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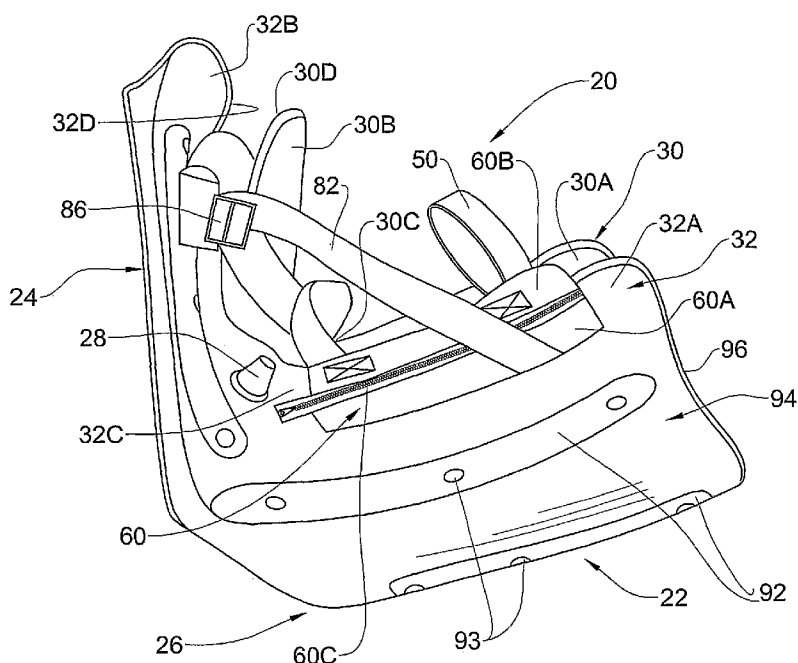
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(57) Abstract: An inflatable splint is presented. The splint comprises integral foot-accommodating portion, calf-accommodating portion and intermediate, ankle-accommodating portion. The splint is configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed. The splint has a collapsed state and has an open state in which it can be mounted on the leg part. When opened, the splint assumes the general form of the leg part.

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Inflatable Splint

FIELD OF THE INVENTION

The present invention relates to an inflatable splint which may be used, for example, in emergency situations, before and after surgical operations on the limbs, fractures, intensive care, and heel spurs.

BACKGROUND OF THE INVENTION

A splint is a medical device for the immobilization of limbs. It can be used by the emergency medical services or by volunteer first responders, to immobilize a fractured limb before the transportation; it is then a temporary immobilization. Splints can also be used by nurses and physicians in an emergency room, operation room, intensive care unit, or by a physiotherapist, via a physician's order, to support or immobilize an articulation (e.g. the ankle).

As many injuries and fractures to legs occur in locations that are distant from immediate, competent medical attention, and transportation of the injured person may be hazardous and painful resulting in further injury to the fractured leg, the splint should meet such requirements as size, ease of application and protection of the injured limb, to be capable of being folded into a compact small size that can fit into a first-aid kit to be easily carried in an ambulance or the like, and to be capable of being properly applied by a person other than a medical doctor and without further injury or damage to the broken leg. Various such splint devices have been developed. Examples of inflatable splint devices are disclosed in U.S. Patent No. 5,957,872, and in co-assigned PCT Application WO 2005/084136.

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SUMMARY OF THE INVENTION

The present invention is concerned with a new inflatable splint that includes novel features over those of known inflatable splints. The splint of the present invention is useable for fixation or support of a leg part. The leg part includes at least the lower
5 part of the leg ("lower leg") including at least the foot, the ankle and the calf, or the whole leg up to above the knee.

The inflatable splint of the invention includes either one continuous air pocket or a plurality of air pockets (tubes) that can be inflated, whereupon the splint assumes a cradle form for the lower limb in which it is relatively stiff, and can optionally assume
10 variable degrees of stiffness to be used as a leg fixation or support. The stiffness of the brace is varied according to the pressure of the inflation. When folded before inflation, the splint is a small flat package.

In the following, some embodiments of the invention are described. These embodiments may be applied separately or each embodiment may be applied in
15 combination with one or more of the other defined embodiments.

In accordance with one embodiment of the invention the splint is configured to have a collapsed or folded state and an open state and once opened the splint assumes the general form of the leg part. This is of advantage as once opened the splint is an immediate configuration for mounting on the leg. The splint may be inflated before or
20 after mounting. Also, at times the splint may be partially inflated before mounting and then inflated to a final desired degree, e.g. based on medical considerations, after mounting.

In accordance with this embodiment there is thus provided an inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an
25 intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint having a collapsed state and having an open state in which it can be mounted on the leg part; when opened the splint assumes the general form of the leg part.

30 As indicated above, the splint assumes the general form of the leg part (at least lower leg) once opened, both in its inflated and non-inflated state.

In accordance with another embodiment of the invention the splint is provided with a rigid foot floor-support panel and a foot cushion disposed above the panel. This

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imparts rigid support for the foot and more evenly distributed pressure on the foot, on the other hand.

In accordance with this embodiment there is thus provided an inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion, the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg are exposed; said foot-accommodating portion has a rigid floor-support panel and a foot cushion, typically although not exclusively, inflatable, disposed above said panel.

In accordance with another embodiment of the invention the splint is provided with adjustable fasteners which have one of their ends connected to the side of one of the splint's portions in a releasable arrangement. This permits rapid mounting of the splint over a patient's leg part.

In accordance with this embodiment there is thus provided an inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint portions having side surfaces that in use are disposed over sides of the leg part with edges that leave the front faces exposed; said side surfaces being provided with one or more first adjustable fasteners that link opposite side surfaces to one another; one end of the first fasteners being linked to an anchor member that is connected in a releasable arrangement to one of the side surfaces.

The releasable arrangement may include a zipper but may also include other types of arrangement such as that which includes a hook-and-pile couple (e.g. one known as "*Velcro*®") or any kind of quick release buckle, one of which is on a member connected to said end of the fastener arrangement and the other to said one of the sides surfaces.

