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- (71) Applicant (for all designated States except US): **TOPIC-AL GEAR, LLC** [US/US]; 613 Robin Dale Drive, Austin, Texas 78734 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **BUE, William D.** [US/US]; 613 Robin Dale Drive, Austin, Texas 78734 (US).
- (74) Agent: **FULLER, Rodney J.**; Booth Udall, PLC, 1155 West Rio Salado Parkway, Suite 101, Tempe, Arizona 85281 (US).
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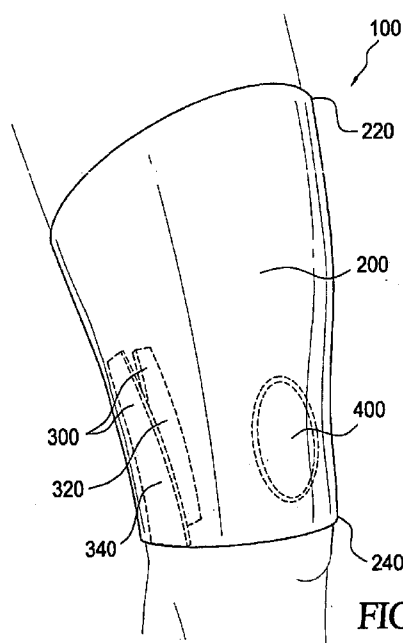


FIG. 1

(57) Abstract: A topical proprioceptive tube and method of use for enhancing performance, reducing the risk of knee injury, or both. The tube includes a flexible sleeve having at least: a hamstring buttress, a knee buttress, or both, wherein the hamstring buttress and the knee buttress are configured to be coupled to the interior of the flexible sleeve such that the hamstring buttress applies pressure to at least a portion of one of the subject's hamstring muscles and the knee buttress applies pressure to at least a portion of the subject's Vastus Medialis Obliquus (VMO) when worn by the subject to provide the desired effect.

TOPICAL PROPRIOCEPTIVE ACL TUBE AND METHODS OF USE

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates generally to a medical device designed to enhance performance and reduce the risk of injury to the knee. Comprised of a flexible sleeve with strategically positioned hamstring and knee buttresses, the Anterior Cruciate Ligament Tube (“ACL Tube”) of the present invention is designed to be worn during periods of physical activity or while at rest. In a preferred embodiment, each component of the ACL Tube is
10 composed of resilient, non-rigid material, and the invention increases proprioception and reduces the risk of injury by applying pressure to the hamstring muscles and/or the Vastus Medialis Obliquus (“VMO”) of a human subject.

2. Discussion of the Background

15 Injuries to the Anterior Cruciate Ligament (“ACL”) are among the most feared by athletes of any sport. This year alone, it is estimated that over a quarter million people will tear their ACL. Roughly 70% of these injuries will require surgical reconstruction at a cost of \$17,000 to \$25,000 per injury. Indeed, injuries to the ACL are the most common knee ligament injuries. Although the affected individual is able to return to sports in 80-95% of
20 cases, the long-term effects of an ACL tear negatively impact one’s quality of life for many years thereafter.

One skilled in the art recognizes that the term “knee” refers to the complex synovial joint in humans that joins the thigh with the leg and consists of two articulations: one between the femur and tibia, and one between the femur and patella. The knee actually comprises
25 three functional compartments: the femoropatellar, or “kneecap”, the patellar groove; and the medial and lateral femorotibial articulations linking the femur, or thigh bone, with the tibia, the main bone of the lower leg.

The ACL is one of the four primary ligaments in the human knee (the others being the medial collateral ligament, the posterior cruciate ligament, and the lateral collateral ligament).
30 As used herein, the term “knee injury” refers to a tear, rupture, or other injury to one or more of these ligaments, or to any dislocation, tracking, or other injury to the patella. The ACL extends between the “notch” of the distal femur and the medial wall of the lateral femoral condyle. The two fibrous bundles comprising the ACL are named for where they attach to the tibial plateau: the anteromedial and the posterolateral. The ACL attaches to the (anterior)

intercondyloid eminence of the tibia, where it blends with the anterior horn of the lateral meniscus. These attachments provide stability to the knee joint by preventing anterior translation of the tibia in relation to the femur.

Interestingly, ACL tears occur disproportionately among women. Research indicates
5 that women who participate in comparable jumping and cutting athletic activities tear their ACL two-to-nine times more often than their male counterparts. Experts have advanced a number of theories to explain this imbalance, including relative differences in environment, lower limb alignment, muscular strength, jump biomechanics, neuromuscular traits, hormone levels, and fitness level (conditioning). According to one theory, women experience
10 higher rates of ACL tears because their hamstrings and quadriceps contract in a different order and at a different rate than do those of men. When men return to the ground after a vertical jump, their hamstrings generally contract before their quadriceps. This keeps the tibia posterior and protects the ACL from injury. When many women return to the ground after a vertical jump, however, the quadriceps fire first and the knee rotates internally. This
15 physiological response places excessive strain on a woman's knees and may cause injury to her ACL. Thus, knee abduction loading appears to be a critical factor that contributes to the rupture of the ACL. Female athletes generate greater abduction loads when cutting and landing (compared to their male counterparts).

It is therefore hypothesized that knee abduction is a critical factor that contributes to
20 the increased incidence of ACL injuries among women. *See, e.g., Palmieri-Smith et. al, "Association of Quadriceps and Hamstrings Cocontraction Patterns with Knee Joint Loading", Journal of Athletic Training, 2009; 44(3):256-63.*

The above study found that women experience lower overall quadriceps-to-hamstrings (Q:H) cocontraction, and that medial-to-lateral Q:H cocontraction appears to be particularly
25 unbalanced in women. This imbalance limits the ability of female athletes to resist abduction loading. This may account for the added incidence of ACL injuries among women, because increased abduction loads create added strain on the ACL. In other words, the experimental and epidemiological evidence suggests that female athletes unwittingly utilize a selective Q:H activation strategy that contributes to abduction loading – a critical factor in the ACL
30 rupture mechanism. Rather than evenly cocontracting the muscles that control abduction loading, women appear to contract the lateral quadriceps and hamstrings while underactivating the medial thigh muscles. Selective activation of the medial knee muscles helps to resist abduction loads. Thus, the pattern of Q:H contraction in women appears harmful to the ACL. In contrast, balanced cocontraction of the quadriceps and hamstrings (in

the so-called frontal plane) enhances joint compression, which increases the stability of the knee joint. Overall, the existing research indicates that Q:H cocontraction is lower among female athletes as compared to their male counterparts.

Moreover, women typically have wider hips and a smaller femoral “notch” (to which
5 the proximal end of the ACL attaches). These unique physiological and biomechanical characteristics observed among female athletes often cause greater internal rotation of the knee and result in an increased incidence of ACL injuries.

Unfortunately, contemporary athletic training programs and orthopedic devices fail to compensate for these unique female characteristics. Existing knee braces and athletic
10 training methods utilize “one-size-fits-all” solutions that all too often focus on men to the exclusion of women. A need exists, therefore, for a device and training method designed to address the unique neurophysiological relationship between the quadriceps, hamstrings, and the ACL in women. Specifically, a need exists for a proprioceptive knee device configured to lower the risk of knee injuries, especially in women athletes. Such a device would
15 preferably enhance neuromuscular communication to coordinate hamstring and quadriceps contraction in women to lower the risk of knee injuries.

SUMMARY OF THE INVENTION

The objective of the present invention is to provide a therapeutic proprioceptive
20 device and method of use for enhancing performance and reducing the risk of knee injury. Instead of a bulky, ill-fitting knee brace commonly used in the art, the present invention employs a topical proprioceptive ACL tube with a flexible sleeve comprising an upper end and a lower end, the upper end and the lower end each having an interior and an exterior surface; and one or more hamstring buttresses having a base portion and an upper portion, the
25 one or more hamstring buttresses being coupled to the interior of the flexible sleeve so that the one or more hamstring buttresses are over at least one of the subject’s hamstring muscles, the base portion being coupled towards the lower end of the flexible sleeve and the upper portion being coupled towards the upper end of the flexible sleeve, wherein the one or more hamstring buttresses are configured to apply sufficient pressure to at least one of the subject’s
30 hamstring muscles when worn; and one or more knee buttresses coupled to the interior surface of the flexible sleeve so that the one or more knee buttresses is over the subject’s Vastus Medialis Obliquus (VMO), the one or more knee buttresses comprising: a pad comprised of resilient material, the pad being configured to apply pressure to the VMO when worn by the subject.

