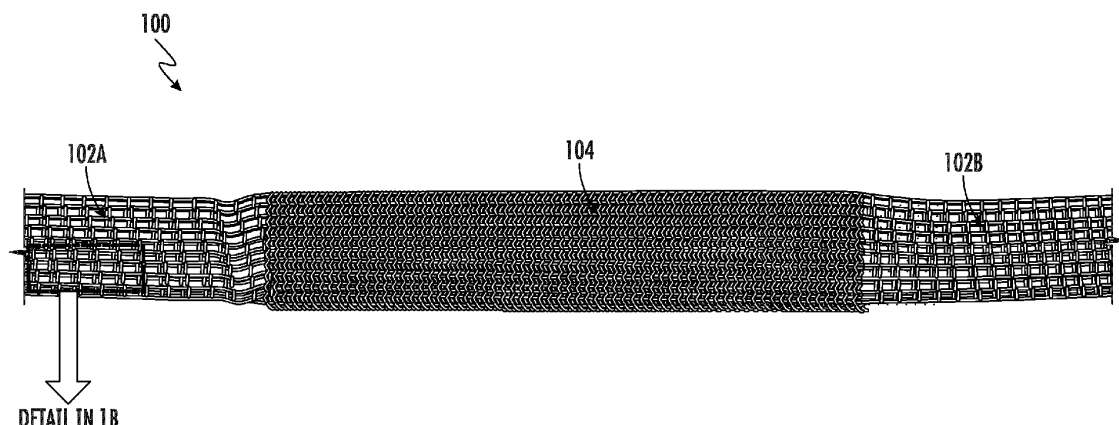


FIG. 1A

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Description

TECHNICAL FIELD

[0001] . The present disclosure relates generally to suspension bands. In particular, it relates to the suspension bands having energy absorbing properties.

BACKGROUND

[0002] . Suspension bands or straps for use in helmet anti-concussion cradles or harness suspensions may have a webbing structure with fabric straps weaved by polyester, nylon yarns, or blended synthetic yarns by interweaving in weft and warp directions. The Applicants have identified various technical problems with existing suspension bands or straps.

[0003] . Through applied effort, ingenuity, and innovation, the Applicants has solved problems relating to suspension bands by developing solutions embodied in the present disclosure, which are described in detail below.

SUMMARY

[0004] . In general, embodiments of the present disclosure provide suspension bands, helmet systems, and/or the like.

[0005] . In accordance with various embodiments of the present disclosure, there is provided a suspension band including a plurality of knitted loop structures; and a plurality of knitted inlay structures, wherein the plurality of knitted inlay structures is inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures.

[0006] . In some embodiments, the suspension band includes one or more inlay sections and a reinforcement section, and wherein a greater portion of the plurality of knitted loop structures are disposed on, beneath, or within the reinforcement section than are disposed on, beneath, or within the one or more inlay sections.

[0007] . In some embodiments, the one or more inlay sections include a first inlay section and a second inlay section, wherein the first inlay section is disposed on a first side of the reinforcement section and wherein the second inlay section is disposed on a second side of the reinforcement section.

[0008] . In some embodiments, the suspension band has a length ranging from 335 mm to 390 mm, wherein the one or more inlay sections include a width ranging from 20 mm to 24 mm and a thickness ranging from 1.3 mm to 1.7 mm, and wherein the one or more reinforcement sections include a width ranging from 23 mm to 27 mm and a thickness ranging from 2 mm to 2.4 mm.

[0009] . In some embodiments, the plurality of knitted loop structures and the plurality of knitted inlay structures are yarn.

[0010] . In some embodiments, one or more knitted loop structures of the plurality of knitted loop structures include polyester DTY and wherein one or more knitted

inlay structures of the plurality of knitted inlay structures include liquid crystal polymer (LCP).

[0011] . In some embodiments, the yarn size of one or more knitted loop structures of the plurality of knitted loop structures is 300D and the yarn size of one or more knitted inlay structures is 1000D.

[0012] . In some embodiments, the yarn tensile strength of one or more knitted loop structures of the plurality of knitted loop structures is 3.52 cN/dtex and the yarn tensile strength of one or more knitted inlay structures is 2.1N/tex.

[0013] . In some embodiments, the suspension band includes a plurality of elongation structures, wherein one or more elongation structures of the plurality of elongation structures are inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures and disposed adjacent to one or more inlay structures of the plurality of inlay structures.

[0014] . In some embodiments, the one or more elongation structures of the plurality of elongation structures include elongation yarn.

[0015] . In some embodiments, the suspension band is integrated with a helmet, a fall protection harness, or a rope.

[0016] . According to various embodiments, there is provided a helmet system including a shell configured to protect the head of a wearer; a harness disposed on, beneath, or within the shell; and a plurality of suspension bands, wherein at least one suspension band of the plurality of suspension bands includes a plurality of knitted loop structures; and a plurality of knitted inlay structures, wherein the plurality of knitted inlay structures is inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures, wherein the suspension band defines one or more inlay sections, and wherein the suspension band defines a reinforcement section, wherein the harness is operably engaged with the plurality of suspension bands.

[0017] . In some embodiments, the suspension band includes one or more inlay sections and a reinforcement section, and wherein a greater portion of reinforcement structures are disposed on, beneath, or within the reinforcement section than are disposed on, beneath, or within the one or more inlay sections.

[0018] . In some embodiments, the one or more inlay sections include a first inlay section and a second inlay section, wherein the first inlay section is disposed on a first side of the reinforcement section and wherein the second inlay section is disposed on a second side of the reinforcement section.

[0019] . In some embodiments, the suspension band includes a length ranging from 335 mm to 390 mm, wherein the one or more inlay sections include a width ranging from 20 mm to 24 mm and a thickness ranging from 1.3 mm to 1.7 mm, and wherein the one or more reinforcement sections include a width ranging from 23 mm to 27 mm and a thickness ranging from 2 mm to 2.4 mm.

[0020] . In some embodiments, the plurality of knitted loop structures and the plurality of knitted inlay structures are yarn.

[0021] . In some embodiments, one or more knitted loop structures of the plurality of knitted loop structures include polyester DTY and wherein one or more knitted inlay structures of the plurality of knitted inlay structures include liquid crystal polymer (LCP).

[0022] . In some embodiments, the yarn size of one or more knitted loop structures of the plurality of knitted loop structures is 300D and the yarn size of one or more knitted inlay structures is 1000D.

[0023] . In some embodiments, the yarn tensile strength of one or more knitted loop structures of the plurality of knitted loop structures is 3.52 cN/dtex and the yarn tensile strength of one or more knitted inlay structures is 2.1N/tex.

[0024] . In some embodiments, the helmet system further includes a plurality of elongation structures, wherein one or more elongation structures of the plurality of elongation structures are inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures and disposed adjacent to one or more inlay structures of the plurality of inlay structures.

[0025] . The above summary is provided merely for purposes of summarizing some example embodiments to provide a basic understanding of some embodiments of the disclosure. Accordingly, it will be appreciated that the above-described embodiments are merely examples. It will be appreciated that the scope of the disclosure encompasses many potential embodiments in addition to those here summarized, some of which will be further described below.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

[0026] . Having thus described the disclosure in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

. FIG. 1A shows a top plan view of an example suspension band in accordance with various embodiments of the present disclosure;

. FIG. 1B shows a detail view of an example suspension band in accordance with various embodiments of the present disclosure;

. FIG. 1C shows a flat knitted strap structure of an example inlay section of an example suspension band in accordance with various embodiments of the present disclosure;

. FIG. 1D shows a flat knitted strap structure of an example reinforcement section of an example suspension band in accordance with various embodiments of the present disclosure;

. FIG. 2A-2C show top plan views of example weaving patterns for example suspension bands in accor-

dance with various embodiments of the present disclosure;

. FIG. 3A shows a top plan view of example suspension bands in accordance with various embodiments of the present disclosure;

. FIG. 3B shows a top angled view of an example helmet in accordance with various embodiments of the present disclosure;

. FIGS. 4A and 4B show tensile strength of example suspension bands in accordance with various embodiments of the present disclosure;

. FIGS. 5A-5C show example test data of example suspension bands and suspension helmets in accordance with various embodiments of the present disclosure; and

. FIGS. 6A-6C show example test data of example suspension bands and suspension helmets in accordance with various embodiments of the present disclosure.

DETAILED DESCRIPTION OF SOME EXAMPLE EMBODIMENTS

[0027] . Various embodiments of the present disclosure now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the disclosure are shown. Indeed, this disclosure may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. The term "or" (also designated as "/") is used herein in both the alternative and conjunctive sense, unless otherwise indicated. The terms "illustrative" and "exemplary" are used to be examples with no indication of quality level. Like numbers may refer to like elements throughout. The phrases "in one embodiment," "according to one embodiment," and/or the like generally mean that the particular feature, structure, or characteristic following the phrase may be included in at least one embodiment of the present disclosure and may be included in more than one embodiment of the present disclosure (importantly, such phrases do not necessarily may refer to the same embodiment).

Overview

[0028] . According to various embodiments, there is provided a suspension band having a knitted structure with a plurality of knitted loop structures and a plurality of knitted inlay structures, wherein the suspension band is divided into one or more inlay sections and one or more reinforcement sections. Textile structure can generally divide into three categories which are woven, knitting, nonwoven. The knitted category also divided into flat knitted, warp knitted, and circular knitted, which may produce differing loop structures. In some embodiments, different types of knitted structure rely on different knitting

machines, while the same knitted structure cannot be knitted by different machines. The orientation, number, and material of the inlay structures in the suspension band's knitted structure may be varied and thereby affect the tension strength and energy absorption properties of the suspension band. In some embodiments, one or more suspension bands may be used in various applications, including (but not limited to) a helmet, webbing for a fall protection harness, a rope, and/or the like.

Example Suspension Bands

[0029] . FIG. 1A shows a top plan view of an example suspension band 100, according to various embodiments. In the depicted embodiment, the suspension band 100 includes inlay sections 102A, 102B (note that similar descriptions may apply to sections 102A and 102B unless otherwise noted). A detail view of an example inlay section 102A is shown in FIG. 1B and a flat knitted structure of an example inlay section 102A is shown in FIG. 1C. Also, as shown in the depicted embodiment, the suspension band 100 includes at least one reinforcement section 104. A flat knitted structure of an example reinforcement section 104 is shown in FIG. 1D. According to various embodiments, the suspension band 100, including (but not limited to) its inlay sections 102A-B and/or reinforcement section 104, may be created using one or more flat-knitting machines, including (but not limited to) STOLL ADF, CIXIN CX2, SHIMA SEIKI, and/or the like. In some embodiments, the suspension band 100 may be incorporated into one or more applications, including but not limited to a helmet (as will be discussed later in this disclosure), a fall protection harness, a rope, and/or the like.