The first fasteners, in the above embodiment, are typically disposed on side surfaces of the calf-accommodating portion. In some embodiments of the invention, one or more second fasteners are provided that link opposite side surfaces of the foot-accommodation portion.

In accordance with another embodiment of the invention a novel outrigger stabilizer member is provided that can be attached to the splint in a detachable manner

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for inhibiting axial rotation of a fixed patient's leg. The outrigger attachment controls the limb axis rotation.

In accordance with this embodiment there is thus provided an inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint having a collapsed state and having an open state in which it can be mounted on the leg part; the splint being provided with an outrigger stabilizer member configured for attachment in a detachable manner to a bottom face of the foot-accommodating portion and having an edge that once connected is positioned at the rear of the foot-accommodating portion, and projects laterally from the splint.

A typical detachable arrangement is through a hook-and-pile couple arrangement. Typically, said outrigger stabilizer member has an attachment surface that extends lengthwise over a substantial part of the bottom face. For example, the attachment surface of the outrigger stabilizer member may be fitted with one member of the hook-and-pile couple, and the other member of said couple being disposed on said bottom face. According to some embodiments of the invention, the outrigger stabilizer member comprises a tongue that extends rearwards from said edge and is configured for attachment to an attachment surface in the rear face of the ankle-accommodating portion of the splint.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figs. 1-3 shows a splint in accordance with an embodiment of the invention in which Fig. 1 shows the splint in a closed state, Fig. 2 shows the splint, in a non-inflated state, and Fig. 3 shows the splint in an inflated state.

Fig. 4A is a partial longitudinal cross-section through the lower parts of the splint according to an embodiment of the invention, open and in a non-inflated state.

Fig. 4B is a partial cross-section through the lower part of a splint fitted with a heel raise pad.

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Fig. 4C illustrates an inflatable splint according to an embodiment of the invention having a heel raise pad and pad extensions along the sides of the inner surface of the foot-accommodating portion.

Fig. 5 is a partial transverse cross-section through the lower part of the splint of **Fig. 4A**, in an inflated state.

Fig. 6 is a splint according to an embodiment of the invention in which the bottom of the foot-accommodating portion has a pocket for holding a folded outrigger stabilizer member shown removed from the pocket.

Fig. 7 shows the outrigger in an open, unfolded state.

Fig. 8 is a side perspective view of a splint, in an inflatable state, fitted with an outrigger member.

Fig. 9 shows a view from the direction of arrow XI in **Fig. 8**.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

Exemplary embodiments of the invention are shown in and described with reference to **Figs. 1-9**. As will be appreciated, these embodiments while being shown for purpose of illustration of the various features of the invention as claimed herein, is non-limiting and various modifications of this embodiment, as will be clear to a person versed in the art, are possible.

Shown in **Figs. 1-3** is a splint generally designated as **20** having a body including a calf-accommodating portion **22**, a foot-accommodating portion **24** integrally formed and linked together through an intermediate ankle-accommodating portion **26**. In the closed state shown in **Fig. 1**, the splint is folded about the heel part of the ankle-accommodating portion **26** to assume a relatively compact configuration of a small flat package in which it can be stored until use.

As can be seen in **Fig. 2**, the splint includes a filling nozzle to permit introduction of inflation fluid, which may be a liquid or a gas, typically air. The advantage of using a gas is that even while fully inflated, inflated pockets in the splint, to be described below, will have some residual flexibility and a cushion effect. A liquid as an inflation fluid may be useful, for example, for applications in which a cooling effect is desired. Furthermore, the filling with a liquid will render the inflated splint to

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be heavier than the case of a gas, such as air, such weight being of advantage for one application while light weight of a gas-inflated splint being advantageous for others.

In **Fig. 2** the splint is shown in an open, yet non-inflated state. As can be seen in this figure, once opened the splint has already a general boot-like form in which in can be fitted over the leg part (lower leg in the present example). In this form the calf-accommodating portion **22** is essentially normal to the foot-accommodating portion **24**. Upon inflation with a fluid, typically, although not exclusively, air, as shown in **Fig. 3**, the splint becomes rigid. In an inflated state the fluid containing pockets of the splint expand outwards and also towards the splint interior whereby they create a supporting cradle for the subject's leg.

As can be seen in **Figs. 2 and 3**, the splint is formed with side surfaces that include a right side surface **30** and a left side surface **32**, each of which being provided with respectable first side surfaces **30A** and **32A**, which can fit over the sides of a subject's calf, second respective side surfaces **30B** and **32B**, which are intended to fit over sides of a foot and intermediate respective side surfaces **30C** and **32C**, fitting over sides of the ankle. The side surfaces have respective edges **30D** and **32D** that define therebetween an open space for exposure of front faces of the leg part.

The splint shown in **Figs. 1-3** is provided, in this specific embodiment, with a number of inflatable tubes, in fluid communication with one another, such as that disclosed in WO 2005/084136, the content of which is incorporated herein by reference. Thus, all air pockets can be inflated through fluid ingress through nozzle **28**. As will be appreciated the position of the nozzle **28** is but an example and the nozzle may be positioned in any suitable place in the splint.

Reference is now being made to **Figs. 4A and 5**, where **Fig. 4A** is a partially longitudinal cross-section of the splint in a non-inflated state and **Fig. 5** is a transverse cross-section through the sole portion (foot-accommodating portion) **24** in an inflated state of the same splint. As can be seen in **Figs. 4A and 5**, the foot-accommodating portion **24** is provided with a rigid floor support panel **40** overlaid with a foot cushion **42** which in accordance with one embodiment of the invention is inflatable. However, it should be noted that the foot cushion may be formed also, for example, from a flexible, non-inflatable matrix, typically covered or completely enclosed within a sheet which may be made of a cloth, liquid impermeable polymer, etc.