The ACL tube of the present invention is uniquely designed to stimulate Q:H cocontraction and reduce incidences of patellar tracking. The present invention further comprises methods of use, wherein the topical ACL tube is applied to the subject's knee during physical activities.

5 The present invention is also directed to a therapeutic proprioceptive method for enhancing performance and reducing the risk of knee injury in a human subject by enhancing cocontraction of the subject's quadriceps and hamstrings, said method comprising the steps of:

10 (a) stimulating neuromuscular communication with the hamstrings by applying topical pressure to at least one of the subject's hamstring muscles;

 (b) stimulating neuromuscular communication with the knee and reducing patellar tracking by applying topical pressure to the VMO; and

 (c) reducing the abduction load on the knee by the concurrent topical application of (a) and (b).

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

 The accompanying drawings, described below, illustrate preferred embodiments of the present invention. It will be understood that no limitation to the scope of the invention is intended thereby. These drawings depict various features and further advantages of the present invention. The invention is not limited to the particular embodiments disclosed in
20 these drawings, as it should be understood by one skilled in the art that additional features, modifications, and alternative embodiments are contemplated by the invention as disclosed herein.

 FIG. 1 is a front and side perspective view of a preferred embodiment of the present invention showing the device on a subject's leg.

25 FIG. 2 is a front perspective view of a preferred embodiment of the present invention.

 FIG. 3 is a front elevational view of a preferred embodiment of the present invention showing the device in the Open position.

 FIG. 4 is an alternate rear elevational view of a preferred embodiment of the present invention.

30 FIG. 5 is a bottom plan view of a preferred embodiment of the present invention.

 FIG. 6 is a front elevational view of a preferred embodiment of the present invention showing a hamstring buttress optionally attached via hook and loop fasteners.

FIG. 7 is a front elevational view of a preferred embodiment of the present invention showing the device on the leg of a human subject.

FIG. 8 is a rear elevational view of a preferred embodiment of the present invention showing the device on the leg of a human subject.

5 FIG. 9 is a bottom plain view of a preferred embodiment of the present invention showing a grid of rounded lines on an outer surface of a knee buttress.

FIG. 10 is a front elevational view of a preferred embodiment of the present invention showing the device on the leg of a human subject.

10 FIG. 11 is a bottom plain view of a preferred embodiment of the present invention showing a grid of rounded lines on an outer surface of a hamstring buttress.

FIG. 12 is a front elevational view of a preferred embodiment of the present invention showing the device on the leg of a human subject.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 The following is a description of the preferred embodiments of the present invention and is not intended to limit the scope of the invention to the particular embodiments discussed below.

In accordance with the present invention, **FIGS. 1-8** depict topical proprioceptive ACL Tube **100** for enhancing performance and reducing the risk of knee injuries in human subjects, including women athletes. In a preferred embodiment, topical ACL tube **100** includes flexible sleeve **200**, which is comprised of a lower end **240** and an upper end **220**, the upper end **220** and the lower end **240** each having an interior surface **270** and an exterior surface **280**. Flexible sleeve **200** is preferably comprised of a thin, resilient, radially stretchable material designed to conform and contour to a subject's knee. Preferably, flexible sleeve **200** is comprised of a loose-knit fiber breathably configured to release perspiration and allow air flow during use. The loose-knit fiber can be any one of a number of commercially available stretchable materials such as LYCRA, SPANDEX, BIOSKIN, or EpX. More preferably, the material is a tri-laminate (bonded) material having a first polyurethane-polyurea copolymer on the inside and a second polyurethane-polyurea copolymer on the outside, with a thin polyurethane membrane between the first and second copolymers. In a preferred embodiment, the tri-laminate material is less than 2mm thick and is sufficiently elastic to provide between 15-25 mm Hg compression to the lower leg, ankle, and/or foot of the subject. As shown in **Figs. 3-4**, flexible sleeve **200** is stitched together and vertically

bisected along seam **210**. Optionally, seam **210** is comprised of one or more hook-loop fasteners suitable for releasably coupling the proximal and distal ends of flexible sleeve **200** together along seam **210**.

Preferably, the lower (distal) end **240** of flexible sleeve **200** terminates at the superior
5 (top) portion of the patella and the upper (proximal) end **220** terminates approximately between 2.54 cm and 12.7 cm below the gluteal fold. Preferably, upper end **220** of flexible sleeve **200** terminates at least 7.62 cm below the gluteal fold.

In an alternate embodiment, lower end **240** of flexible sleeve **200** extends beyond the patella and terminates in the upper calf region of the lower leg of a subject. Advantageously,
10 this alternative embodiment may include one or more apertures **290** encircling the patella.

Advantageously, topical ACL tube **100** further comprises one or more hamstring buttresses **300**. Preferably, topical ACL tube **100** includes a medial hamstring buttress **320** and a biceps femoris buttress **340**, wherein both the medial hamstring buttress **320** and the biceps femoris buttress **340** are coupled to the interior surface **270** of the lower end **240** of
15 flexible sleeve **200** and extend into the interior surface **270** of the upper end **220** of flexible sleeve **200**. More preferably, the two hamstring buttresses **300** are mirror images of each other and comprise a lower (distal) base portion **350** and an upper (proximal) portion **370**. Most preferably, the two hamstring buttresses **300** are positioned in the sleeve such that when the topical ACL tube **100** is worn by the subject, both medial hamstring buttress **320** and
20 biceps femoris buttress **340** extend over and apply pressure to the medial hamstring muscles (the semimembranosus and the semitendinosus) and the biceps femoris, respectively. Preferably, medial hamstring buttress **320** is centered over the medial hamstring muscles at approximately 50% of thigh length (measured between the front tip of the hip at the anterior superior iliac spine and the knee joint line). Preferably, the hamstring buttresses **300** are
25 positioned such that the upper (proximal) portion **370** is approximately between 2.54 cm and 12.7 cm below the gluteal fold. More preferably, the upper portion **370** of hamstring buttresses **300** is between 5.08 cm and 10.16 cm below the gluteal fold. Most preferably, hamstring buttresses **300** are positioned such that the upper (proximal) portion is between 7.62-8.89 inches below the gluteal fold.

In their preferred embodiments, hamstring buttresses **300** are oval or elliptical shaped. Preferably, each hamstring buttress **300** is between 2.54 cm and 12.7 cm long. More preferably, hamstring buttresses **300** are between 7.62 cm and 10.16 cm long. Most preferably, hamstring buttresses are 8.89 cm long. Advantageously, each hamstring buttress **300** is between 2 cm and 10.16 cm wide. More advantageously, each medial hamstring

buttruss **300** is between 5.08 cm and 7.62 cm wide. Most advantageously, medial hamstring buttresses **300** are 6.35 cm wide. Thus, in their preferred embodiments, hamstring buttresses **300** have a surface area of between 0.82 cm² and 135.48 cm². More preferably, hamstring buttresses **300** have a surface area of between 9.75 cm² and 77.42 cm².

5 Preferably, the amount of pressure applied to the hamstring muscles by hamstring buttresses **300** is between 15-400 mm Hg of compression. More preferably, the amount of pressure applied to the hamstring muscles by hamstring buttresses **300** is between 25-350 mm HG compression. Most preferably, the amount of pressure applied to the hamstring muscles by hamstring buttresses **300** is between 35-200 mm HG compression. In a preferred
10 embodiment, hamstring buttress **320** applies more pressure to the medial hamstring muscles than biceps femoris buttress **340** applies to the biceps femoris. In an alternate embodiment, hamstring buttress **320** applies less pressure to the medial hamstring muscles than biceps femoris buttress **340** does to the biceps femoris. In another alternative embodiment, medial hamstring buttress **320** applies the same amount of pressure to the medial hamstring as the
15 biceps femoris buttress **340** applies to the biceps femoris.