[0030] . Referring now to FIG. 1B, in the depicted embodiment, the inlay section 102A includes one or more inlay structures 106A, 106B, 106C (note that similar descriptions may apply across the one or more inlay structures 106A-C unless otherwise noted) and a loop structure 108. In some embodiments, the inlay structures 106A-C are substantially straight, knitted structures disposed perpendicularly to one or more loops of the loop structure 108. In some embodiments, the inlay structures 106A-C are yarn structures having energy-absorbing properties configured to reinforce and/or strengthen the tension strength of the suspension band 100. Still referring to FIG. 1B, in the depicted embodiment, the loop structure 108 is a weft knitted structure having a lateral and longitudinal stretch formed into a plurality of loops distributed into a plurality of rows. In some embodiments, the loop structure 108 may be a continuous thread, wherein the loops of the plurality of loops are interlocked. In some embodiments, the loop structure 108 may be composed of polyester yarn having a yarn size of 600D and a tensile strength of 3.52cN/dtex.

[0031] . In some embodiments, the inlay structures 106A-C are disposed on, beneath, or within the loop structure 108. As shown in at least FIG. 1B, the inlay

structures 106A-C are stitched through the loops of the loop structure 108. In at least the depicted embodiment, the inlay structures 106A-C are interwoven (i.e., inlaid) within the loop structure 108. In some embodiments, the inlay structures 106A-C may be composed of yarn and may be liquid crystal polymer (LCP) yarn.

[0032] . In some embodiments, the inlay structures 106A-C may have a low elongation ratio (e.g., ~3%). According to various embodiments, the inlay structures 106A-C may be inlay yarn material based on polyester (drawn textured yarn, full drawn yarn, and/or the like), modified polyester, biobased PA56, PA66, or liquid crystal polymer (LCP), high-performance polyethylene (HPPE), high density polyethylene (HDPE), low density polyethylene (LDPE), and/or the like. According to various embodiments, the inlay structures 106A-C may have a yarn size (D) of 1000D and a yarn tensile strength of 2.1 N/TEX, 3.1 N/TEX, or 2 N/TEX. According to various embodiments, the loop structure 108 may be loop yarn material including (but not limited to) PA6, PA56, PA66, polyester (which may be modified with, for example, PA6, PA66, or blended with cotton), CVC (80/20, 60/40, or 55/45), and/or TC (80/20, 60/40, 65/35).

[0033] . Referring now to FIG. 1C, in the depicted embodiment, the inlay sections 102A, 102B may be flat knitted structures, as may the reinforcement section 104, as shown in at least FIG. 1D. The arrows will be understood as being for illustrative purposes, to show the steps of knitting the inlay sections 102A-B (in FIG. 1C) and the reinforcement section 104 (in FIG. 1D); that is, the knitting steps follow the arrows. FIG. 1C shows the knitting process of the inlay sections 102A-B, with the first line having a single bed needle loop to be knitted and the second line having a double bed needle loop to be knitted and insert the inlay yarn. FIG. 1D shows the knitting process of the reinforcement section 104, with double beds needle loops and inlay structures 106A inserted with each loop line or every other line or every second line. Further, as shown in FIGS. 1C-D, the reinforcement section 104 may include a greater number of loop structures 108, in addition to the inlay structure 106A (or 106B, 106C). As shown, the loop structures 108 may be knitted such that the inlay structures 106A-C are disposed between the loops of the loop structures 108.

[0034] . Referring now to FIGS. 2A-C, alternative embodiments of the inlay sections 200A, 200B and 200C are shown, according to various embodiments. In the depicted embodiments, alternate structures 200A, 200B, 200C, are shown having a plurality of inlay structures 202A-E and a loop structure 204. It will be understood that the alternate structures 200A-C are alternative arrangements for the previously-described inlay sections 102A-B, and it will further be understood that these alternate structures 200A-C are not exhaustive.

[0035] . As previously described, and as shown in the embodiments depicted in FIGS. 2A-C, the inlay structures 202A-E are interknit on, beneath, or within the loop structure 204. It will be understood that the inlay struc-

tures 202A-E may be described similarly to the inlay structures 106A-C, as previously described in the specification, unless explicitly stated otherwise. It will also be understood that the loop structure 204 may be described similarly to the loop structure 108, as previously described in the specification, unless explicitly stated otherwise.

[0036] . In some embodiments, and as shown in at least FIGS. 2A and 2B, there are five inlay structures 202A-E, two more than the inlay structures 106A-C shown and described with respect to at least FIGS. 1A-B. In some embodiments, increasing the number of inlay structures 202A-E may increase one or more mechanical properties (e.g., tension strength) of the suspension bands 200A-C.

[0037] . In the embodiments shown in at least FIGS. 2B and 2C, the alternate structures 200B and/or 200C may include a plurality of elongation structures 206A-E. As shown, the elongation structures 206A-E may be paired with and/or laid adjacent to the plurality of inlay structures 202A-E. As shown, the elongation structures 206A-E may be interknit and/or inlaid with the loop structure 204, as the plurality of inlay structures 202A-E are. In some embodiments, the elongation structures 206A-E may be configured to increase the tension strength of the suspension bands (200B, 200C). In some embodiments, the elongation structures 206A-E may be knitted yarn. In some embodiments, the elongation structures 206A-E may be composed of liquid crystal elastomer (LCE), high-performance polyethylene (HPPE), and/or the like.

Example Helmet Systems

[0038] . FIGS. 3A and 3B show top plan and top angled views, respectively, of example helmet system 300. In some embodiments, the helmet system 300 may be used to protect the head of a user from trauma (e.g., being struck on the head by a falling object). In some embodiments, the helmet system 300 may be used in a variety of activities, including (but not limited to) climbing, mining, utility repair/maintenance, and/or construction. In some embodiments, the helmet system 300 includes a plurality of suspension bands 302A, 302B, 302C. In the embodiments shown and described in FIGS. 3A-3B, the suspension bands 302A-C are described similarly to the suspension band 100 shown and described with respect to FIGS. 1A-D. It will be understood that, in some embodiments, the suspension bands 302A-C may include one of the alternative suspension bands 200A-C, described and shown with respect to at least FIGS. 2A-C. In some embodiments, the suspension bands 302A-C may vary in length, width, and/or thickness between each other. For example, one suspension band (e.g., 302B) may be shorter than the other suspension bands (e.g., 302A and 302C).

[0039] . In some embodiments, and referring now to FIG. 3B, the helmet system 300 may include a shell 312. In some embodiments, the shell 312 may be a dome-

shaped structure designed to fit around the head of a user. In some embodiments, the shell may be composed of a "hard," substantially rigid material designed to absorb and/or deflect one or more blows. In some embodiments, the shell 312 may be composed of polycarbonate and/or fiberglass of varying durability and thickness.

[0040] . In some embodiments, the helmet system 300 may include a harness 304. In some embodiments, one or more of the suspension bands 302A-C may be disposed through and operatively engaged with the harness 304. In some embodiments, the harness 304 may be a substantially circular structure having one or more slots for receiving the plurality of suspension bands 302A-C. The suspension bands 302A-C, as shown in at least FIG. 3B, are disposed through the harness 304 and attached to one or more slots of the shell 312 of the helmet system 300.

[0041] . In some embodiments, the helmet system 300 may include a frame 306. The frame 306 may be disposed around a perimeter of the helmet shell 312. In some embodiments, the frame 306 may provide stability to the helmet system 300.

[0042] . In some embodiments, the helmet system 300 may include one or more cushion structures 308A, 308B disposed on, beneath, or within the frame 306. In some embodiments, the one or more cushion structures 308A, B may be "soft" material intended to make a user's head comfortable when wearing the helmet system 300.

[0043] . In some embodiments, the helmet system 300 may include one or more straps 310A, 310B. In some embodiments, the one or more straps 310A-B may include a clasp or buckle and may be configured to secure the helmet system 300 to a user's head. In some embodiments, the one or more straps 310A-B may be adjusted to increase or decrease the "tightness" of the helmet system 300 and adjust the "fit" of the helmet system 300 around a user's head.

Example Test Data

[0044] . FIGS. 4A and 4B show example test data for tests run using an example suspension band 100 and an example helmet system 300. The test was performed using an INSTRON 5967 test machine and the ISO 13934 test standard. The tensile speed was 100 mm/min, the temperature was 26 degrees Celsius (+/- 3 degrees), and the test humidity was 85%.

[0045] . FIG. 4A shows the test results for a helmet 300 using example suspension bands 100 having 6 pieces of inlay yarn (i.e., 6 inlay structures, as previously described), and FIG. 4B shows the results for an example suspension band 100 having 8 pieces of inlay yarn (i.e., 8 inlay structures, as previously described). As shown, the results charted in FIG. 4A show a helmet having a maximum load (in Newtons) of approximately 800 and a maximum load extension of 68 mm (+/- 5 mm), and FIG. 4B shows a helmet having a maximum load (in Newtons) or approximately 1000 and a maximum load

extension of 62 mm (+/- 5 mm). As shown, there is a general trend observed of the load increasing steadily as the suspension band continues to extend, and the general trend is broken when the suspension band snaps under the load.

[0046] . FIGS. 5A-5C show example test data run using an example suspension band 100 and an example helmet system 300. The test was performed using a load cell device. FIG. 5A shows example test data at -30 degrees Celsius, FIG. 5B shows example test data at 50 degrees Celsius, and FIG. 5C shows example test data at 20 degrees Celsius and shows test data for a helmet system 300 that was in water during the test. Note that, when temperatures are referenced with respect to the test data in this disclosure, those temperatures refer to the test conditions at which sample helmets were kept to pre-condition (from 4-24 hours) the helmet prior to the tests; the preconditioned helmets underwent the load under atmospheric pressure conditions at $22^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and a humidity of $55\% \pm 30\%$

[0047] . Referring now to FIG. 5A, as shown, tests were run six times (32#1 through 32#6) and a mean of the results was calculated and shown on the example helmet system 300. Tests were also run two times (SFH-1 to SFH-2) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2590N, and the comparison reached a mean of 3416N.

[0048] . Referring now to FIG. 5B, as shown, tests were run six times (32#1 through 32#6) and a mean of the results was calculated and shown on the example helmet system 300. Tests were also run eight times (SFH-1 to SFH-8) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2440N, and the comparison reached a mean of 3220N.

[0049] . Referring now to FIG. 5C, as shown, tests were run six times (32#1 through 32#6) and a mean of the results was calculated and shown on the example helmet system 300. Tests were also run two times (SFH-1 to SFH-2) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2533N, and the comparison reached a mean of 2991N.

[0050] . FIGS. 6A-6C show example test data run using an example suspension band 100 and an example helmet system 300. The test was performed using ANSI Z89.1 peak force at 50 degrees Celsius (for FIG. 6A), at -30 degrees Celsius (FIG. 6B), and at 20 degrees Celsius (FIG. 6C). The 50°C test conditions need to keep the helmet in the pre-condition cabinet at least 2 hours, -30°C test conditions need to keep the helmet in the pre-condition cabinet at least 4 hours, 20°C test conditions need to keep the helmet in the pre-condition cabinet at least 2 hours, hot and low temperature conditioned samples

were tested for impact test within 30 seconds after their removal from the condition environment, and the "wet" sample was tested within 90 seconds from their removal of the water bath.

[0051] . Referring now to FIG. 6A, as shown, tests were run nine times, three for three different groups of the example suspension band 100 (#32, #35, and #36 and a mean was found for each band. Tests were also run four times (FSH-1 to FSH-4) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2170N with #36, and the comparison reached a mean of 2648N.

