Nov. 7, 1967 M. GOTTFRIED 3,351,055

PRESSURE BANDAGE-SPLINT AND METHOD OF FORMING SAME

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FIG. 2

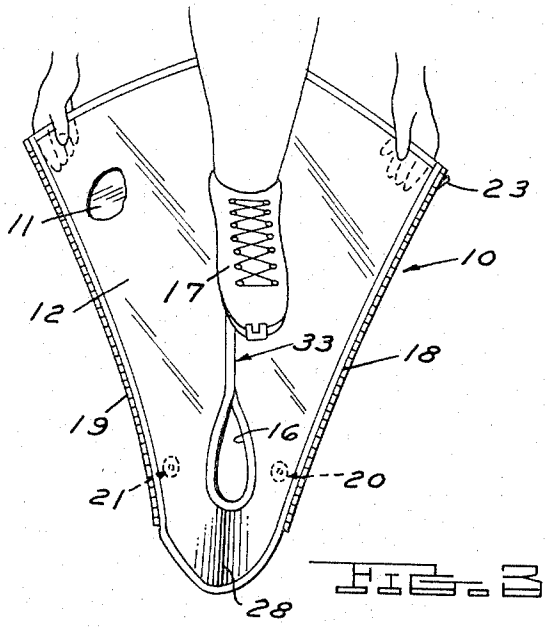



FIG. 1

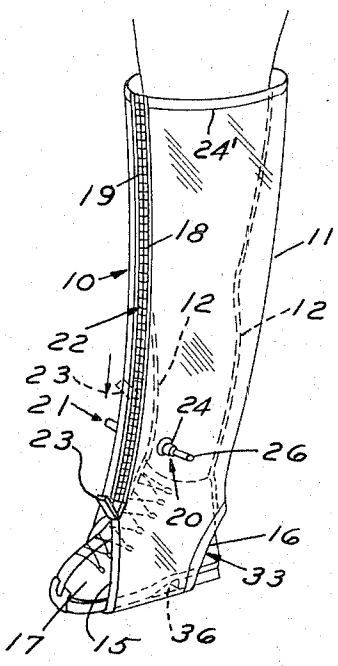



FIG. 3

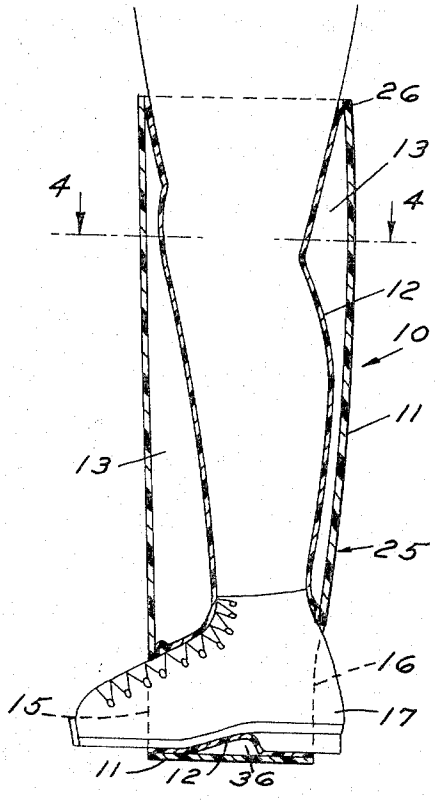
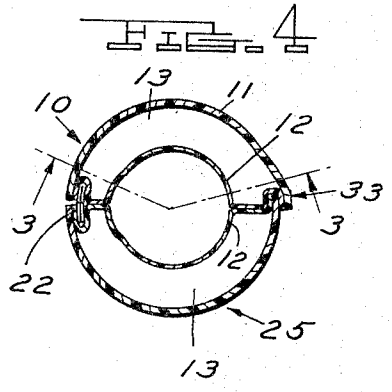