In a preferred embodiment, hamstring buttresses **300** are comprised of a compressible material. Preferably, the compressible material is comprised of one or more of the following: foam or foam-like material, a gel or gel-like material, or any other compressible material suitable to apply pressure to the hamstring muscles and receptors. Preferably, flexible sleeve
20 **200** compresses hamstring buttresses **300** toward the subject's hamstrings with a force sufficient to stimulate sensory and tactile receptors located in the hamstring region. Most preferably, the hamstring buttresses **300** extend over and apply pressure to the semitendinosus, semimembranosus, biceps femoris, and/or popliteal fossa. Preferably, hamstring buttresses **300** further comprise two sets of grid lines **315**, **325** on the outer surface
25 of the medial hamstring buttress **320** and the biceps femoris buttress **340**. Preferably, the first set of grid lines **315** run parallel to the medial hamstring muscle fibers **335** and the second set of grid lines **325** run perpendicular to the medial hamstring muscle fibers. Preferably, each rounded grid line **315**, **325** is between 0.16 cm and 1.27 cm wide and between .32 cm and 2.54 cm deep. More preferably, each rounded grid line **315**, **325** is between 0.32 cm and 0.64
30 cm wide and between 0.64 cm and 1.28 cm deep (perpendicular lines may be deeper in order to enhance proprioception). The preferred rounded grid lines **315**, **325** are typically grooves formed below the horizon of the hamstring buttress's outer surface. Alternatively, however, the grid lines **315**, **325** can also rise above the surface of the hamstring buttresses and provide the required effect.

Preferably, hamstring buttresses **300** are releasably coupled to the interior of flexible sleeve **200**. More preferably, hamstring buttresses **300** are further comprised of hook loop fasteners **350** affixed to the interior portion **310** of the hamstring buttresses **300**, wherein the hook loop fasteners are suitable for releasably coupling the interior portion **310** of hamstring buttresses **300** to the interior surface **270** of flexible sleeve **200**. Most preferably, both hamstring buttress **320** and biceps femoris buttress **340** are releasably coupled to the interior surface **270** of the lower end **240** of flexible sleeve **200**.

Advantageously, topical ACL tube **100** further comprises one or more knee buttresses **400** coupled to the interior surface **270** of the lower end **240** of flexible sleeve **200**. Preferably, the one or more knee buttresses **400** comprise an oval or elliptical shaped pad comprised of resilient material, wherein the pad is configured to extend at least partially over and apply pressure to the subject's Vastus Medialis Obliquus (VMO). Preferably, knee buttress **400** is centered over the medial hamstring muscles at approximately 67% of thigh length (measured between the front tip of the hip at the anterior superior iliac spine and the knee joint line). Advantageously, knee buttress **400** is between 2.54 cm and 7.62 cm wide and 5.08 cm and 10.16 cm long. More advantageously, knee buttress **400** is 5.08 cm wide and 7.62 cm long. In a preferred embodiment, the surface area of the knee buttress **400** is between 0.1-135.48 cm. More preferably, the surface area of knee buttress **400** is between 7.62 cm² and 67.74 cm². In a preferred embodiment, the distal end of buttress **400** terminates 1.27 cm to 5.08 cm above the patella. More preferably, the distal end of buttress **400** terminates 2.54 cm to 3.81 cm above the patella.

Preferably, the amount of pressure applied to the VMO is between 15-400 mm Hg of compression. More preferably, the amount of pressure applied to the VMO by knee buttress **400** is between 25-350 mm HG compression. Most preferably, the amount of pressure applied to the VMO by knee buttress **400** is between 35-200 mm HG compression.

Preferably, knee buttresses **400** further comprise two sets of grid lines **415** on the outer surface **405** of the knee buttress **400**. Preferably, the first set of grid lines **415** run parallel to the Vastus Medialis Obliquus (VMO) muscle fibers **435** and the second set of grid lines **425** run perpendicular to the Vastus Medialis Obliquus (VMO) muscle fibers **435**. The first set of grid lines preferably run parallel to the Vastus Medialis Obliquus (VMO) muscle fibers **435** and are positioned at a 60 degree angle on the outer surface of the knee buttress **440** to provide the desired effect. Furthermore, each grid line **415**, **425**, preferably rounded, is between 0.32 cm and 0.64 cm wide and between 0.64 and 1.27 cm deep (perpendicular lines may be deeper in order to enhance proprioception). The preferred rounded grid lines are

typically grooves formed below the horizon of the knee buttress's outer surface. Alternatively, however, the grid lines **415**, **425** can also rise above the surface of the knee buttress and provide the required effect.

In a preferred embodiment, ACL Tube **100** comprises medial hamstring buttress **320**,
5 biceps femoris buttress **340**, and knee buttress **400**. Preferably, ACL Tube **100** is positioned on the leg and/or knee of the subject such that that medial hamstring buttress **320** and the biceps femoris buttress **340** extend substantially over and apply pressure to the hamstring muscles (the semimembranosus, semitendinosus, biceps femoris, and/or popliteal fossa) and knee buttress **400** extends substantially over and applies pressure to the VMO. More
10 preferably, the ACL tube **100** is positioned such that: buttress **320** extends substantially over and applies pressure to the medial hamstring muscles, biceps femoris buttress **340** extends substantially over and applies pressure to the biceps femoris, and knee buttress **400** extends substantially over and applies pressure to the VMO. Advantageously, hamstring buttress **320** mirrors the medial hamstring musculature, biceps femoris buttress **340** mirrors the biceps
15 femoris musculature, and knee buttress **400** mirrors the shape of the VMO. In alternate embodiments, hamstring buttress **320** and biceps femoris buttress **340** include a tapered base portion **350** and a wide upper portion **370**. Alternatively, medial hamstring buttress **320** and biceps femoris buttress **340** include a wide base portion **350** and a tapered upper portion **370**.

In an alternate embodiment, hamstring buttress **320** substantially covers (e.g., at least
20 50%, 60%, 70%, 80% or 90%) and applies pressure to the medial hamstring muscles but preferably does not substantially extend over or apply pressure to any other part of the leg or knee covered by flexible sleeve **200**. In this embodiment, biceps femoris buttress **340** substantially covers and applies pressure to the semimembranosus and semitendinosus but preferably does not substantially extend over other part of the leg or knee covered by flexible
25 sleeve **200**. In this same embodiment, knee buttress **400** substantially covers and applies pressure to the VMO but does not extend over or apply pressure to any other part of the leg or knee covered by flexible sleeve **200**.

Most preferably, hamstring buttress **320** is positioned such that it substantially covers and applies pressure to the medial hamstring musculature without radially extending into or
30 intruding upon any other hamstring muscles or any ancillary portion of flexible sleeve **200**. In this most preferred embodiment, biceps femoris buttress **340** substantially covers and applies pressure to the biceps femoris without radially extending into or intruding upon the medial hamstring muscles or any ancillary portion of flexible sleeve **200**. In this same (most preferred) embodiment, knee buttress **400** substantially covers and applies pressure to the

VMO but does not radially extend into or intrude upon the medial or lateral hamstring muscles or any ancillary portion of flexible sleeve **200**. In its most preferred form, ACL tube **100** and flexible sleeve **200** are positioned such that biceps femoris buttress **340**, hamstring buttress **320**, and knee buttress **400** are each positioned as described hereinabove.

5 In one alternate embodiment, ACL tube **100** comprises only two buttresses affixed and/or releasably coupled to flexible sleeve **200**: the medial hamstring buttress **320** and the knee buttress **400**.

10 In an alternate embodiment, the ACL tube **100** of the present invention is included in a topical proprioceptive ACL tube kit. The kit includes, separately, flexible sleeve **200**, one or more hamstring buttresses **300**, and one or more knee buttresses **400**. Preferably, the kit includes printed instructions **500** relating to the use of the topical ACL tube **100**, including instructions to couple the hamstring buttresses **300** to the interior surface **270** of lower end **240** of flexible sleeve **200** such that hamstring buttresses **300** extend into the interior surface **270** of the upper end **220**. More preferably, printed instructions **500** explain that hamstring
15 buttresses **300** should be situated such that they extend over and apply pressure to the hamstring muscles as set forth above. Most preferably, printed instructions **500** explain that hamstring buttresses **300** should be situated such that they extend over and apply pressure to the semitendinosus **630**, semimembranosus **620**, biceps femorus **610**, and/or popliteal fossa of the subject. Advantageously, printed instructions **500** further include instructions for
20 coupling the one or more knee buttresses **400** to the interior surface **270** of the lower end **240** of flexible sleeve **200**. Preferably, printed instructions **500** include specific instructions relating to the positioning of knee buttress **400** such that it extends at least partially over and applies pressure to the subject's Vastus Medialis Obliquus (VMO) **640**.

25 The present invention also comprises methods of using the topical proprioceptive ACL tube **100** of the present invention for enhancing an athlete's performance and/or reducing the risk of a knee and/or hamstring injury. Method **600** comprises (1) applying the topical ACL tube of the present invention to the subject's knee (2) during physical activities (3) over an interval of time. Preferably, the injury prevented is an injury to the Anterior Cruciate Ligament (ACL).