[0052] . Referring now to FIG. 6B, as shown, tests were run nine times, three for three different groups of the example suspension band 100 (#32, #35, and #36 and a mean was found for each band. Tests were also run four times (FSH-1 to FSH-4) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2496N with #32, and the comparison reached a mean of 2672N.

[0053] . Referring now to FIG. 6C, as shown, tests were run nine times, three for three different groups of the example suspension band 100 (#35, #36, and #37 and a mean was found for each band. Tests were also run four times (FSH-1 to FSH-4) and a mean of the results was calculated and shown of an example comparison helmet and suspension band. As shown, the example helmet system 300 reached a mean of 2392N with #36, and the comparison reached a mean of 2775N.

[0054] . Many modifications and other embodiments of the disclosure set forth herein will come to mind to one skilled in the art to which this disclosure pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the disclosure is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. A suspension band comprising:

a plurality of knitted loop structures; and
a plurality of knitted inlay structures,
wherein the plurality of knitted inlay structures is inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures.

2. The suspension band of claim 1, wherein the suspension band comprises one or more inlay sections and a reinforcement section, and wherein a greater

portion of the plurality of knitted loop structures are disposed on, beneath, or within the reinforcement section than are disposed on, beneath, or within the one or more inlay sections.

3. The suspension band of claim 2, wherein the one or more inlay sections comprise a first inlay section and a second inlay section, wherein the first inlay section is disposed on a first side of the reinforcement section and wherein the second inlay section is disposed on a second side of the reinforcement section. 5
4. The suspension band of claim 2, wherein the suspension band comprises a length ranging from 335 mm to 390 mm, wherein the one or more inlay sections comprise a width ranging from 20 mm to 24 mm and a thickness ranging from 1.3 mm to 1.7 mm, and wherein the one or more reinforcement sections comprise a width ranging from 23 mm to 27 mm and a thickness ranging from 2 mm to 2.4 mm. 10 15 20
5. The suspension band of claim 1, wherein the plurality of knitted loop structures and the plurality of knitted inlay structures comprise yarn. 25
6. The suspension band of claim 5, wherein one or more knitted loop structures of the plurality of knitted loop structures comprise polyester DTY and wherein one or more knitted inlay structures of the plurality of knitted inlay structures comprise liquid crystal polymer (LCP). 30
7. The suspension band of claim 5, wherein the yarn size of one or more knitted loop structures of the plurality of knitted loop structures is 300D and the yarn size of one or more knitted inlay structures is 1000D. 35
8. The suspension band of claim 5, wherein the yarn tensile strength of one or more knitted loop structures of the plurality of knitted loop structures is 3.52 cN/dtex and the yarn tensile strength of one or more knitted inlay structures is 2.1N/tex. 40
9. The suspension band of claim 1, further comprising a plurality of elongation structures, wherein one or more elongation structures of the plurality of elongation structures are inserted as a weft inlay stitch on, beneath, or within the plurality of knitted loop structures and disposed adjacent to one or more inlay structures of the plurality of inlay structures. 45 50
10. The suspension band of claim 9, wherein the one or more elongation structures of the plurality of elongation structures comprises elongation yarn. 55
11. The suspension band of claim 1, wherein the suspension band is integrated with a helmet, a fall

protection harness, or a rope.

12. A helmet system comprising:

a shell configured to protect the head of a wearer;
 a harness disposed on, beneath, or within the shell; and
 a plurality of suspension bands,
 wherein at least one suspension band of the plurality of suspension bands comprises the suspension band of any of claims 1 - 8.

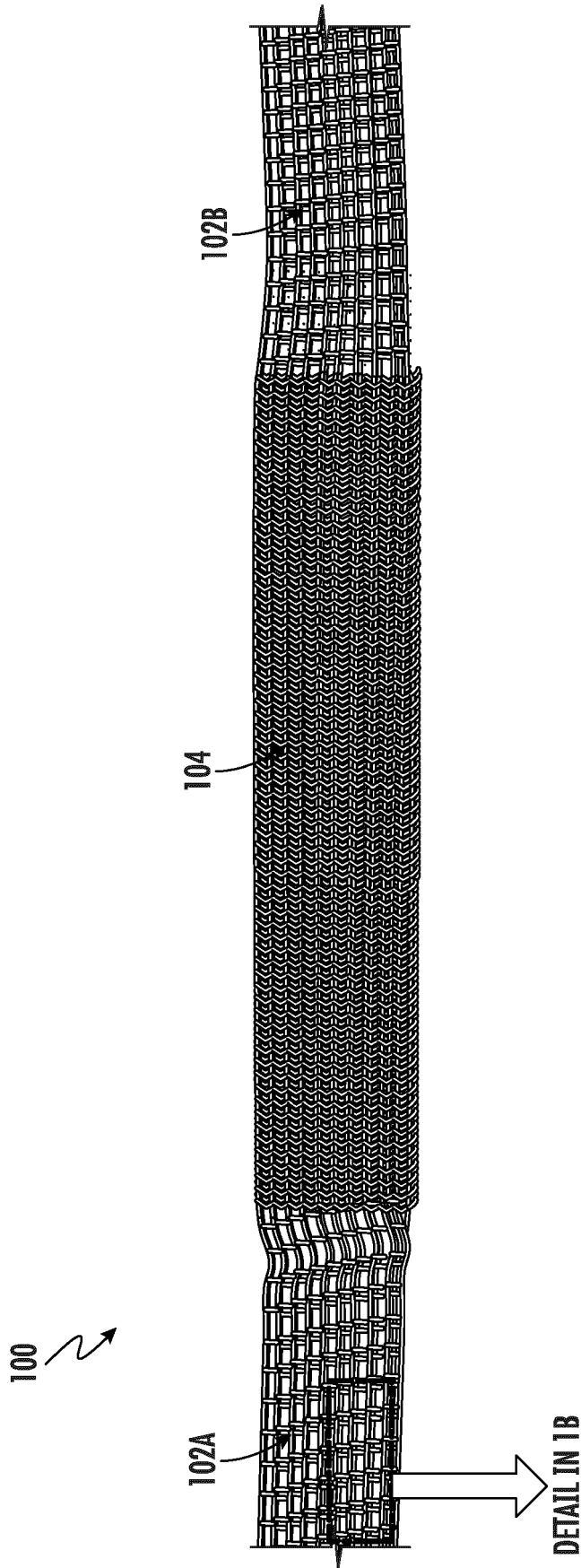


FIG. 1A

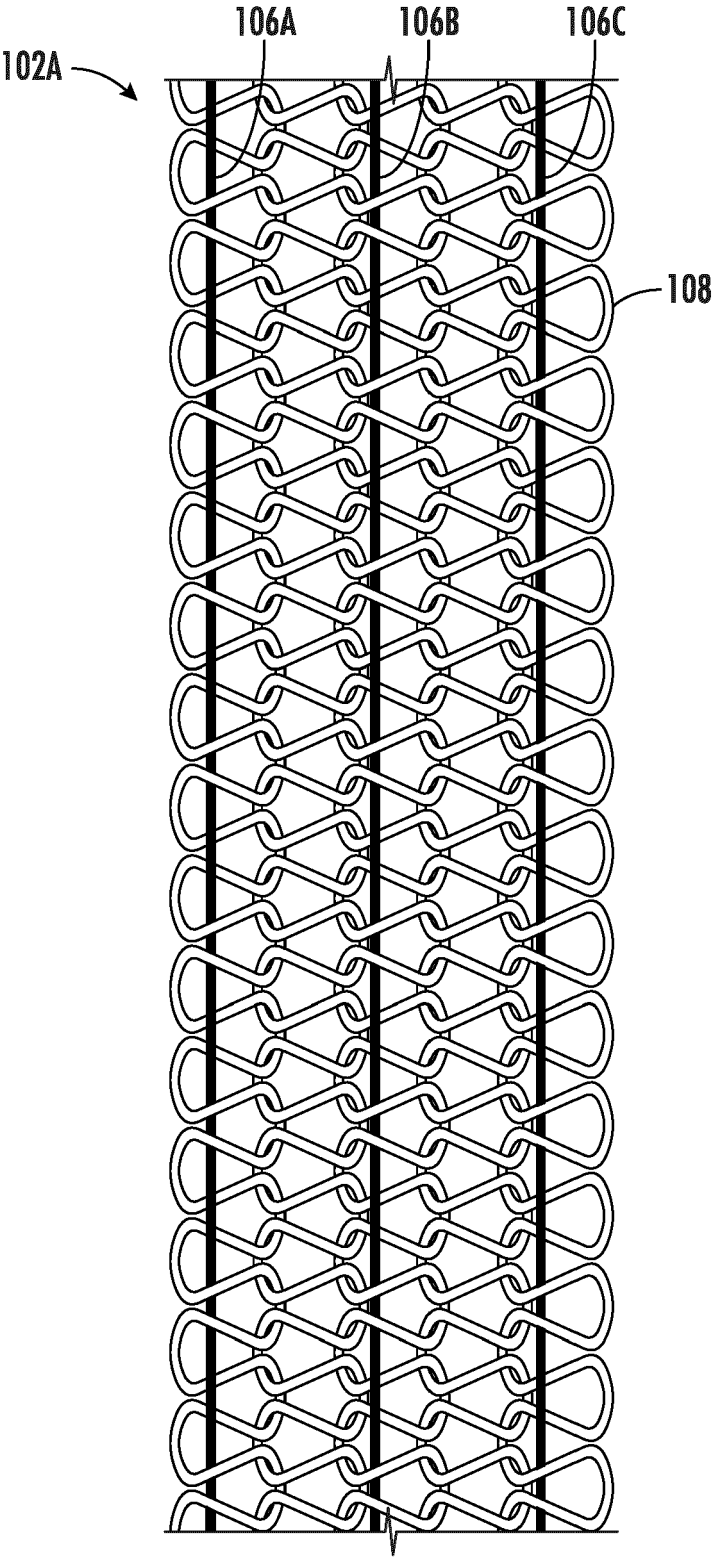
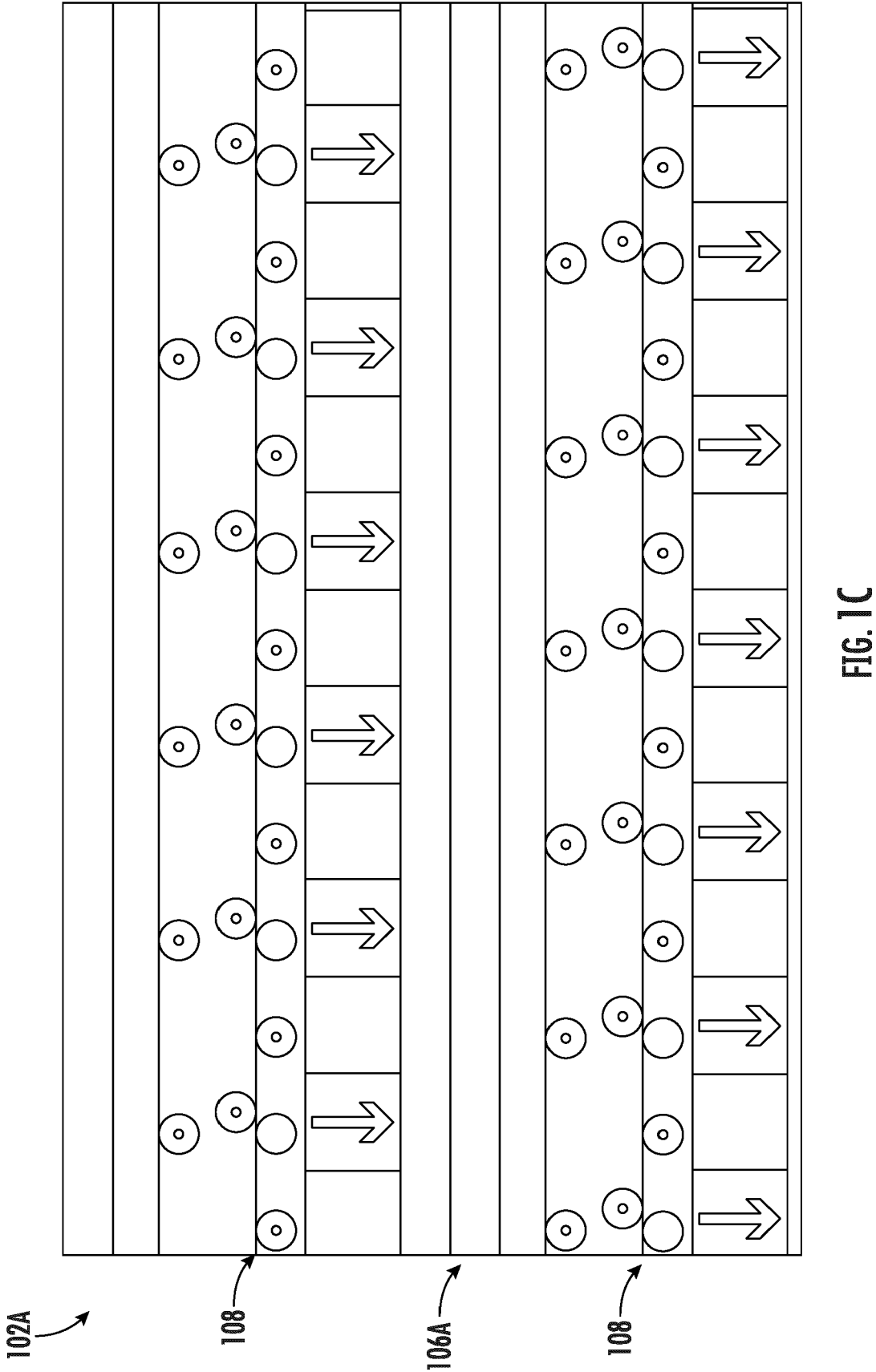