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As can be seen in **Figs. 4B and 4C**, the splint may also be provided with an optional heel raise pad **43**, placed immediately behind and bordering on the special heel depression in the nylon of the heel portion, and possibly also pad extensions **44** along the sides of the inner surface of the foot-accommodating portion **24** which protect the heel and the borders of the foot from pressure injury. The heel raise pad (e.g. with its extensions) may be inflatable or may be made from a soft flexible non-inflatable matrix. In Fig. 4B, pad **43** is shown as raising the heel part in lower leg **45**. In accordance with one embodiment the pad **43** is fixed within the splint. In accordance with another embodiment the pad is removable.

As can be seen in **Figs. 2 and 3**, the first side surfaces **30A** and **32A** are connectable to one another through two length-adjustable straps **50** and **52**. It should be appreciated that the adjustable straps are one of many examples of fasteners that may be used for connecting the two side surfaces to one another, such as for example, strings, laces and others. Furthermore, as can be appreciated, the number of straps or other fasteners may be different than two; there may be one fastener according to some embodiment or a plurality, more than two fasteners according to others.

Fasteners **50** and **52** are fixed at one of their ends to an anchor member **60**, which is secured at side surface **32A** and connected at their other end to side surface **30A** through buckles **62** and **64**. In use, the straps **50** fit over the front face of a subject's calf and ankle and serve to secure the splint in position.

Anchor member **60** is a two part member consisting of parts **60A** and **60B** releasably connected to one another through zipper **60C**. Through opening of zipper **60C** the part **60B** with the associated straps can be released to permit easy fitting of the splint onto a subject's leg and then after fitting rapid securing of the straps over the subject's front leg surfaces. The rapid application arrangement, such as one comprising a zipper **60C** is especially important in long leg versions of the splint. The straps **50** and **52** are connected and are length adjustable through respective buckles **62** and **64**. As will be appreciated a buckle arrangement is one of many length adjustable fastening arrangements known *per se*.

It should be noted that the use of a zipper is only one option for releasable anchor arrangement and other arrangements such as that which make use of a hook and pile couple, are possible.

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Optionally, the splint is provided also with an adjustable fastening arrangement for linking second side surfaces **30B** and **32B**. As can be seen in **Fig. 3**, provided is a strap **70** that links the two side surfaces which is fixed to side surface **32B** and adjustably connected through buckle **72** to side surface **30B**.

5 Another feature according to a preferred embodiment of the invention is an adjustable strap that links the foot-accommodating portion and the calf-accommodating portion for dorsiflexing of the ankle joint. This can be seen in **Figs. 2 and 3** where straps **80** and **82** are provided which are fixed to the upper part of first side surfaces **30A** and **32A** and are adjustably fitted through respective buckles **84** and **86** to side surfaces
10 **30B** and **32B**. Straps **80** and **82** are operative to maintain the ankle at neutral position, e.g. about 90 degrees, or when desired they can be tightened to dorsiflex the ankle creating tension in the heel cord and the plantar fascia of the sole of the foot.

Typically, the splint body is formed from two parallel polymeric sheets and the air pockets within the splint are formed through a series of spaced apart welds that
15 define inflatable air pockets **90** between them, separated by non-inflatable portions, such as portions **92**. These non inflatable portions are perforated by a series of ventilation holes **93**. In accordance with an embodiment of the invention the welds are designed such as to provide a continuous inflatable portion **94** adjacent the splint's upper rim **96**. Preferably, as can be seen also in the embodiment herein, the continuous
20 inflatable portion adjacent to the rim also extends along rims of the side portion **30**.

The body may be made of any suitable weldable material of a kind that can withstand the required pressure of the fluid within the inflatable portions without rupturing. In some embodiments of the invention the gas pressure is around 0.25 atmospheres and may reach as high as 1 atmosphere without leakage of gas. In
25 accordance with some embodiments of the invention, the splint body is made of nylon coated with polyurethane.

The fasteners may be fixed to the splint body through a number of arrangements, among others depending on the material of the splint body and that of the fasteners. In the specific embodiment where the splint body is made from a polymeric material and
30 the straps from a woven material, a typical, but not exclusive, manner of securing may be by sewing.

Figs. 6-9 show an embodiment of the invention in which use is made of an outrigger stabilizer member **100**. In **Figs. 6, 8 and 9** like reference numerals to those of

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Figs. 1-3 are used, shifted by 200 to designate similar components. In the shown example, the outrigger member **100** is substantially rigid and is foldable about line **102** into a folded state as can be seen in **Fig. 6**. In **Fig. 6**, splint **220** is shown in a partial folded state. Splint **220** seen in **Fig. 6** is provided with a pocket with a rear-end opening **104**, formed in the bottom of the foot-accommodating portion **222**. In a typical example, the pocket is a lengthwise space below the floor-support panel **240**.

The outrigger member **100**, has in the shown exemplary embodiment, and overall trapezoidal shape and is provided with an attachment device **106** which is designed for attachment to a corresponding attachment device **108** at the bottom of the leg accommodating portion **222** of the splint **220**. By a specific example, devices **106** and **108** are a hook-and-pile couple. The outrigger member **100** is preferably provided with a tongue **110**, extending from the rear edge **116**, having an attachment device **112**, for attaching to a corresponding attachment device **114**, in the rear face of the ankle-accommodating portion **226** shown in **Fig. 8**.

Figs. 8 and 9 show the outrigger in its operative position being attached to the bottom face of the foot-accommodating portion with its rear edge **116**, being essentially aligned with the heel part of the ankle-accommodating portion **226** or slightly projecting in a rearward direction from the rear end of the bottom of the foot-accommodating portion (e.g. a 3-5 cm), and projecting laterally from the two sides of the splint. The tongue member **110** prevents the outrigger **100** from being torn off when the leg is moved, particularly when the leg is drawn up by flexing the thigh. The outrigger stabilizes the whole leg in neutral rotation and prevents the leg from rolling out or inwards. This is of particular importance in injuries of the thigh and hip.

The embodiment shown herein is designed for supporting the leg and the ankle. As will be appreciated, the invention also applies to inflatable splints for different purposes, such as one intended to support an entire leg and parts of or the whole of the upper limb.