FIG. 4




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PRESSURE BANDAGE-SPLINT AND METHOD OF FORMING SAME

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FIG. 5

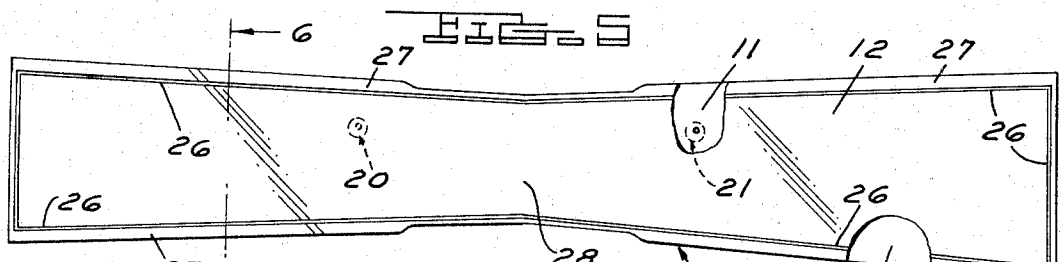



FIG. 7

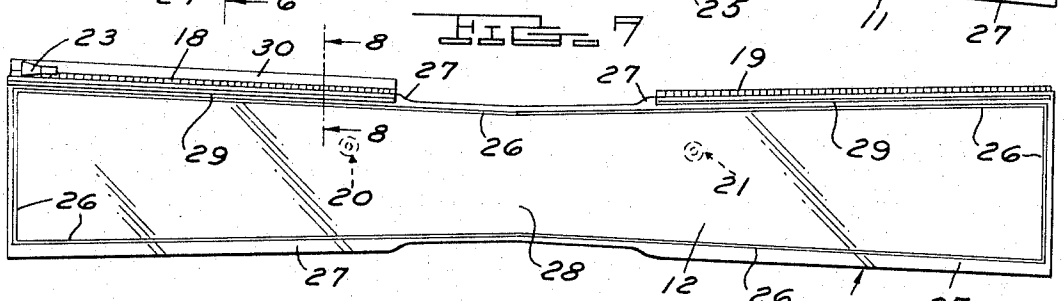



FIG. 9

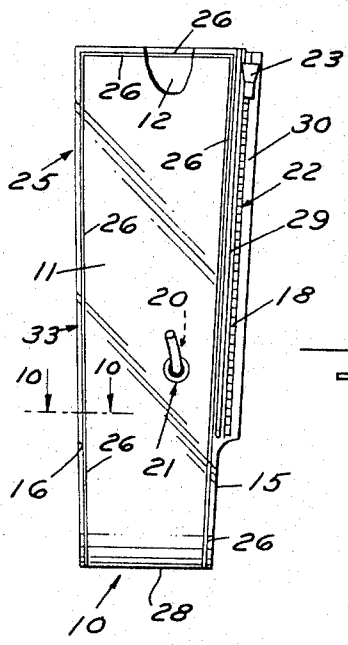



FIG. 8

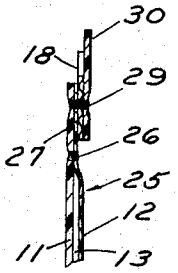



FIG. 10

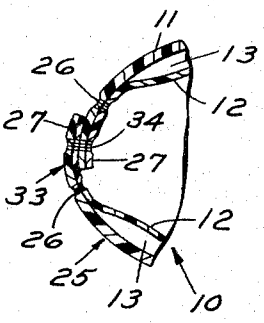
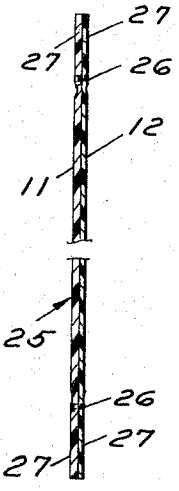



FIG. 6




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3,351,055

# PRESSURE BANDAGE-SPLINT AND METHOD OF FORMING SAME

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Filed Nov. 26, 1963, Ser. No. 326,108
9 Claims. (Cl. 128—87)

The present invention relates to an improved, pneumatically inflatable pressure bandage-splint structure, and, more particularly, to such a splint for use in the emergency immobilizing of a limb fracture, such as the commonly occurring boot top fracture of skiers, and under a universally observed procedure which forbids the removal of the skier's boot at the location of the accident. However, as will be apparent as the present description proceeds, the pneumatically inflatable pressure bandage and splint combination is capable of more general usage for the immobilizing of other injured body members, when ease and speed in doing this without appreciable movement of the injured part are important considerations.

Generally, it is an object of the invention to provide a mouth-inflatable splint of the above description for immobilizing limb fractures, in particular ski fractures, which can be applied to the injured part over the patient's clothing, for example, without removing a ski boot, which itself in effect becomes a component of the splint structure by bracing the limb extremity and preventing chilling thereof after the immediate accident shock. As utilized in such an application the applied and air inflated splint not only holds the fracture against movement but also keeps the limb warm due to the substantial insulating air layer surrounding the limb.

More particularly, the invention contemplates an inflatable air splint for quick and easy application to an injured leg which is of a double-walled envelope construction having hermetically sealed walls containing the air under pressure, and which nevertheless is provided with openings to receive the toe and heel of the injured persons's ski boot. Provisions are made to equip corresponding margins of the envelope adjoining one of said openings with slide fastener means, enabling the splint to be applied to the injured limb, in an open condition along such margins, without significantly moving the limb, then closed about the limb by manipulation of the zipper fastening means prior to inflation to complete the splint.