FIG. 1B



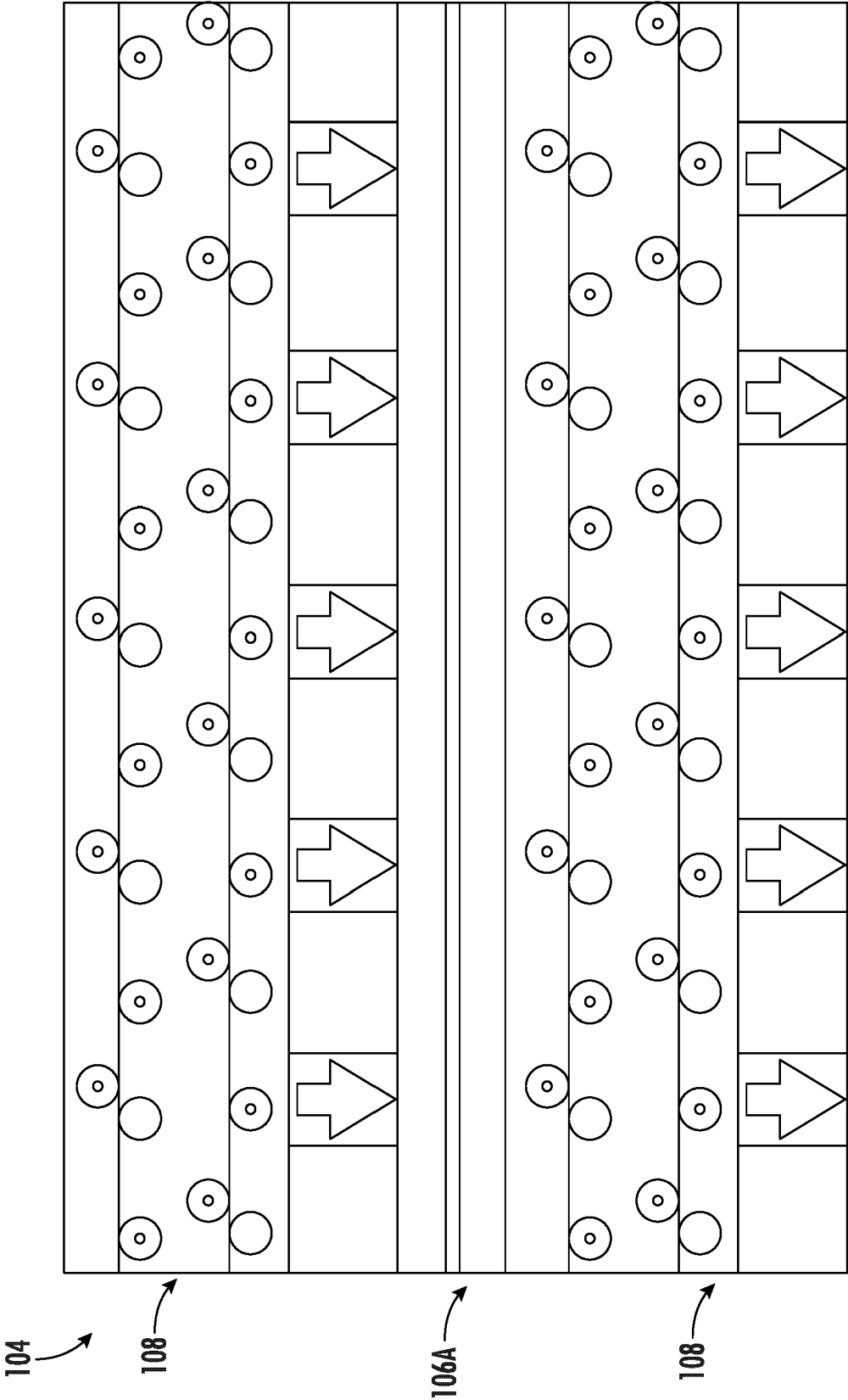


FIG. 1D

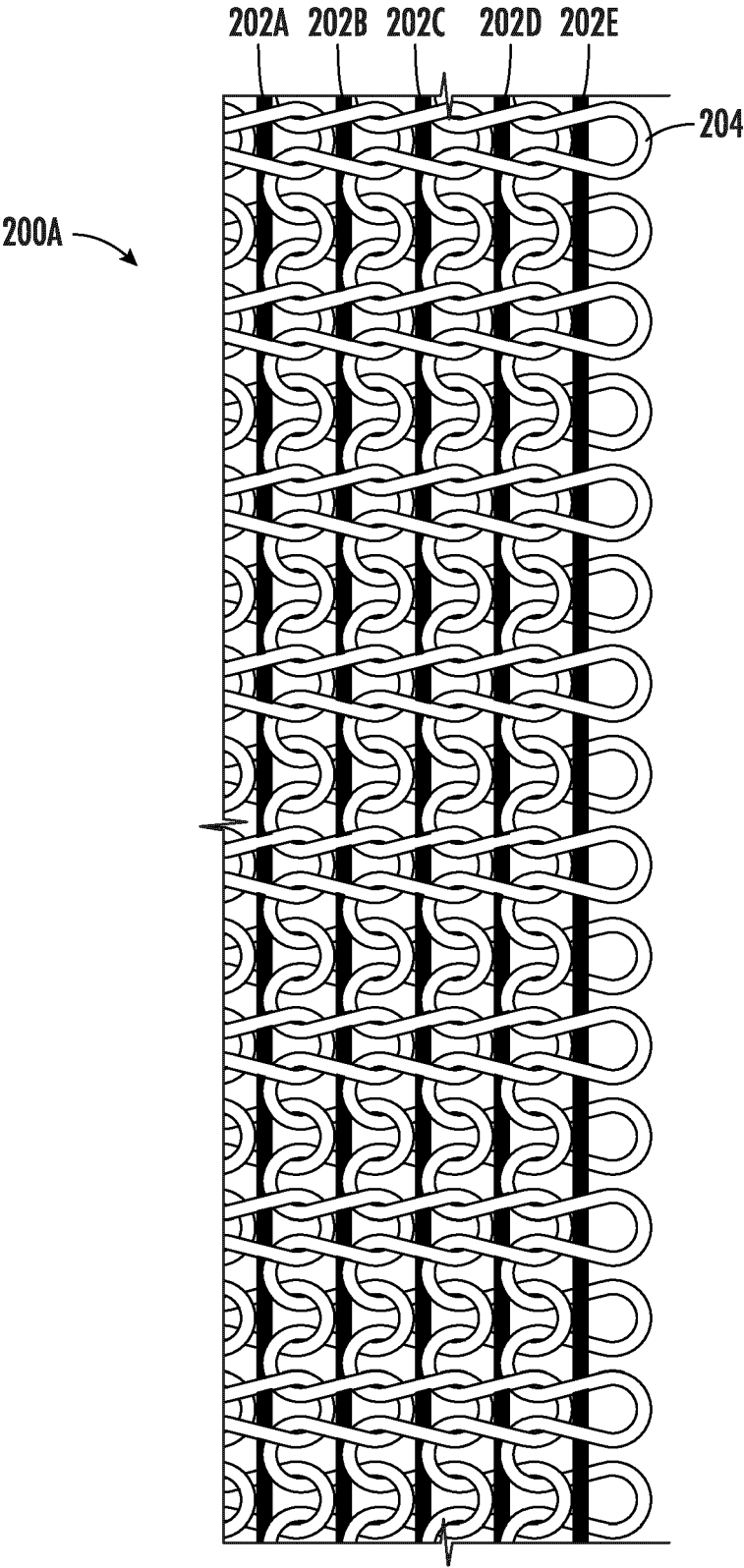


FIG. 2A

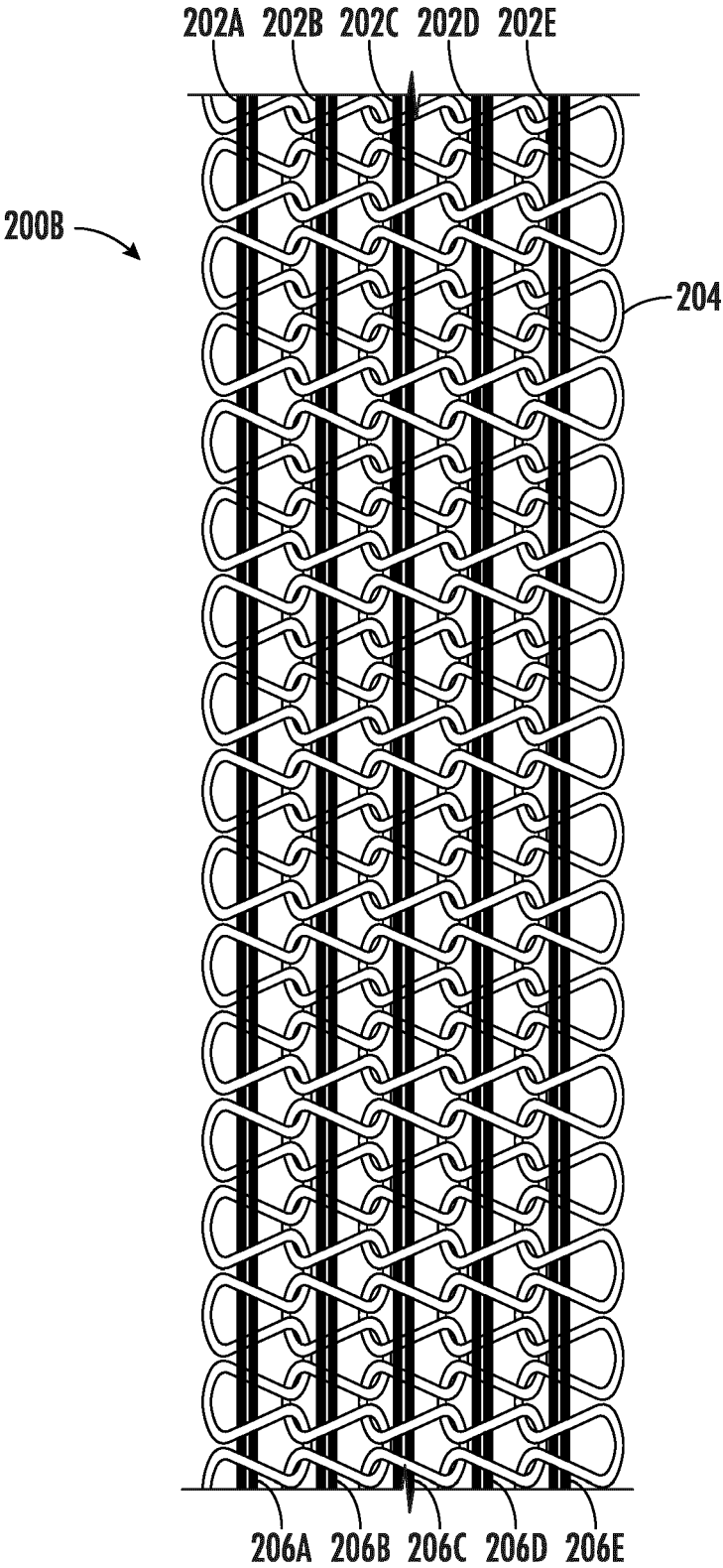