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CLAIMS:

1. An inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint having a collapsed state and having an open state in which it can be mounted on the leg part; when opened the splint assumes the general form of the leg part.
2. An inflatable splint according to Claim 1, which assumes the general form of the leg part in both inflated and non-inflated state.
3. An inflatable splint according to Claim 1 or 2, wherein said foot-accommodating portion has a rigid floor-support panel and a foot cushion disposed above said panel.
4. An inflatable splint according to Claim 3, wherein said foot cushion is inflatable.
5. An inflatable splint according to Claim 3 or 4, comprising a pocket defined under the foot panel for accommodating at least one splint accessory.
6. An inflatable splint according to Claim 5, wherein said accessory is an outrigger stabilizer for attachment to the splint to hinder axial rotation of the leg.
7. An inflatable splint according to any one of preceding Claims, wherein the splint portions have side surfaces that in use are disposed over sides of the leg part with edges that define therebetween the exposed front faces, said side surfaces being provided with one or more first adjustable fasteners that link opposite side surfaces to one another; one end of the first fasteners being linked to an anchor member that is connected in a releasable arrangement to one of the side surfaces.
8. An inflatable splint according to Claim 7, wherein said releasable arrangement is a zipper or a hook-and-pile couple or a quick release buckle.
9. An inflatable splint according to Claim 7 or 8, wherein said first fasteners are disposed on side surfaces of the calf-accommodating portion.
10. An inflatable splint according to Claim 9, comprising one or more second fasteners that link opposite side surfaces of the foot-accommodating portion.
11. An inflatable splint according to any one of Claims 6 to 10, wherein said outrigger stabilizer member is configured to be attachable to the splint in a detachable manner, and configured for attachment to a bottom face of the foot-accommodating

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portion, the outrigger stabilizer member having an edge that once connected is position at the rear of the foot-accommodating portion and projects laterally from the splint.

12. An inflatable splint according to Claim 11, wherein the detachable attachment is through a hook-and-pile couple arrangement.

5 13. An inflatable splint according to Claim 12, wherein said outrigger stabilizer member has an attachment surface that extends lengthwise over a substantial part of said bottom face.

14. An inflatable splint according to any one of Claims 11-13, wherein said outrigger stabilizer member comprises a tongue extending rearwards from said edge and
10 being configured for attachment to an attachment surface in a rear face of the splint.

15. An inflatable splint according to any one of Claims 11-14, wherein said outrigger stabilizer member is foldable.

16. An inflatable splint according to Claim 15, comprising a pocket for accommodating said outrigger stabilizer member.

15 17. An inflatable splint according to any one of preceding Claims, comprising adjustable straps between the foot-accommodating portion and the ankle portion for dorsiflexing the ankle joint.

18. An inflatable splint according to any one of preceding Claims, comprising inflatable and non-inflatable portions, said inflatable portions being designed to
20 withstand pressures of up to 1 atmosphere without gas leakage or bursting.

19. An inflatable splint according to Claim 18, wherein at least said inflatable portions are made of nylon coated with polyurethane.

20. An inflatable splint according to any one of Claims 1-10, comprising an inflatable cushioned heel raise support pad.

25 21. An inflatable splint according to Claim 20, comprising foot border protection pads.

22. An inflatable splint according to Claim 20 or 21, wherein the pad is non-inflatable.

23. An inflatable splint according to any one of Claims 20 to 22, wherein the pad is
30 fixed within the splint.

24. An inflatable splint according to any one of Claims 20 to 22, wherein the pad is removable.

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25. An inflatable splint according to any one of preceding Claims, comprising inflatable and non-inflatable portions, said inflatable portions defining a substantially continuous inflatable belt adjacent an edge of the splint.

26. An inflatable splint according to Claim 23, wherein said inflatable portions
5 define a substantially continuous inflatable belt adjacent an upper edge of the splint.

27. An inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion, the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; said foot-accommodating portion having a rigid
10 floor-support panel and a foot cushion disposed above said panel.

28. An inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint portions having side surfaces that in
15 use are disposed over sides of the leg part with edges that define therebetween the exposed front faces; said side surfaces being provided with one or more *first adjustable* fasteners that link opposite side surfaces to one another; one end of the first fasteners being linked to an anchor member that is connected in a releasable arrangement to one of the side surfaces.

20 29. An inflatable splint comprising integral foot-accommodating portion, a calf-accommodating portion and an intermediate, ankle-accommodating portion; the splint being configured to be fitted over a leg part comprising a foot, ankle and calf such that front faces of the leg part are exposed; the splint having a collapsed state and having an open state in which it can be mounted on the leg part; the splint being provided with an
25 outrigger member attachable to the splint in a detachable manner, the outrigger member configured for attachment to a bottom face of the foot-accommodating portion and having an edge that once connected is position at the rear of the foot-accommodating portion, and projects laterally from the splint.