30 In another alternative embodiment or embodiments, the above device is optionally configured to supply transcutaneous nerve stimulation (TENS), heat, and/or cold to subject-selected regions of upper end **220** and/or lower end **240**.

 Upon reading the teachings of this specification, those with ordinary skill in the art will appreciate that, under certain circumstances, considering issues such as changes in

technology, subject requirements, etc., a variety of fastening devices may be used to “fasten,” “secure,” “releasably secure,” and/or “releasably couple” one or more components of the present invention. These fasteners or fastening means may include one or more of the following: adhesives, bolts, buckles, clasps, latches, locks, screws, snaps, clamps, connectors, couplings, ties or other fastening means yet to be developed.

Likewise, upon reading the teachings of this specification, those with ordinary skill in the art will appreciate that, under certain circumstances, considering issues such as changes in technology, subject requirements, etc., a variety of fastening devices, such as adhesives, belts, bolts, buckles, clasps, latches, locks, screws, snaps, clamps, connectors, couplings, ties or other fastening means yet to be developed may be used in lieu of – or in conjunction with – any of the fasteners or fastening means discussed above.

Although applicant has described applicant’s preferred embodiments of this invention, it will be understood that the broadest scope of this invention includes modifications. Such scope is limited only by the claims as read in connection with the above specification. Further, many other advantages of applicant’s invention will be apparent to those skilled in the art from the above descriptions and the claims below.

CLAIMS

WE CLAIM:

1. A topical proprioceptive anterior cruciate ligament (ACL) tube for enhancing performance and/or reducing the risk of knee injury in a human subject, the topical ACL tube comprising:

a flexible sleeve comprising an upper end and a lower end, the upper end and the lower end each having an interior and an exterior surface; and

one or more hamstring buttresses having a base portion and an upper portion, the one or more hamstring buttresses being coupled to the interior of the flexible sleeve so that the one or more hamstring buttresses extend over at least a portion of one of the subject's hamstring muscles, the base portion being coupled towards the lower end of the flexible sleeve and the upper portion being coupled towards the upper end of the flexible sleeve, wherein the one or more hamstring buttresses are configured to apply a sufficient amount of pressure to at least a portion of one of the subject's hamstring muscles when worn by the subject to reduce the risk of knee injury.

2. A topical proprioceptive anterior cruciate ligament (ACL) tube for enhancing performance and/or reducing the risk of knee injury in a human subject, the topical ACL tube comprising:

a flexible sleeve comprising an upper end and a lower end, the upper end and the lower end each having an interior and an exterior surface; and

one or more knee buttresses coupled to the interior surface of the flexible sleeve so that the one or more knee buttresses are over at least a portion of the subject's Vastus Medialis Obliquus (VMO), the one or more knee buttresses comprising:

a pad comprised of resilient material, wherein the pad is configured to apply a sufficient amount of pressure to the VMO when worn by the subject to reduce the risk of knee injury.

3. A topical proprioceptive anterior cruciate ligament (ACL) tube for enhancing performance and/or reducing the risk of injury in a human subject, the topical ACL tube comprising:

a flexible sleeve comprising an upper end and a lower end, the upper end and the lower end each having an interior and an exterior surface; and

one or more hamstring buttresses having a base portion and an upper portion, the one or more hamstring buttresses being coupled to the interior of the flexible sleeve such that the one or more hamstring buttresses cover at least a portion of one of the subject's hamstring muscles, the base portion being coupled towards the lower end of the flexible sleeve and the upper portion being coupled towards the upper end of the flexible sleeve, wherein the one or more hamstring buttresses are configured to apply an amount of pressure to at least a portion of one of the subject's hamstring muscles when worn by the subject; and

one or more knee buttresses coupled to the interior surface of the flexible sleeve so that the one or more knee buttresses is over at least a portion of the subject's Vastus Medialis Obliquus (VMO), the one or more knee buttresses comprising: a pad comprised of resilient material, the pad being configured to apply an amount of pressure to the VMO when worn by the subject.

4. A method of enhancing a subject's performance and/or reducing the risk of a knee injury, the method comprising: applying the topical ACL tube of any one of claims 1-3 to the subject's knee during physical activities.

5. The method of claim 4, wherein the knee injury is an anterior cruciate ligament injury.

6. A therapeutic proprioceptive method for enhancing performance and/or reducing the risk of knee injury in a human subject by enhancing cocontraction of the subject's quadriceps and hamstrings, said method comprising the steps of:

(a) stimulating neuromuscular communication with the hamstrings by applying topical pressure to at least at a portion of one or more of the subject's hamstring muscles;

(b) stimulating neuromuscular communication with the knee and reducing patellar tracking by applying topical pressure to at least a portion of the subject's Vastus Medialis Obliquus (VMO); and

(c) reducing the abduction load on the knee by the concurrent topical application of (a) and (b).

7. A therapeutic proprioceptive device for enhancing performance and/or reducing the risk of knee injury in a human subject, said device comprising:

(a) a means for stimulating neuromuscular communication with the hamstrings by applying topical pressure to at least a portion of one or more of the subject's hamstring muscles;

(b) a means for stimulating neuromuscular communication with the knee and reducing patellar tracking by applying topical pressure to at least a portion of the subject's Vastus Medialis Obliquus (VMO); and

(c) a means for reducing the abduction load on the subject's knee by the concurrent topical application of (a) and (b).

8. The topical proprioceptive ACL tube of claims 1-3, wherein the flexible sleeve is comprised of a loose-knit fiber breathably configured to release perspiration and allow air-flow during use.

9. The topical proprioceptive ACL tube of claim 8, wherein the loose nit fiber comprises a tri-laminate (bonded) material having a first polyurethane-polyurea copolymer on an inside layer of the material and a second polyurethane-polyurea copolymer on an outer layer of the material, with a thin polyurethane membrane between the first and second copolymers.

10. The topical proprioceptive ACL tube according to claims 1, 2, or 3, wherein the flexible sleeve is stitched together and vertically bisected along the seam.

11. The topical proprioceptive ACL tube according to claims 1, 2, or 3, wherein the seam is comprised of one or more hook-loop fasteners releasably coupled to the proximal and distal ends of the flexible sleeve along the seam.

12. The topical proprioceptive ACL tube according to claims 1, 2, or 3, wherein the upper end of the flexible sleeve is configured to terminate at the superior (top) portion of the patella, approximately between 2.54 cm and 12.7 cm below the gluteal fold.

13. The topical proprioceptive ACL tube according to claim 12 wherein the upper end of flexible sleeve is configured to terminate at least 7.62 cm below the gluteal fold.

14. The topical proprioceptive ACL tube according to claims 1, 2, or 3, wherein the lower end of the flexible sleeve is configured to extend beyond the patella and terminate in the upper calf region of the lower leg of a subject.

15. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses comprise:

a medial hamstring buttress, and

a biceps femoris buttress, wherein

the medial hamstring buttress is configured to be centered over the medial hamstring muscles at approximately 50% of thigh length (measured between the front tip of the hip at the anterior superior iliac spine and the knee joint line).

16. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses are configured such that the upper portion is approximately positioned between 2.54 cm and 12.7 cm below the gluteal fold.

17. The topical proprioceptive ACL tube according to claim 16, wherein the upper portion of the one or more hamstring buttresses is configured to be positioned between 5.08 cm and 10.16 cm below the gluteal fold.

18. The topical proprioceptive ACL tube according to claim 17, wherein the one or more hamstring buttresses are configured such that the upper portion is positioned between 19.35-22.58 cm below the gluteal fold.

19. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses are oval or elliptical shaped.

20. The topical proprioceptive ACL tube according to claims 1 or 3, wherein each of the one or more hamstring buttresses is between 2.54 cm and 12.7 cm long and between 2 cm and 10.16 cm wide.

21. The topical proprioceptive ACL tube according to claim 20, wherein the one or more hamstring buttresses are between 7.62 cm and 10.16 cm long and between 5.08 cm and 7.62 cm wide.

22. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses have a surface area of between 0.82 cm^2 and 135.48 cm^2 .

23. The one or more hamstring buttresses of claim 22, wherein the one or more hamstring buttresses have a surface area of between 9.75 cm^2 and 77.42 cm^2 .

24. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the amount of pressure the one or more hamstring buttresses is configured to apply to the hamstring muscles is between 15-400 mm Hg.

25. The topical proprioceptive ACL tube according to claim 25, wherein the amount of pressure the one or more hamstring buttresses is configured to apply is between 25-350 mm HG.

26. The topical proprioceptive ACL tube according to claim 25, wherein the amount of pressure the one or more hamstring buttresses is configured to apply is between 35-200 mm HG.

27. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the medial hamstring buttress is configured to apply more pressure to the medial hamstring muscles than the biceps femoris buttress applies to the biceps femoris.

28. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the medial hamstring buttress is configured to apply less pressure to the medial hamstring muscles than the biceps femoris buttress applies to the biceps femoris.

29. The topical proprioceptive ACL tube of claim 15, wherein the medial hamstring buttress is configured to apply the same amount of pressure to the medial hamstring as the biceps femoris buttress applies to the biceps femoris.

30. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses are comprised of a compressible material, suitable to apply pressure to the hamstring muscles and receptors.

31. The topical proprioceptive ACL tube according to claim 30, wherein the compressible material is comprised of one or more of the following: foam or foam-like material, a gel or gel-like material.

32. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses is configured to extend over and apply pressure to the semitendinosus, semimembranosus, biceps femoris, and/or popliteal fossa.

33. The topical proprioceptive ACL tube according to claim 15, wherein, the one or more hamstring buttresses further comprise:

a grid of rounded lines on the outer surface of the medial hamstring buttress, and the outer surface the biceps femoris buttress, wherein the grid of rounded lines further comprises

a first set of rounded lines configured to run parallel to the medial hamstring muscle fibers,

and a second set of rounded lines configured to run perpendicular to the medial hamstring muscle fibers.

34. The topical proprioceptive ACL tube according to claim 33, wherein, the first set of rounded lines is between 0.16 cm and 1.27 cm wide and between .32 cm and 2.54 cm deep.

35. The topical proprioceptive ACL tube according to claim 34, wherein, the first set of rounded lines is between 0.32 cm and 0.64 cm wide and between 0.64 cm and 1.28 cm deep.

36. The topical proprioceptive ACL tube according to claim 33, wherein, the second set of rounded lines is deeper than the first set of rounded lines.

37. The topical proprioceptive ACL tube according to claims 1 or 3, wherein the one or more hamstring buttresses are releasably coupled to the interior of the flexible sleeve.

38. The topical proprioceptive ACL tube according to claim 37, wherein the one or more hamstring buttresses are further comprised of one or more hook loop fasteners affixed to an interior portion of the one more hamstring buttresses, wherein the hook loop fasteners are releasably coupled to the interior surface of flexible sleeve.

39. The topical proprioceptive ACL tube according to claims 2 or 3, wherein, the one or more knee buttresses is between 2.54 cm and 7.62 cm wide and between 5.08 cm and 10.16 cm long.

40. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the surface area of the one or more knee buttresses, is between 0.10 cm and 135.48 cm.

41. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the surface area of the knee buttress is between 7.62 cm^2 and 67.74 cm^2 .

42. The topical proprioceptive ACL tube according to claims 2 or 3, wherein, the distal end of the one or more knee buttresses is configured to terminate 2.54 cm to 3.81 cm above the patella.

43. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the amount of pressure the one or more knee buttresses is configured to apply to the VMO is between 15-400 mm Hg.

44. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the amount of pressure the one more knee buttress is configured to apply to the VMO is between 25-350 mm HG.

45. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the amount of pressure the one or more knee buttresses is configured to apply to the VMO is between 35-200 mm HG.

46. The topical proprioceptive ACL tube according to claim 3, wherein the one or more hamstring buttresses comprise a medial buttress and a biceps femoris buttress.

47. The topical proprioceptive ACL tube according to claim 46, wherein the medial buttress is configured to mirror at least a portion of the medial hamstring musculature, and the biceps femoris buttress is configured to mirror at least a portion of the biceps femoris musculature.

48. The topical proprioceptive ACL tube according to claims 2 or 3, wherein the knee buttress is configured to mirror the shape of the VMO.

49. The topical proprioceptive ACL tube according to claims 1 or 3,

the medial buttress and the biceps femoris buttress each include either a tapered base portion and a wide upper portion, or a wide base portion and a tapered upper portion.

50. The topical proprioceptive ACL tube according to claim 46, wherein the medial buttress is configured to substantially cover and apply pressure to the medial hamstring muscles but to not substantially extend over or apply pressure to any other part of the leg or knee covered by the flexible sleeve,

the biceps femoris hamstring buttress is configured to substantially cover and apply pressure to the semimembranosus and semitendinosus but to not substantially extend over other parts of the leg or knee covered by flexible sleeve, and

the knee buttress is configured to substantially cover and apply pressure to the VMO but to not extend over or apply pressure to any other part of the leg or knee covered by the flexible sleeve.

51. The topical proprioceptive ACL tube according to claim 3, wherein the one or more hamstring buttresses comprise a single medial hamstring buttress, wherein the medial buttress and the knee buttress are affixed and/or releasably coupled to the flexible sleeve.

52. The topical proprioceptive ACL tube according to claim 2, wherein, the knee buttresses further comprise:

a grid of rounded lines on the surface of the knee buttress, wherein the grid of rounded lines further comprises:

a first set of rounded lines that run parallel to the VMO muscle fibers,
and a second set of rounded lines run perpendicular to the VMO muscle fibers.

53. The topical proprioceptive ACL tube according to claim 52, wherein, the first set of rounded lines is between 0.32 cm and .64 cm wide and between .64 and 1.27 cm deep.

54. The topical proprioceptive ACL tube according to claim 52, wherein, the second set of rounded lines is deeper than the first set of rounded lines.

55. A topical proprioceptive kit for enhancing performance and/or reducing the risk of knee injury in a human subject, the kit comprising:

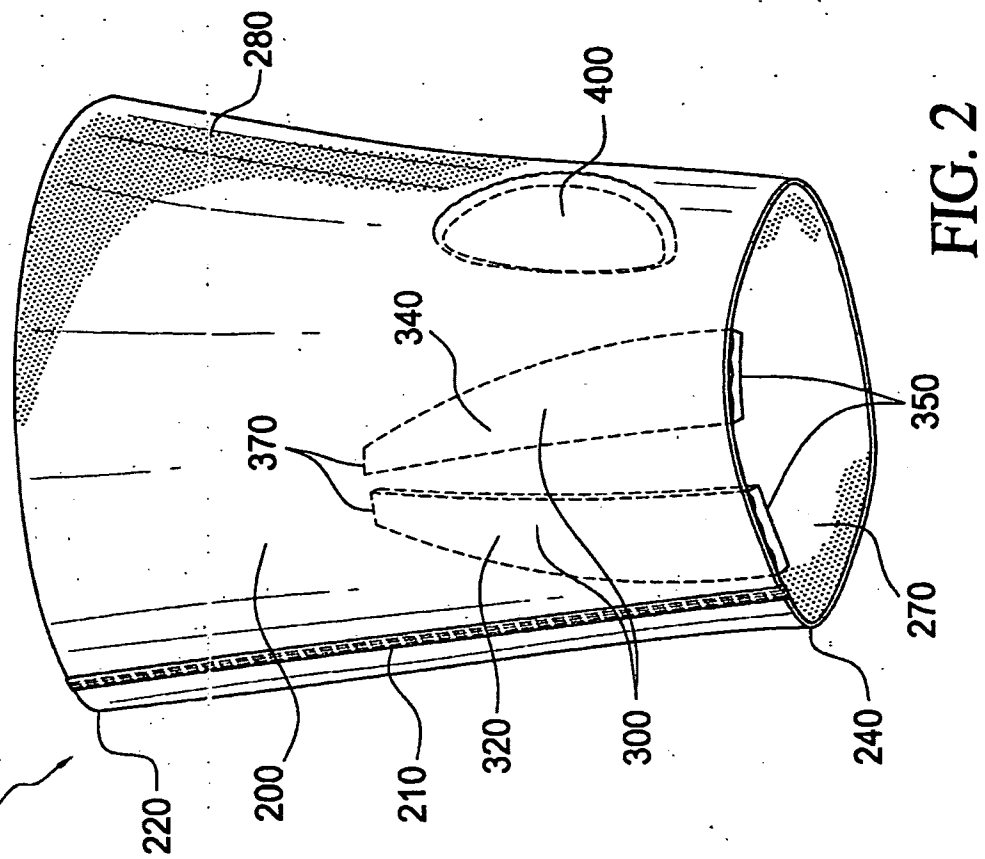
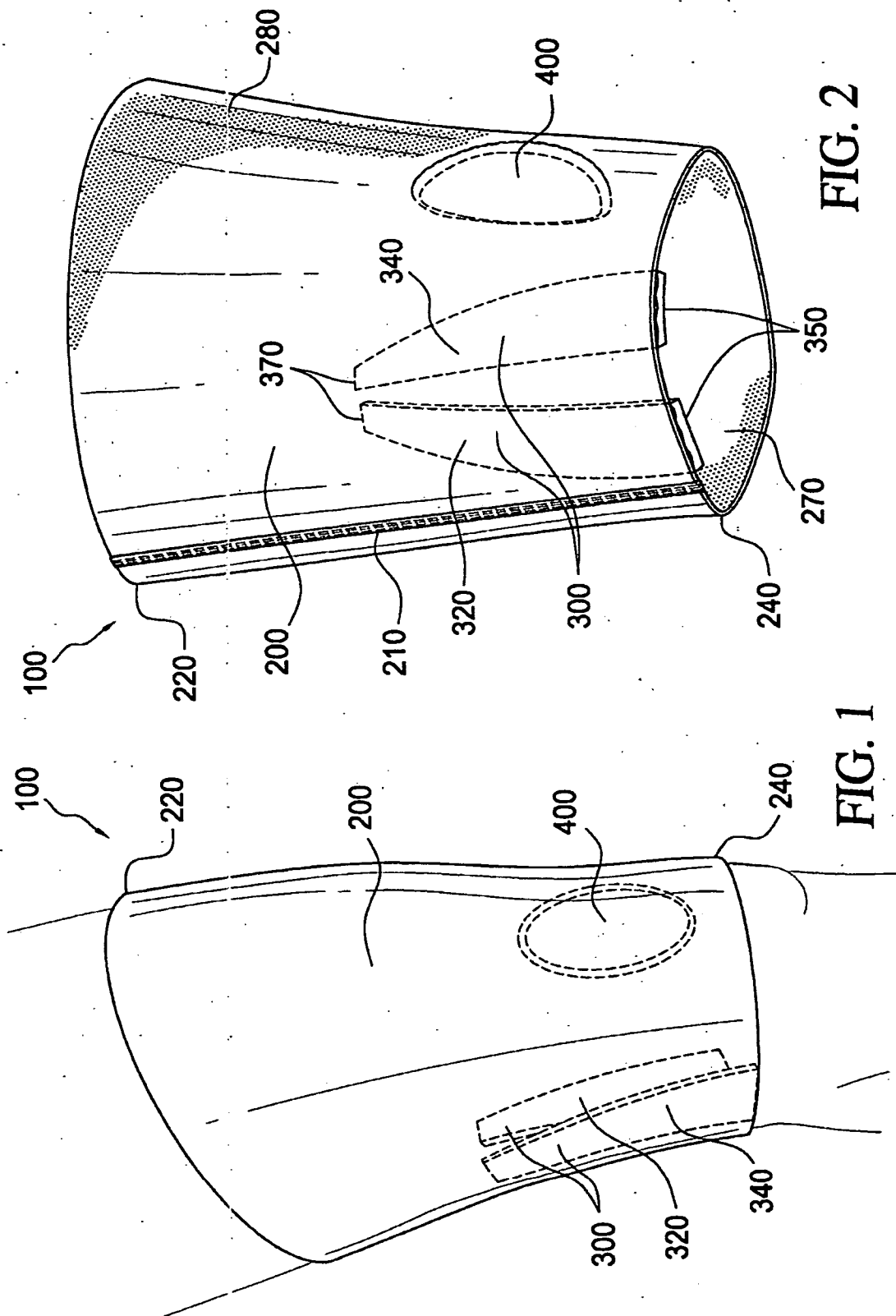
a flexible sleeve comprising an upper end and a lower end, the upper end and the lower end each having an interior and an exterior surface; and

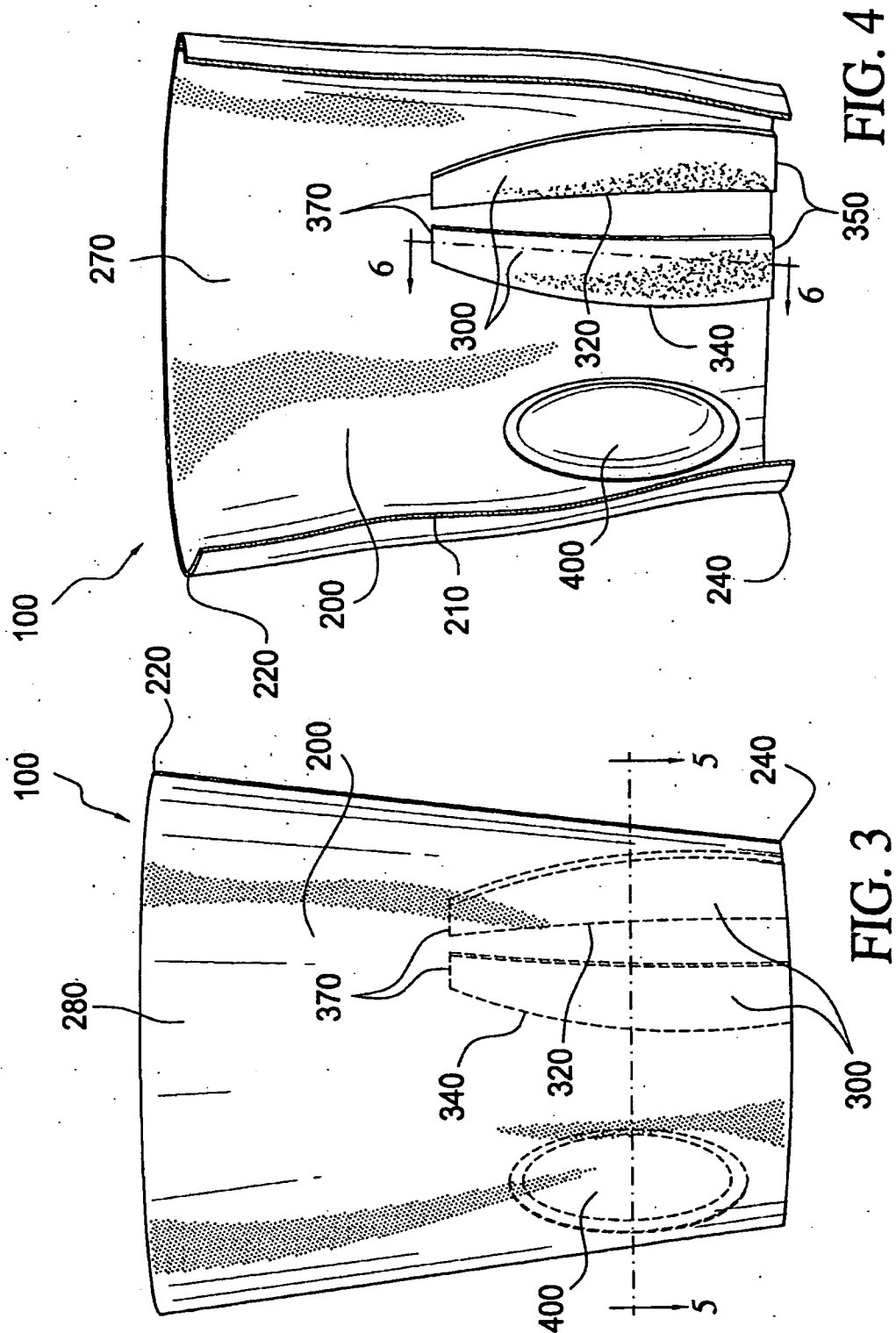
one or more hamstring buttresses having a base portion and an upper portion, the one or more hamstring buttresses configured to be coupled to the interior of the flexible sleeve such that the one or more hamstring buttresses cover at least a portion of one or more of the subject's hamstring muscles, the base portion being configured to be coupled towards

the lower end of the flexible sleeve and the upper portion being configured to be coupled towards the upper end of the flexible sleeve, wherein the one or more hamstring buttresses are configured to apply an amount of pressure to at least a portion of one or more of the subject's hamstring muscles when worn by the subject; or

one or more knee buttresses configured to be coupled to the interior surface of the flexible sleeve so that the one or more knee buttresses is over at least a portion of the subject's Vastus Medialis Obliquus (VMO), the one or more knee buttresses comprising: a pad comprised of resilient material, the pad being configured to apply an amount of pressure to the VMO when worn by the subject sufficient to enhancing performance and/or reducing the risk of knee injury in a human subject.