The result of these arrangements is to provide a double-walled splint which will receive the toe and heel of the ski boot, in which zones splinting is unnecessary in any event, thus minimizing to this degree the amount of air necessary to thoroughly inflate the splint, which is a consideration of some significance when the emergency treatment is performed at high altitude and in thin air.

Further in accordance with the objective of the invention, the zipper fastening means mentioned above is arranged on the margins of the splint envelope in such fashion that its movable zipper element is moved toward the toe or heel opening which the fastener means adjoins, rather than away from said opening to the opposite end of the splint envelope. Because of this, the fastener means may be joined to any length downwardly along the splint margins which is desired, and which will of course vary with ski boots of different instep and ankle design or proportioning. Thus, the inner wall of the inflatable two-walled splint envelope may, when the splint is inflated, take full engagement with the injured limb down to the ski boot. This is a reversal of the normal orientation of zipper fasteners, the movable element of which usually operates along adjoining margins from a fixed meeting point of such margins to a terminal point at which they are to be fully released from one another.



Still further in accordance with the objective in question, the zipper fastener is one which automatically locks in any adjusted position against shift of its movable element from that position, other than under an endwise pull in the direction of the fastener and fastened margins.

An important object of the invention is to provide an inflatable pressure splint and bandage which is in its entirety, other than the mentioned slide fastener means and provisions to orally inflate the same, fabricated of fully transparent material, thus enabling the external observation of an injury, such as a compound fracture, without removal or deflation of the splint, as well as to facilitate whatever manipulation of the injury on location as may be deemed advisable or desirable.

Still another object is to provide an inflatable splint of the foregoing character which, in addition to an opening or openings at toe and heel zones above which the splint envelope is slide fastener-connected to afford inflatable air chamber means surrounding the injured limb, has its air chambers in communication with one another between unsealed margins of the sealed splint envelope at which the toe and/or heel opening or openings are defined. This in effect provides a bottom communicating chamber simultaneously inflatable with the limb-surrounding chamber means, to provide a bracing action at the bottom of the instep of the leg, which is of assistance particularly when the splint is applied to an unshod leg.

Further in accordance with the invention, the splint is equipped with dual, valved inflating tubes communicating with the air chamber space between its transparent, hermetically sealed walls. This permits the simultaneous services of two persons in quickly inflating the splint, particularly under a high altitude, thin air condition. These valved inflating means are applied to opposite sides of the splint envelope, but, as mentioned above, the entire chamber space is equalized as to pressure by the communicating bottom instep provision referred to above.

Another object of the invention is to provide an improved method for producing an inflatable bandage-splint having the above characteristics, as the result of which method, the splint is quickly and rapidly constructed by the use of relatively simple heat sealing equipment, yet is very effectively lap seam-sealed along margins of its double-walled envelope in a manner to best resist the tendency of the inflating air to weaken, split or rupture the sealed seam.

The foregoing as well as other objects will become more apparent as this description proceeds, especially when considered in connection with the accompanying drawings illustrating the invention, wherein:

FIG. 1 is a perspective view illustrating the improved pneumatically inflatable splint of the invention as fully and operatively applied to a skier's limb, the action of slide fastener margin sealing means of the splint being indicated in solid and dotted lines;

FIG. 2 is a plan view showing the manner of initially applying the splint to an injured limb with a minimum movement of the latter, prior to fully surrounding the limb and being inflated to immobilize the injury;

FIG. 3 is a view in vertical section along broken line 3—3 of FIG. 4, showing the inflated splint and the manner in which its inner wall or ply grips the limb to immobilize the latter;

FIG. 4 is a view in horizontal section along line 4—4 of FIG. 3;

FIG. 5 is a top plan view, partially broken away, of a prefabricated envelope unit of the splint, as laid out prior to application of slide fastener means thereto, the unit being shown with its component transparent walls hermetically sealed about the perimeter thereof;

FIG. 6 is an enlarged fragmentary view in vertical section on line 6—6 of FIG. 5;

FIG. 7 is a top plan view, similar to FIG. 5, showing the splint envelope with slide fastener means applied thereto;

FIG. 8 is a fragmentary, enlarged scale view in vertical section on line 8—8 of FIG. 7;

FIG. 9 is a top plan view of the completed splint, as foldably manipulated about its longitudinal midpoint from the flat condition of FIG. 7 and further sealed along parts of the longitudinal meeting margins of the envelope halves to afford toe and heel openings; and

FIG. 10 is a fragmentary enlarged scale view in section along a line corresponding to line 10—10 of FIG. 9, with the splint partially inflated to more clearly show the lapped seam seal along the margins of the envelope opposite its slide fastener-bearing margins.