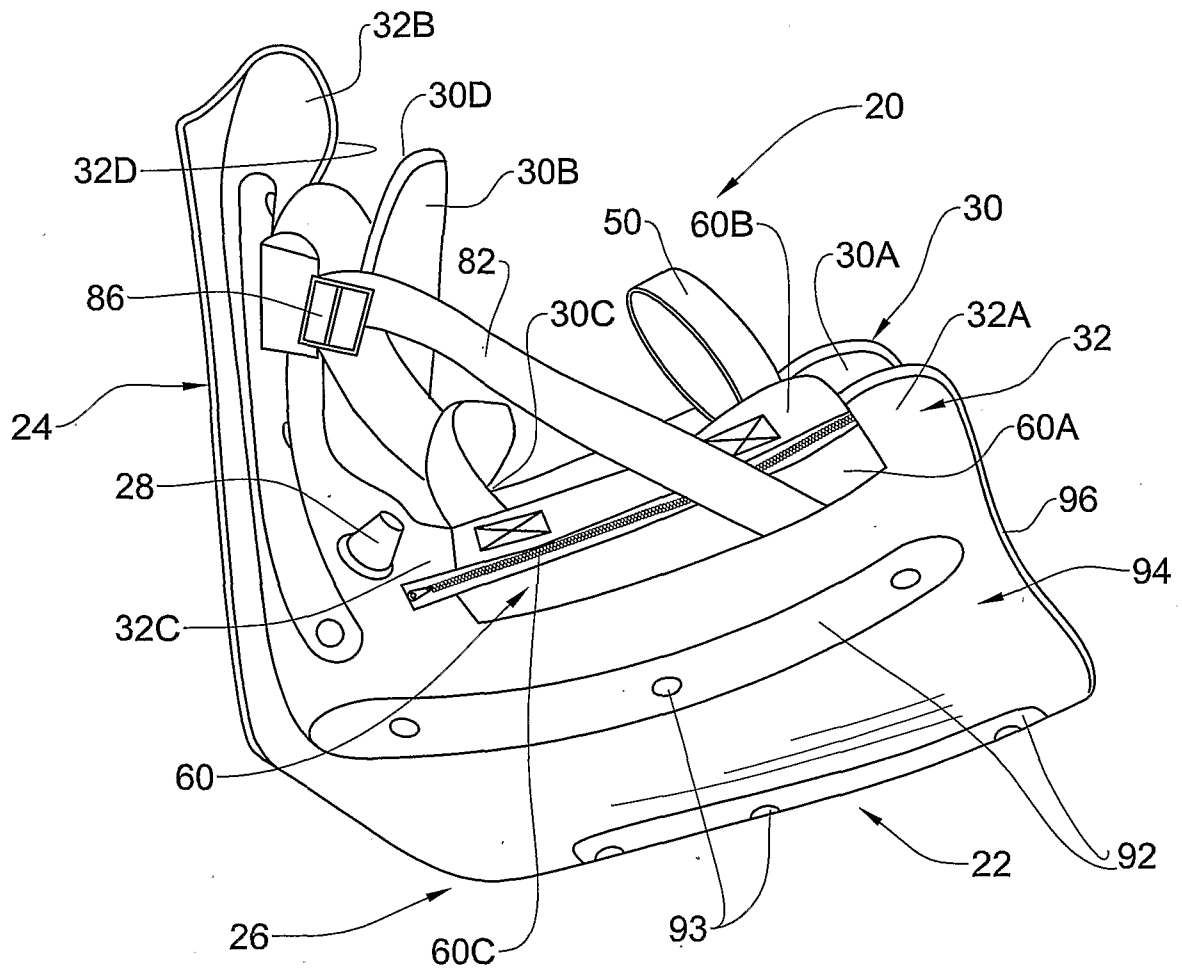
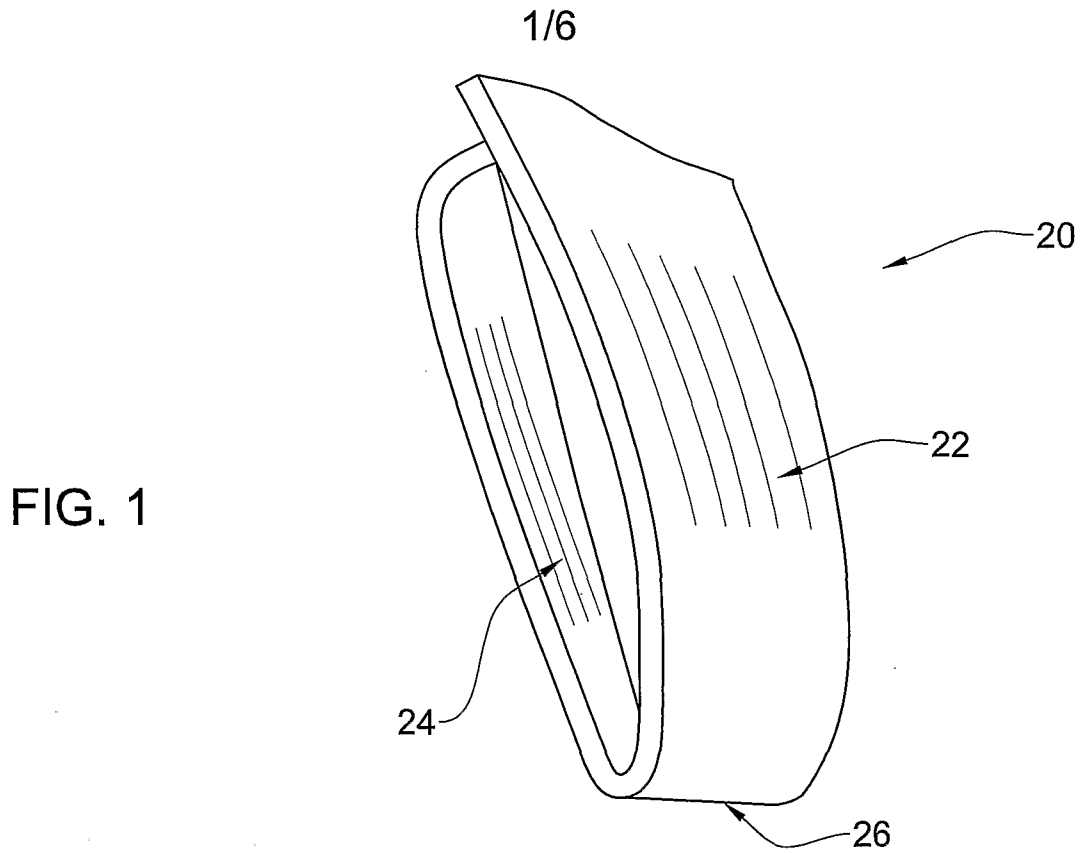