FIG. 2B

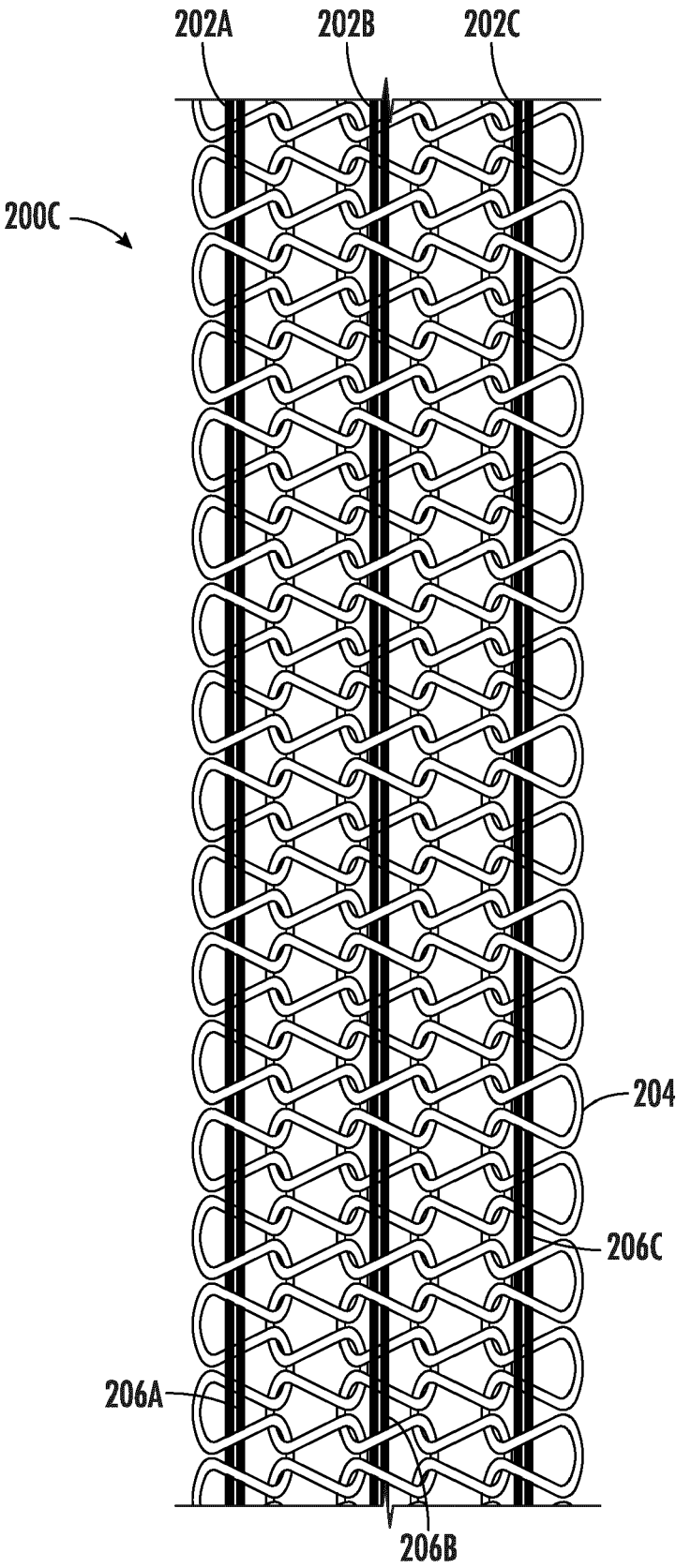


FIG. 2C

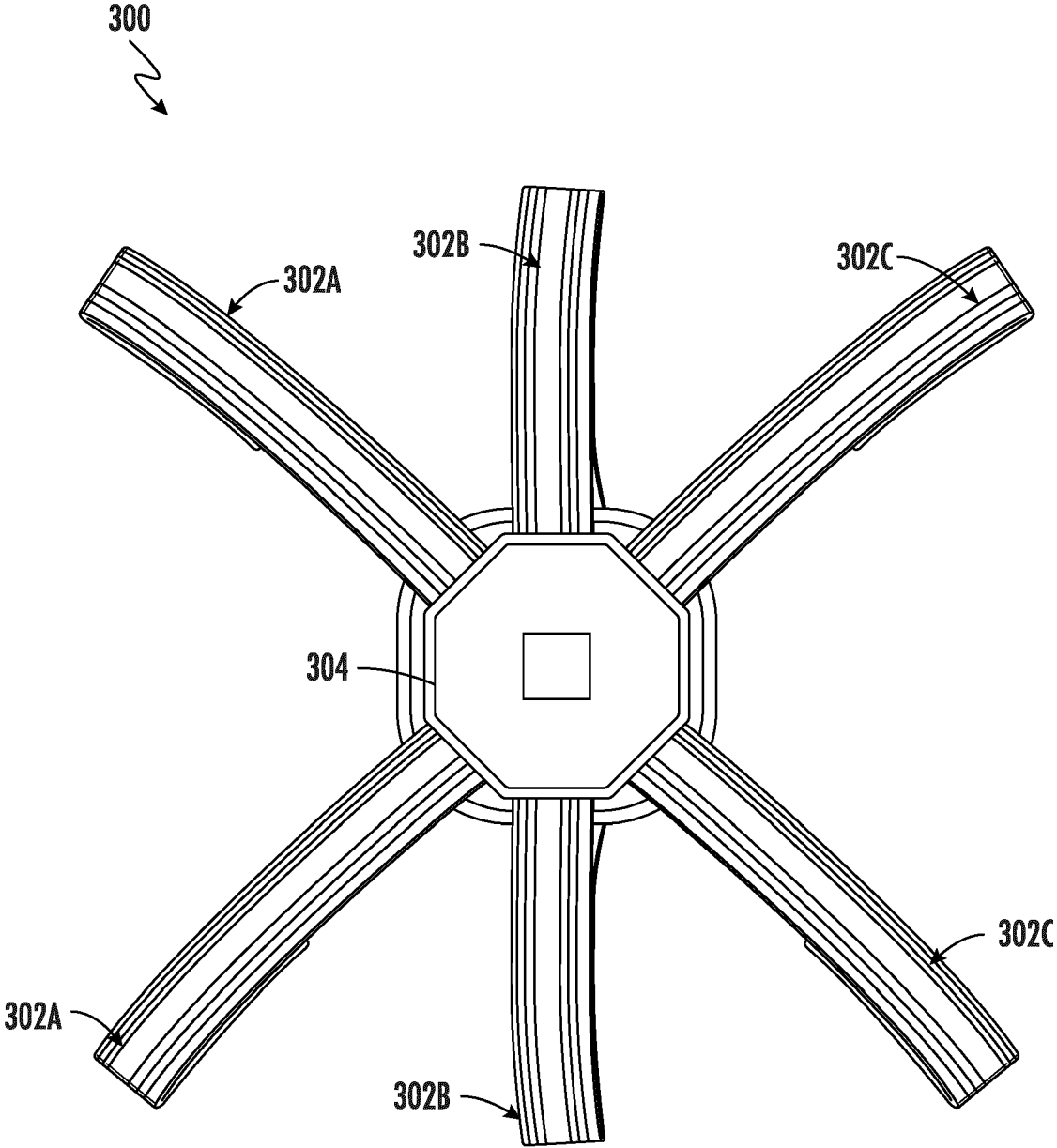
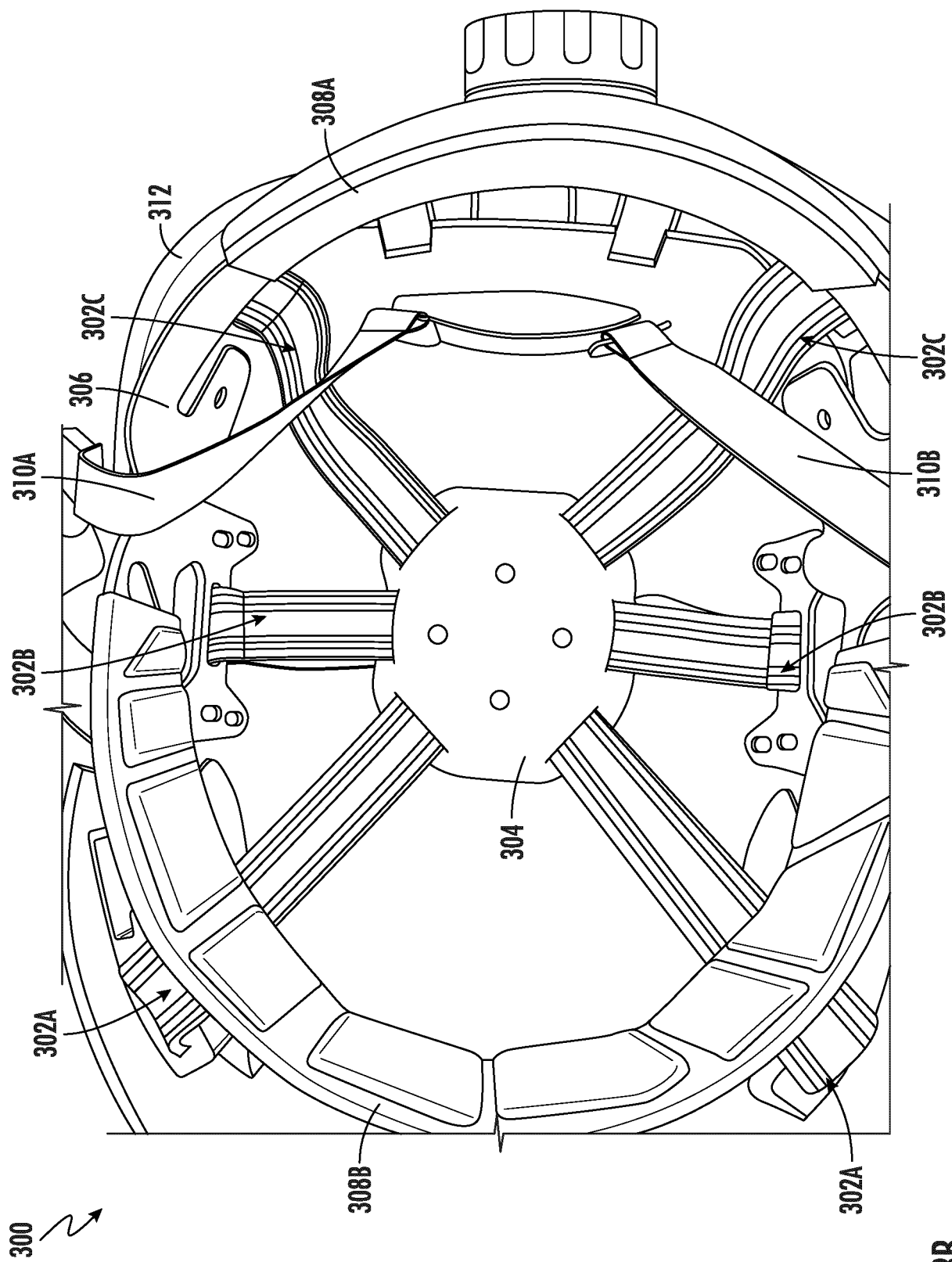