56. The topical proprioceptive kit according to claim 55, wherein, the kit comprises one or more hamstring buttresses and one or more knee buttresses.





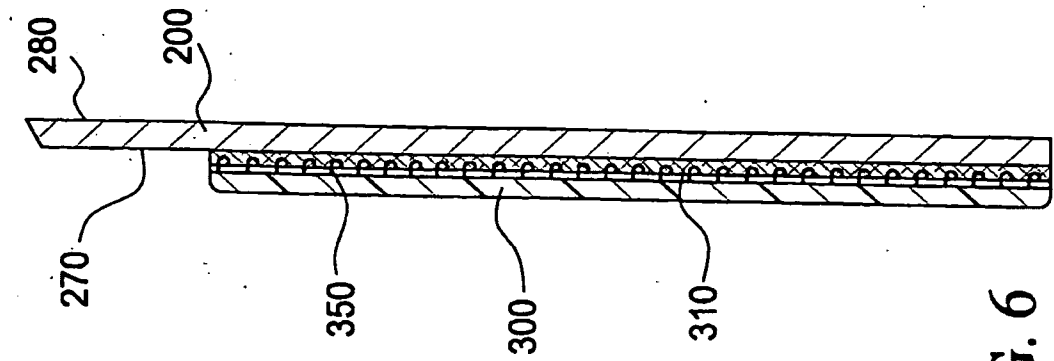


FIG. 6

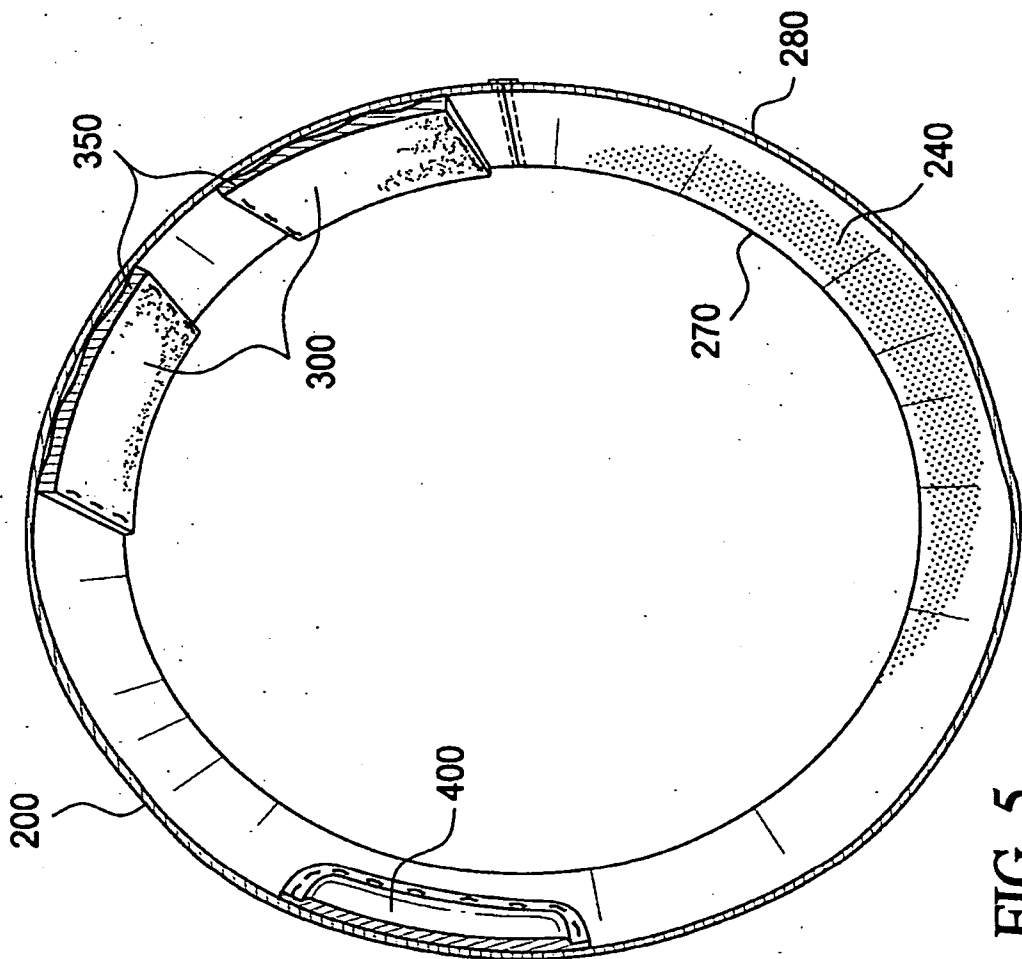


FIG. 5

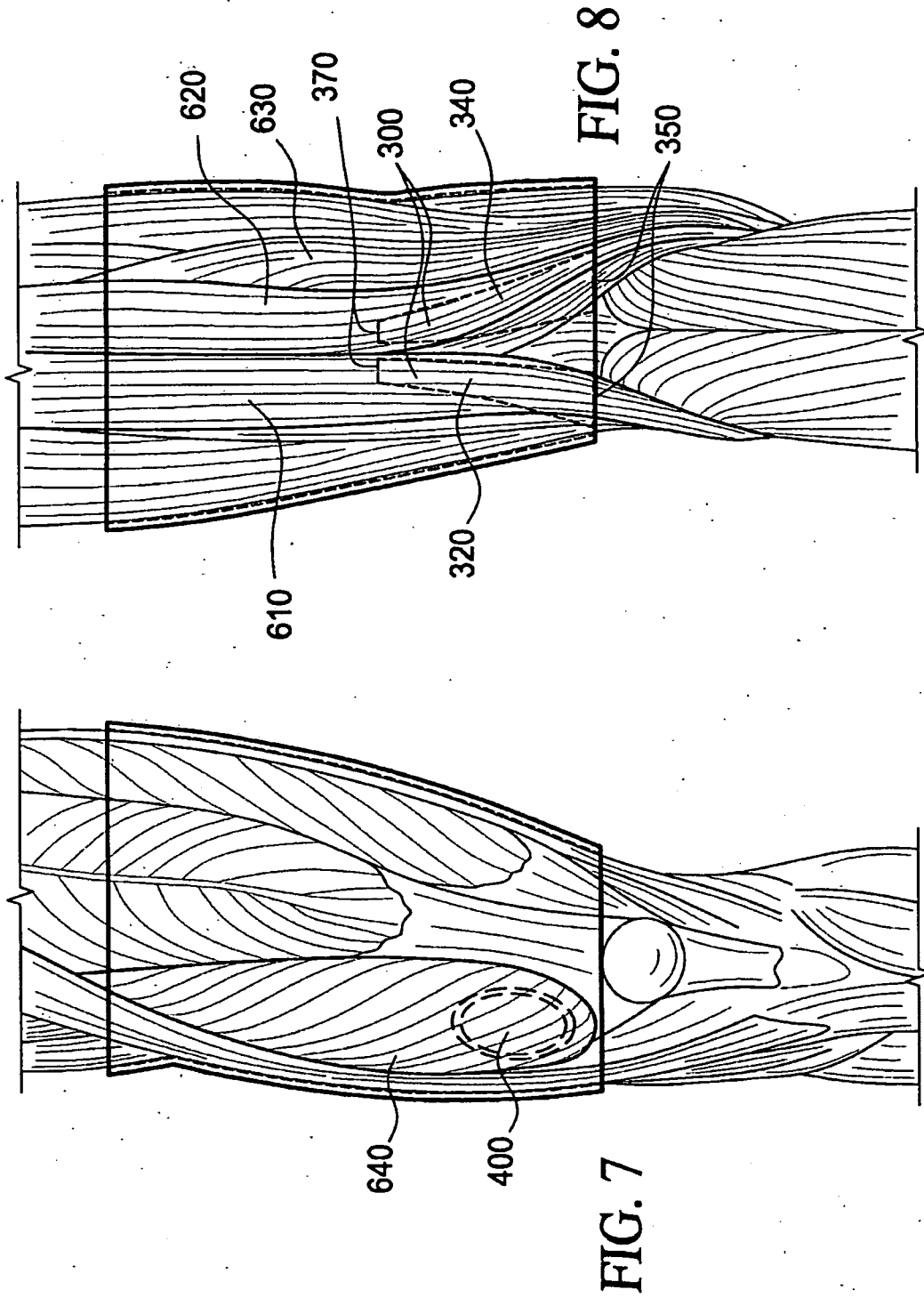


FIG. 9

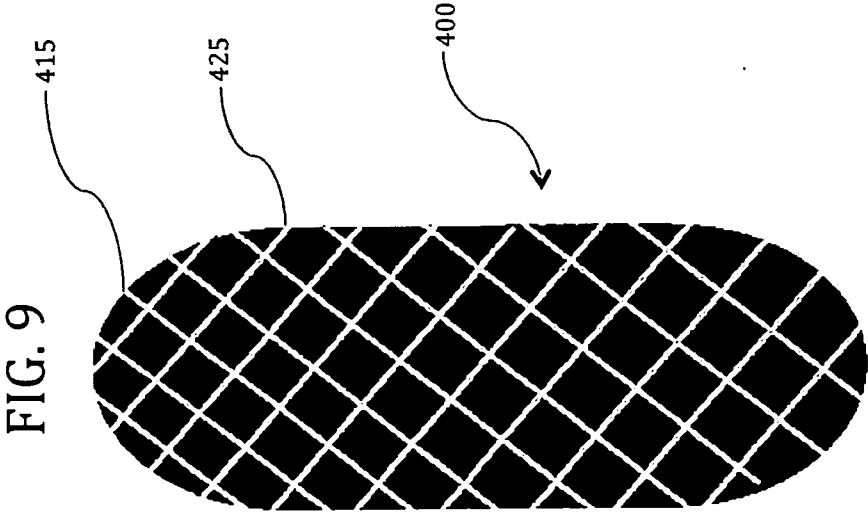
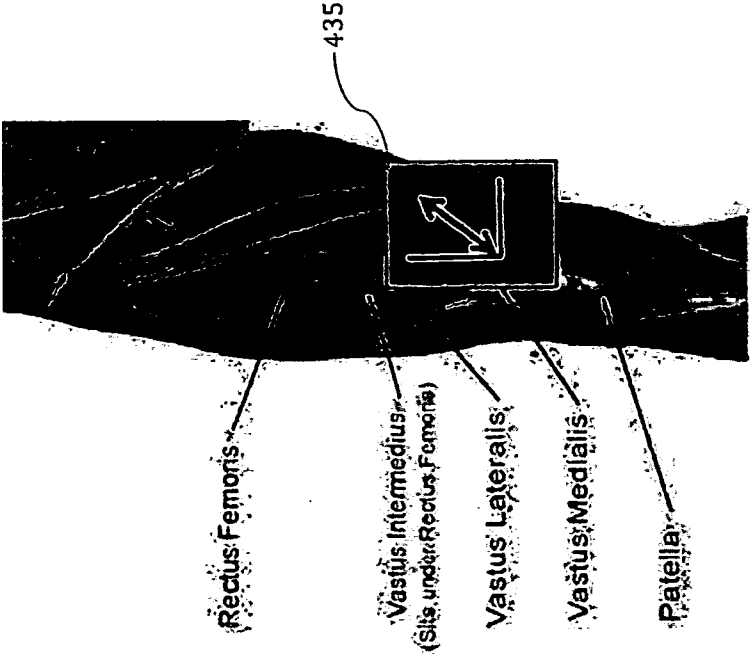
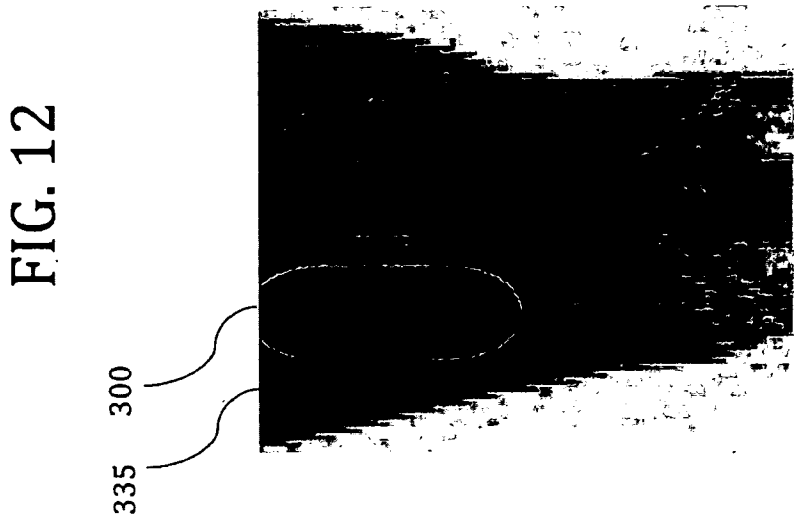
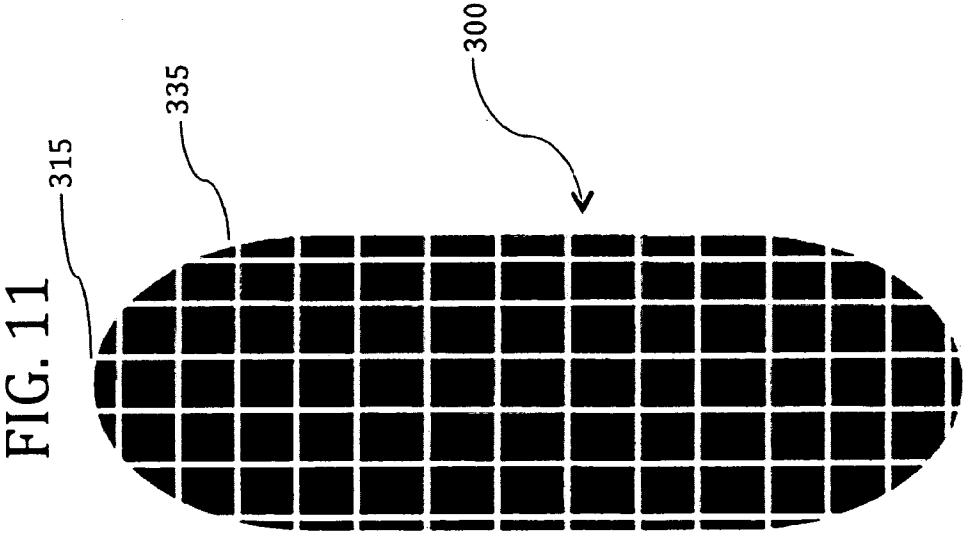


FIG. 10





INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/039748

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61F 5/01 (2012.01)

USPC - 602/23

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)

IPC(8) - A61F 5/00, 5/01, 5/02, 5/30, 5/32, 5/34 (2012.01)

USPC - 602/1, 5, 6, 12, 23, 26, 60, 61, 62, 63, 75

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)

PatBase; Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	DE 9417221 U1 (ROTHE) 05 January 1995 (05.01.1995) entire document	1-7, 12, 13, 15-29, 32, 37, 39-51, 55, 56
Y	US 2005/0261617 A1 (HALL) 24 November 2005 (24.11.2005) entire document	8-11, 14, 30, 31, 33-36, 38, 52-54
Y	US 4,084,584 A (DETTY) 18 April 1978 (18.04.1978) entire document	8, 9
Y	US 4,084,584 A (DETTY) 18 April 1978 (18.04.1978) entire document	10
Y	US 6,135,974 A (MATZ) 24 October 2000 (24.10.2000) entire document	11
Y	US 2007/0021699 A1 (BRAUNSTEIN et al) 25 January 2007 (25.01.2007) entire document	14, 30, 31
Y	EP 0 262 638 A2 (SCHIEBLER) 06 April 1988 (06.04.1988) entire document	33-36, 52-54
Y	US 5,267,928 A (BARILE et al) 07 December 1993 (07.12.1993) entire document	38
A	US 5,968,002 A (MORRISSEAU) 19 October 1999 (19.10.1999) entire document	1-56
A	US 2005/0154336 A1 (KLOECKER et al) 14 July 2005 (14.07.2005) entire document	1-56
A	US 2008/0125842 A1 (PETITT) 29 May 2008 (29.05.2008) entire document	1-56

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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

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"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

"&"

document member of the same patent family

Date of the actual completion of the international search

27 August 2012

Date of mailing of the international search report

21 SEP 2012

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Authorized officer:

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