FIG. 2

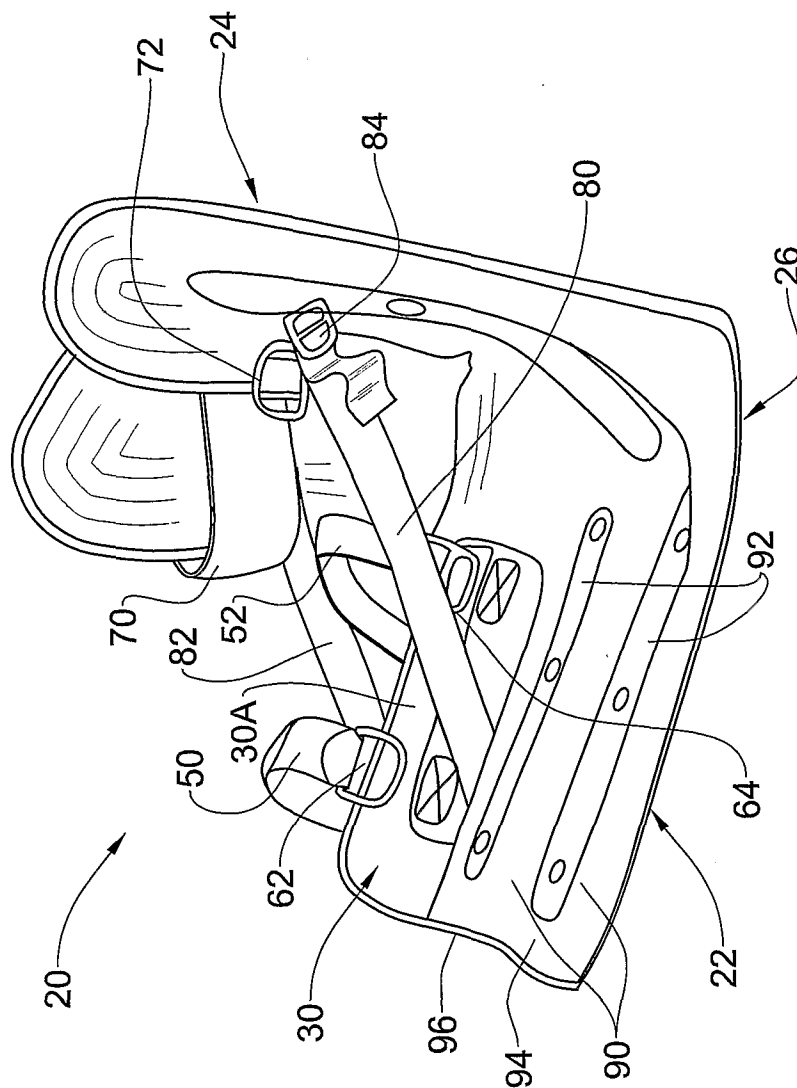


FIG. 3

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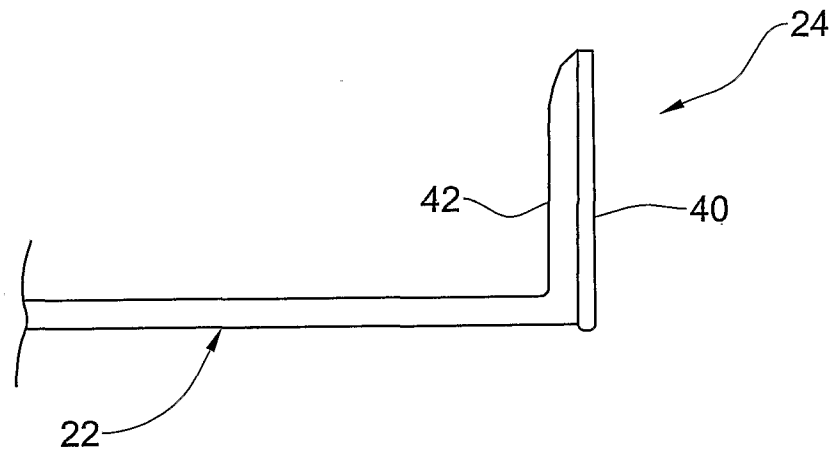