FIG. 3A



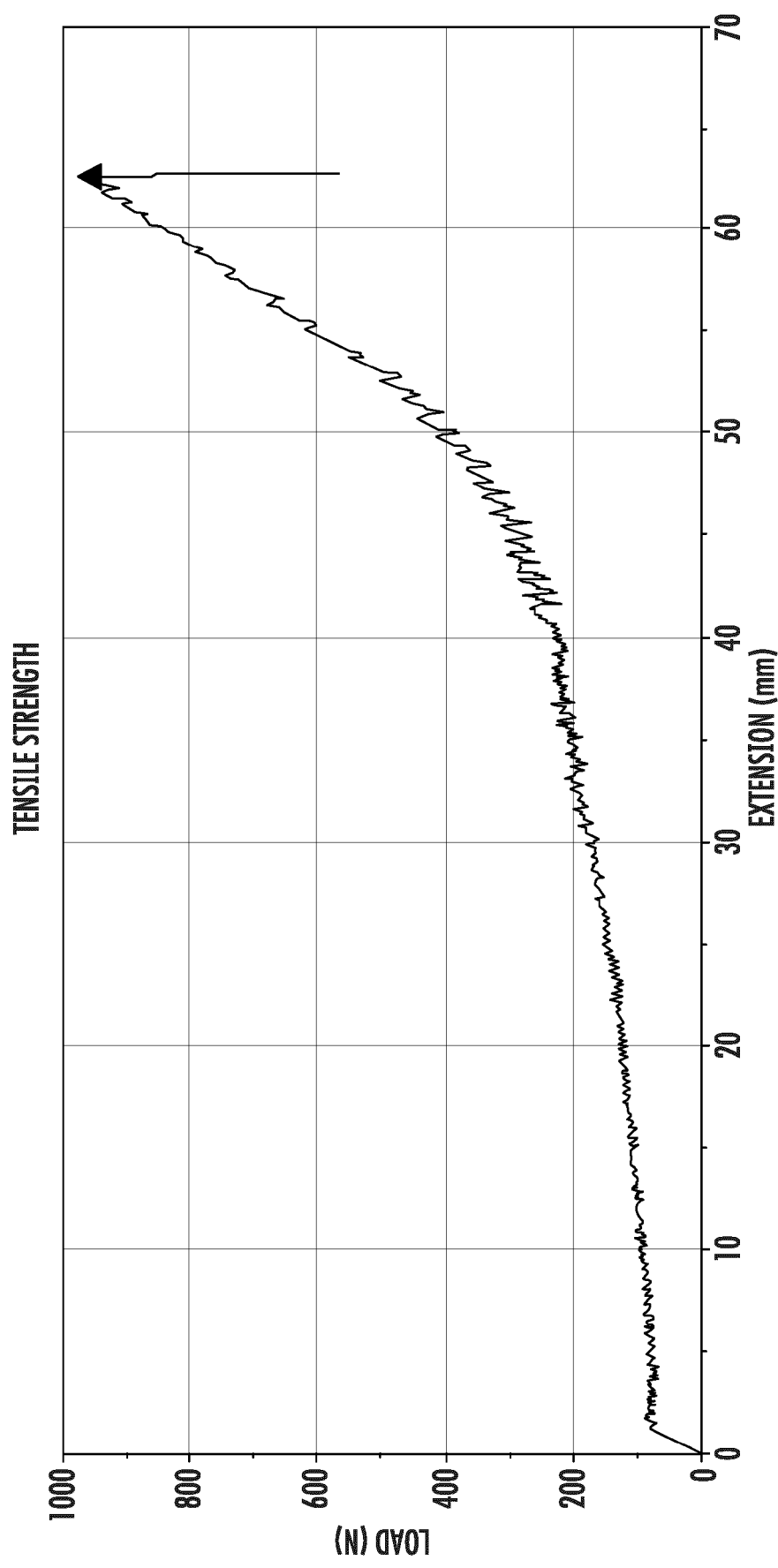


FIG. 4A

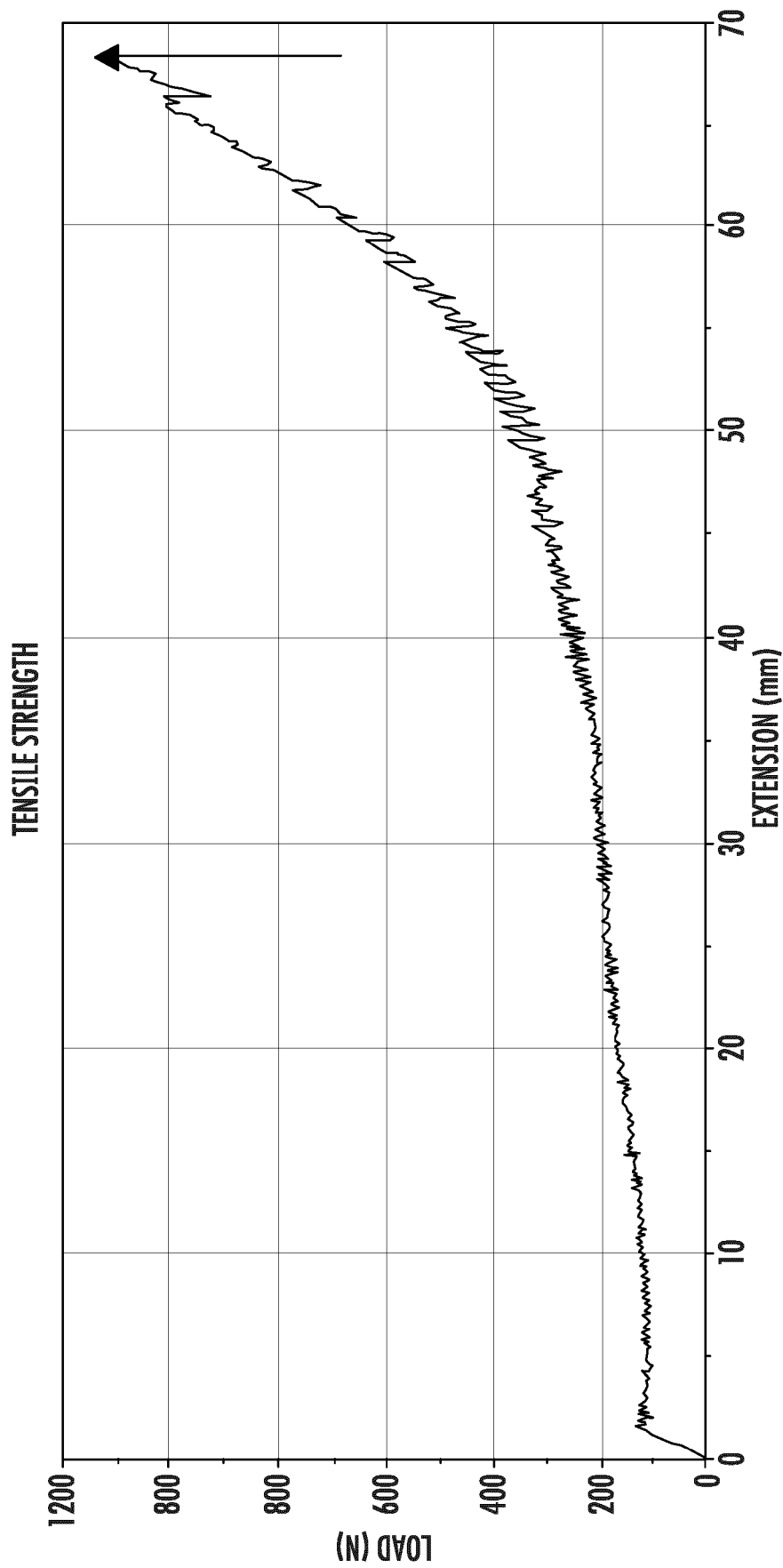


FIG. 4B

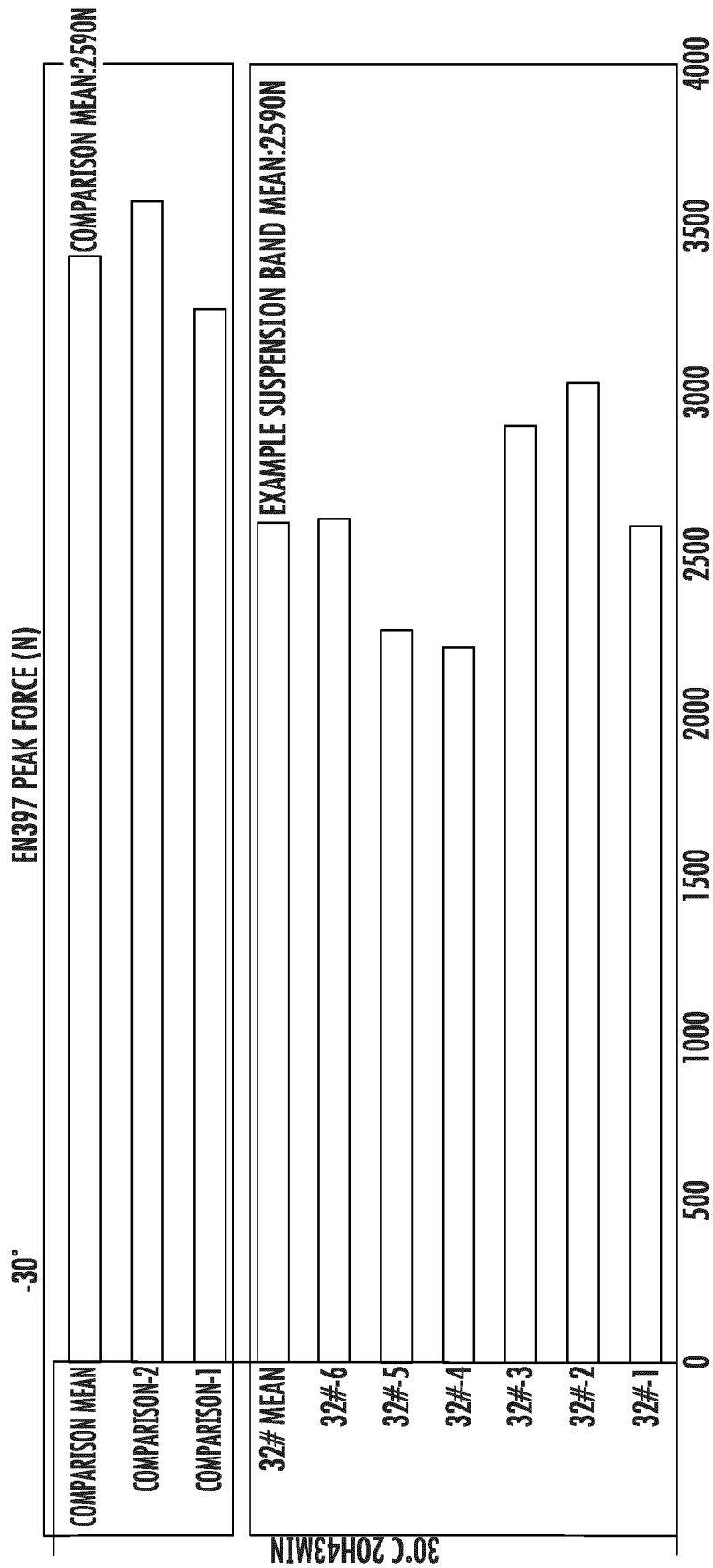


FIG. 5A

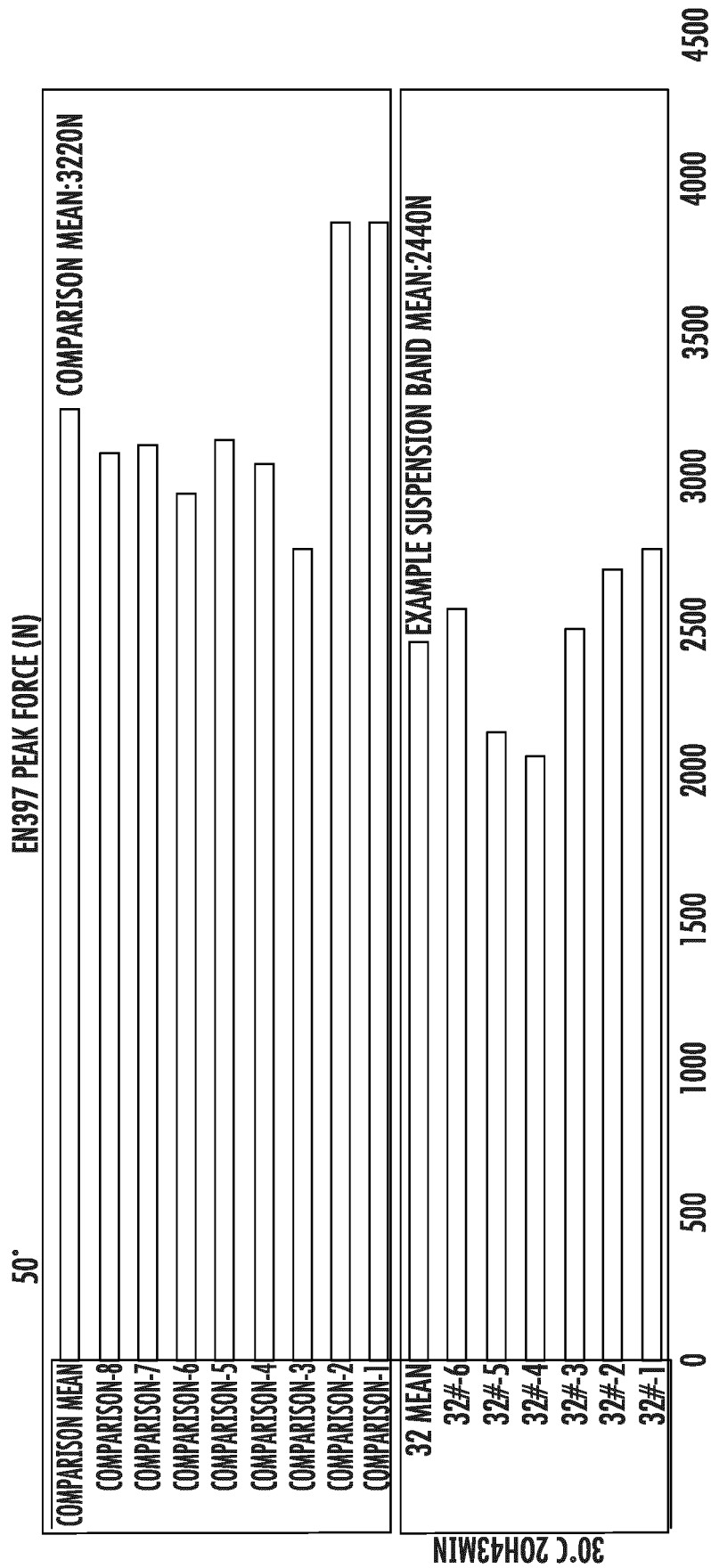


FIG. 5B

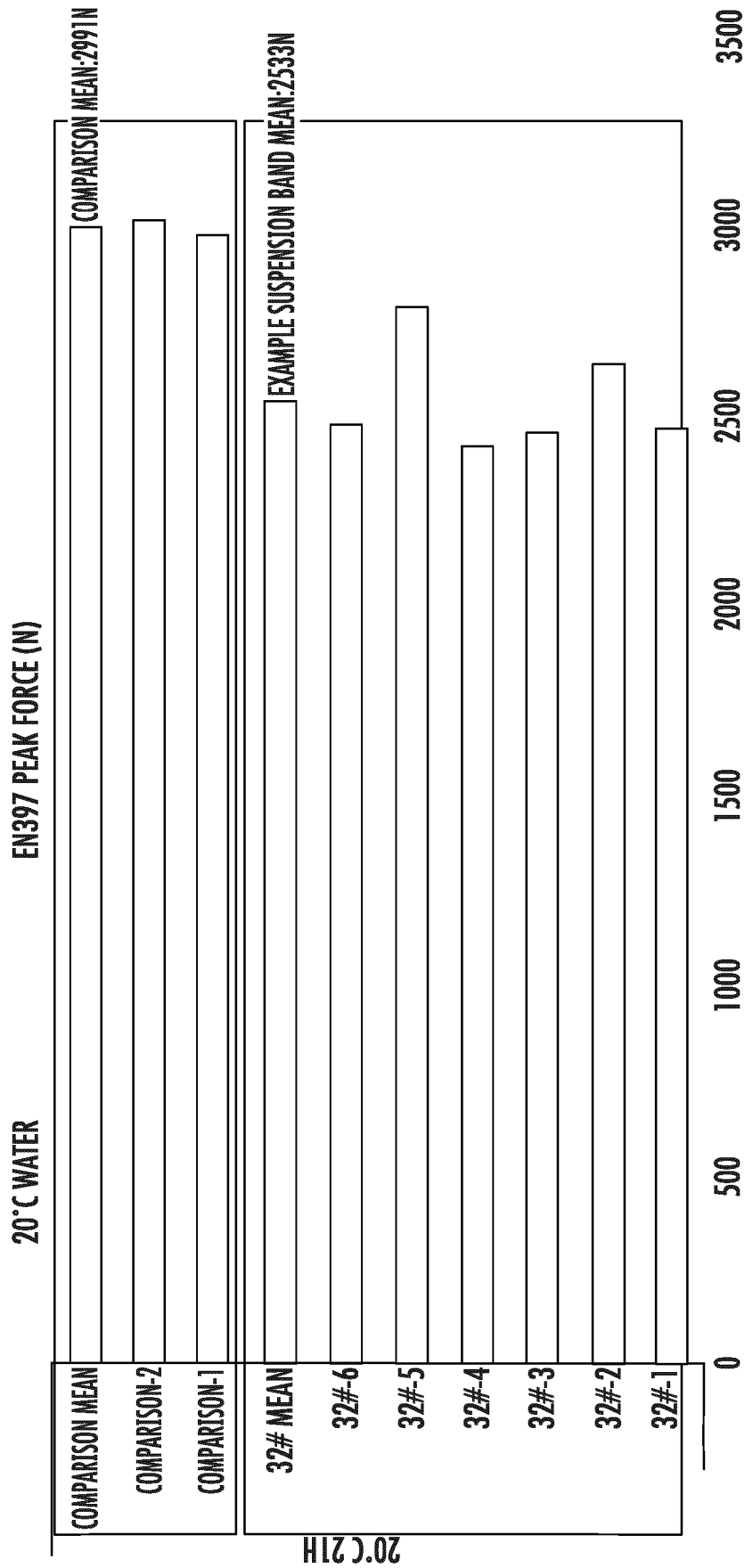


FIG. 5C

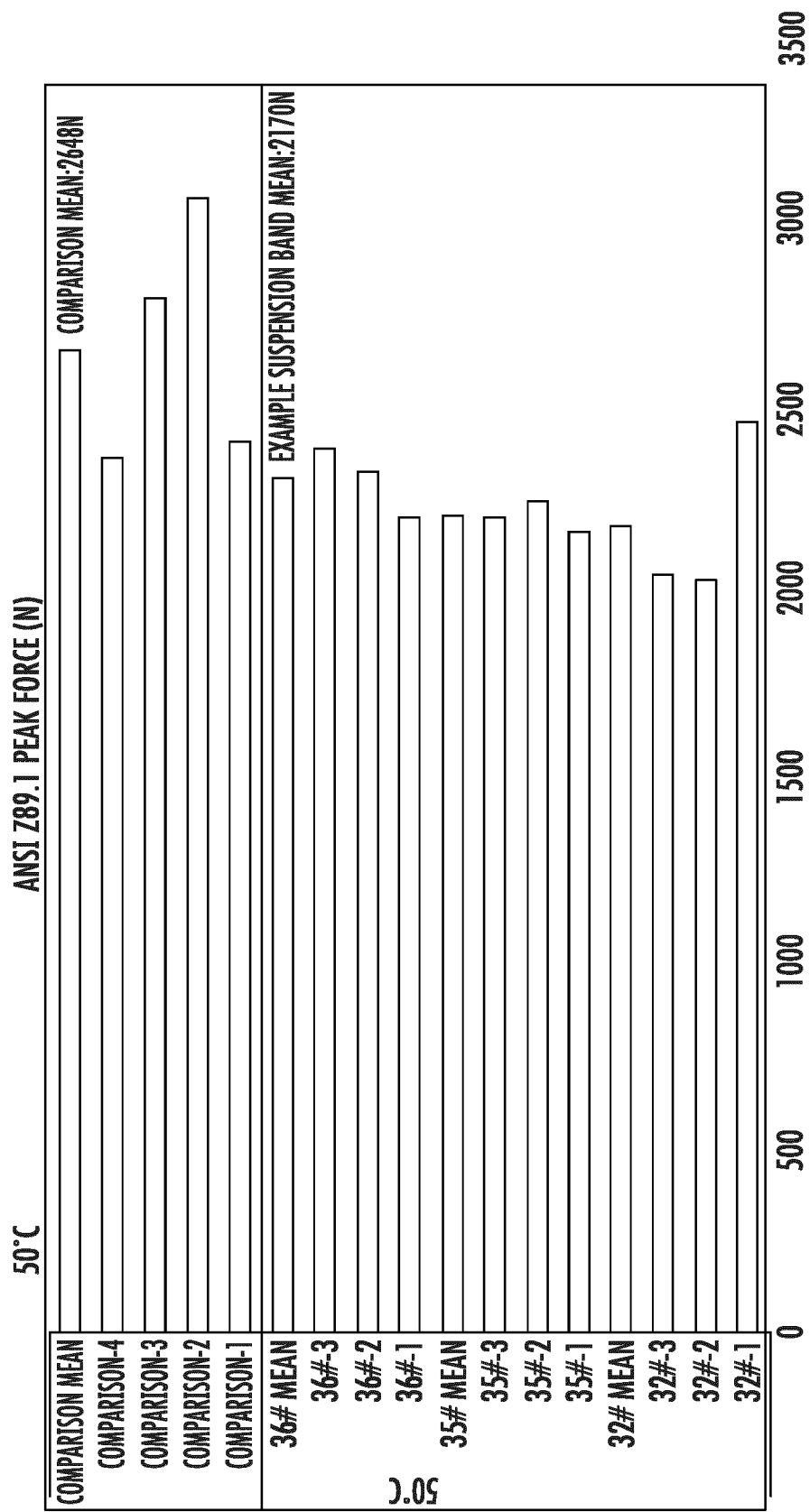