FIG. 4A

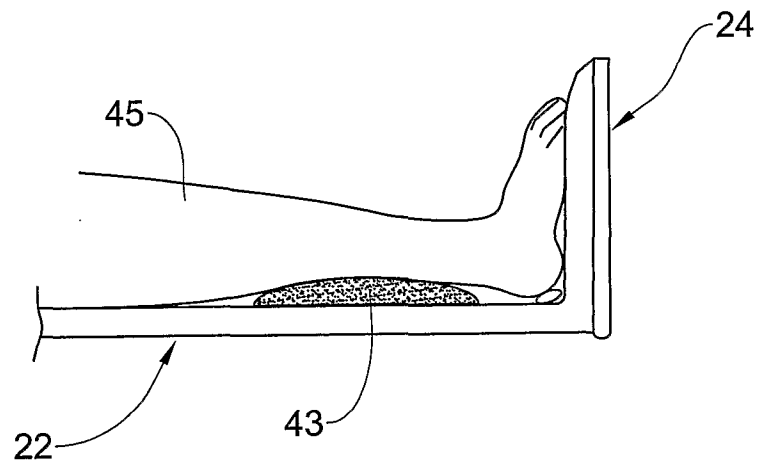


FIG. 4B

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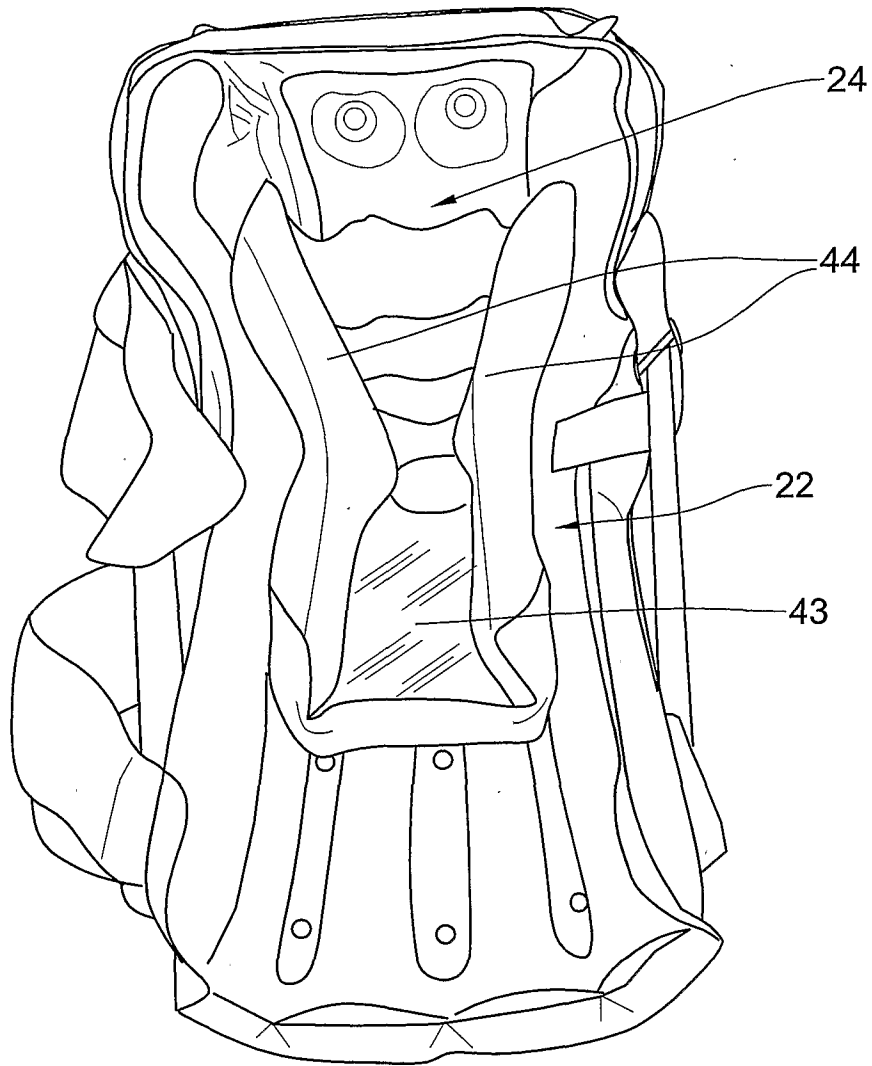


FIG. 4C

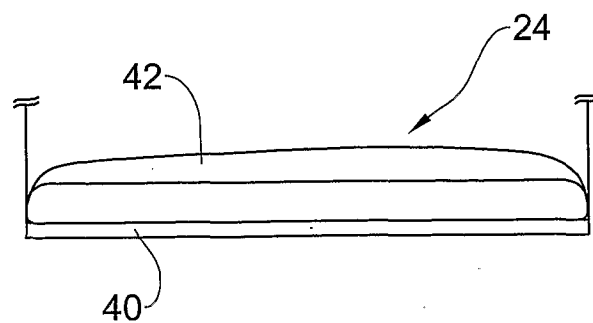


FIG. 5

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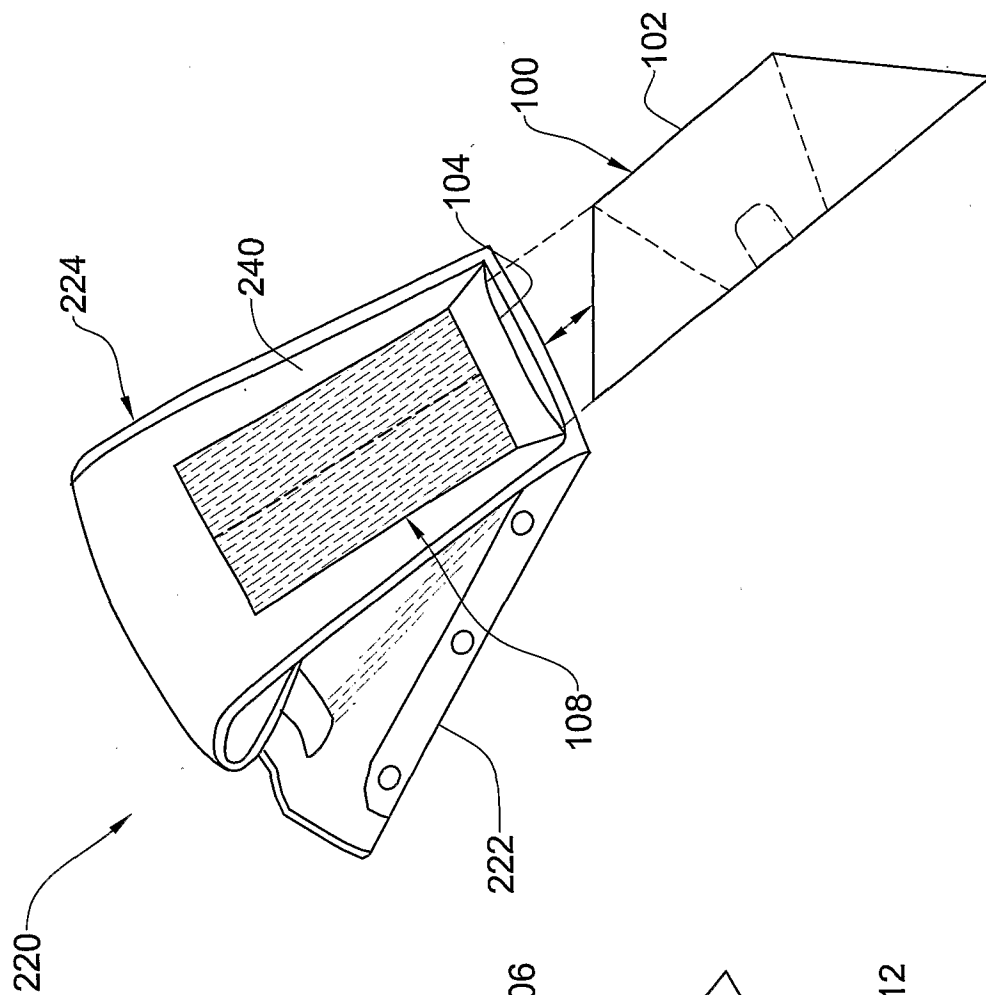