FIG. 6A

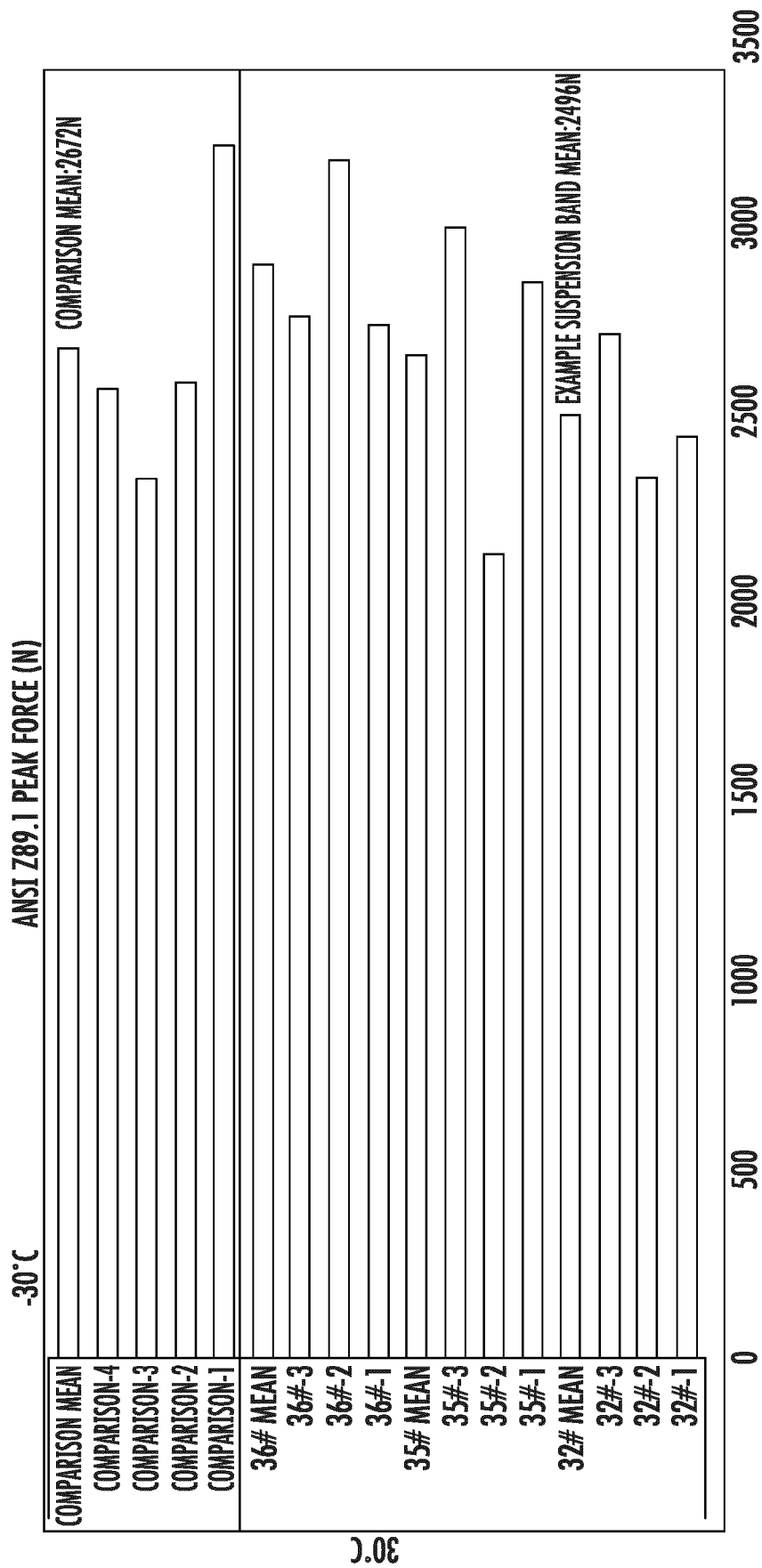


FIG. 6B

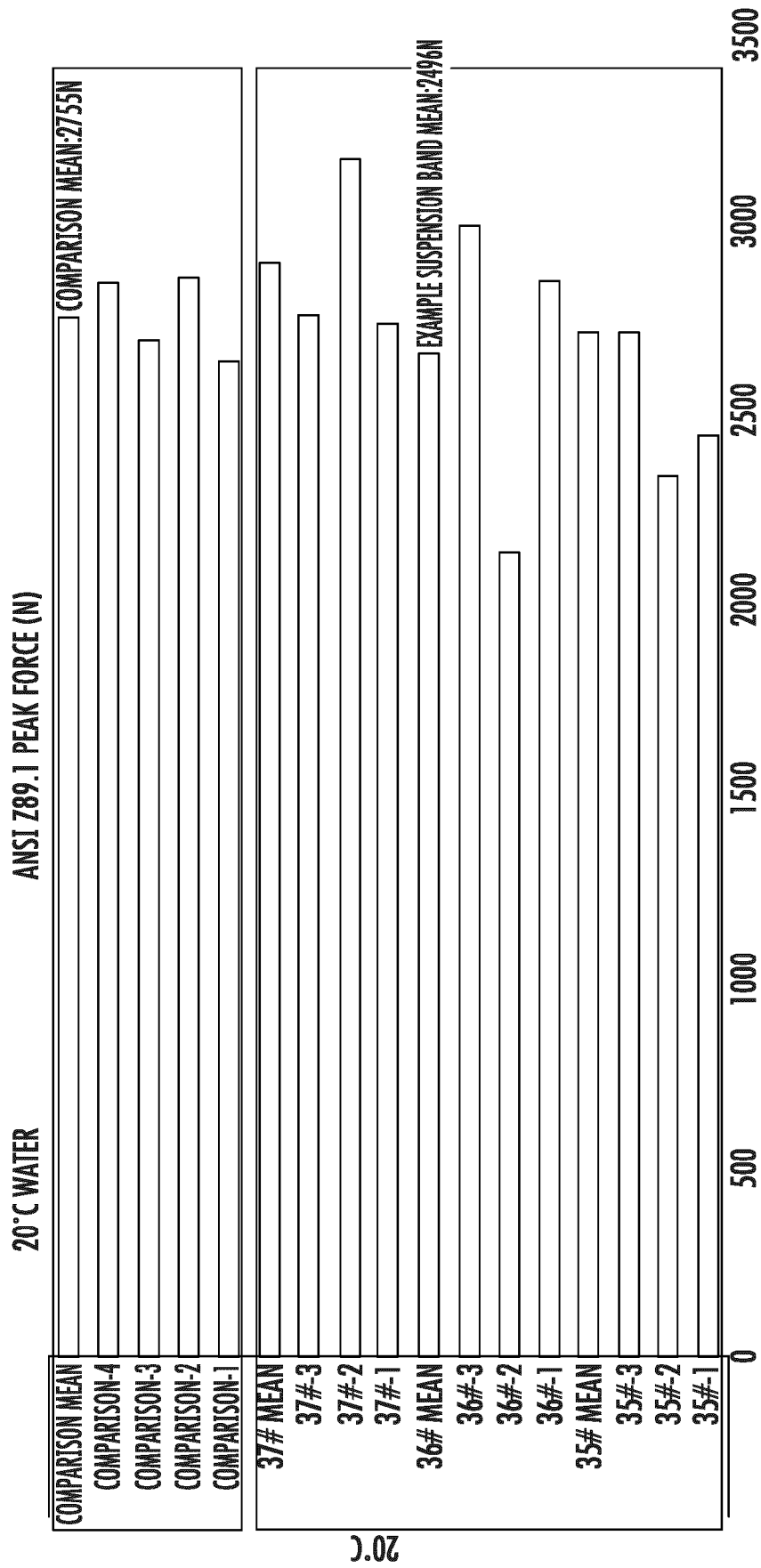


FIG. 6C



EUROPEAN SEARCH REPORT

Application Number

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Y	* column 2, line 56 - column 3, line 47; figures 1, 2 *	12	A42B3/14 D04B1/12 D04B1/22
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A	* page 1, left column, line 39 to page 1, right column, line 30; figures 1-3 *	5,6,12	
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A	* paragraphs [0022] - [0024]; figures 2, 10, 11 *	2-12	
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