FIG. 6

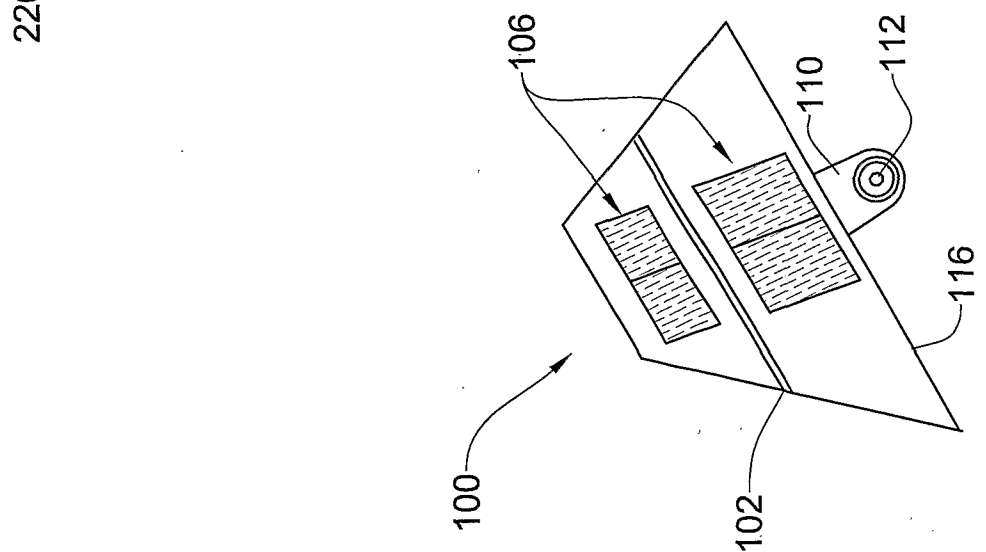


FIG. 7

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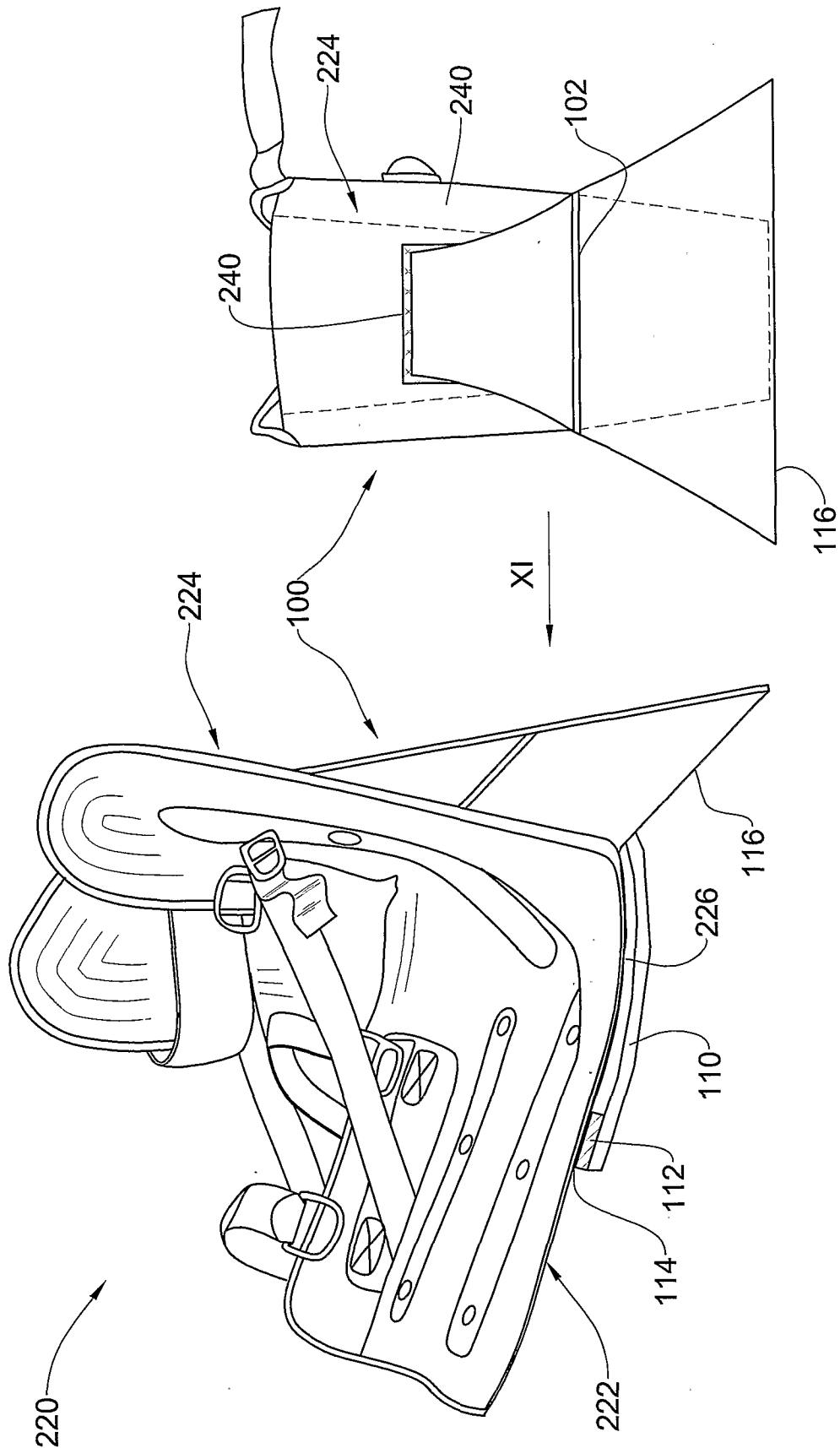


FIG. 9

FIG. 8