As depicted in FIGS. 1, 2 and 3 of the drawings, the improved air-inflatable splint of the invention, generally designated by the reference numeral **10**, is essentially comprised of outer and inner wall sheets **11**, **12**, respectively, of a fully transparent material, preferably of a thermally sealable plastic material such as polyvinyl chloride. These wall sheets or plies are readily flexible, and since the outer wall **11** must retain air pressure in the chamber space **13** between the walls without stretching or ballooning, the wall sheet **11** may be a twelve gauge polished vinyl chloride such as is marketed under the designation KDA2940. This sheet, while being adequately flexible, is sufficiently inelastic not to deform under the pressures involved in the use of the splint. On the other hand, the inner wall sheet **12** must be sufficiently flexible and pliable to conform readily to the shape of the limb when the envelope chamber space **13** is inflated, hence may be of an eight gauge polyvinyl chloride composition. As illustrated best in FIGS. 1 and 3, the completed splint **10** affords toe and heel openings **15**, **16**, respectively, for receiving corresponding portions of a wearer's ski boot **17**, with the advantages of increased ease of initially applying the splint to the injured limb, and decreasing the amount of lung air required to inflate the latter.

FIGS. 1 and 2 show the splint **10** as being completed by slide fastener members **18**, **19** fixedly applied to portions of its longitudinal envelope margins to one side of the zone at which the toe opening **15** is formed when these slide fastener tapes are brought together and sealed; and by valved inflating tube members **20**, **21** applied to the outer wall panel **11** of the splint in a manner to be described.

It will be observed in FIG. 1 that the slide fastener elements **18**, **19** are oriented, in the longitudinal sense relative to the envelope margins, reversely of the usual fashion. That is, it is intended that the splint be closed by the slide fastener, generally designated **22**, by manipulating its movable tongue piece **23** from the top of fastener **22**, which is fully open before application of the splint, to the bottom at the toe opening **15**, thus enabling this opening to be brought snugly around the boot **17**, regardless of the particular size or shape of the latter. Slide fastener **22** is of the usual and conventional self-locking type, enabling the device **10** to remain snug on the limb when inflated for the desired splinting effect.

FIG. 2 of the drawings shows the manner of applying the splint to the injured limb. Without moving the latter appreciably, the fully opened and spread out splint **10** is slid under the limb, disposing the heel of the boot **17** in the opening **16**, whereupon the tube envelope is wrapped about the limb and sealed in place by the slide fastener **22**, in the manner referred to above. It is then inflated fully, or to the intent necessary to adequately immobilize the injury, by mouth pressure applied to one or both of the valved inflating members **20**, **21**. These are of a type available on the market, including a stem **25** to which (FIG. 1) a mouth tube **24'** is applied, rotation of the stem in one direction or another opening or closing a sealing



valve (not shown) of the valve inflating member **20** or **21**.

FIGS. 4 through 10 show in greater detail and in larger scale (FIGS. 6, 8 and 10) the method of making the splint **10** to provide the structural features and characteristics referred to above in connection with FIGS. 1, 2 and 3.

An inflatable envelope, generally designated **25**, of the splint is illustrated in FIG. 5 as comprising the relatively thick and comparatively inelastic transparent plastic outer wall sheet **11**, and the relatively thin and more flexible transparent plastic inner wall sheet **12** disposed in superposed relation to one another. These sheets or panels are of similar size and shape and have their perimetral margins in register. The two inflating members **20** and **21** will have been applied externally in sealed covering relation to small openings of the outer sheet **11**, at points spaced on opposite sides of the longitudinal center line of the envelope **25**; and the latter is completed by heat sealing the envelope walls **11**, **12** together in a suitable press along a continuous heat seal zone **26** extending entirely around the outline of the superposed wall sheets, but in slightly inwardly spaced relation to the margin extremity. The shape of sheets **11** and **12** is such as to provide slightly widened longitudinal flanges **27** on either side of a central transverse zone, generally designated **28** at the longitudinal center of the sealed envelope **25**.

FIG. 7 of the drawings shows slide fastener tapes **18**, **19** as applied to the envelope **25** along one pair of its marginal flanges **27**, although the application of the slide fastener means may, if desired, be made coincidentally of the marginal heat sealing of sheets **11**, **12** earlier to constitute enevelope **25**. This is done by heat sealing the fastener tapes **18**, **19** to the zones in question along longitudinal, hermetically tight seams **28** outwardly of the primary envelope seam at **26**; and concurrently with this, a relatively wide external protective flap **30** may be heat sealed in place along the slide tape **18**, so as to fall externally of the splint fastener **22** when the latter is closed. The slide fastener is thus shielded from moisture.

As shown in FIG. 7, the zones at which the tapes **18**, **19** are sealed to envelope **25** on seams **29** both terminate substantially short of the medial transverse zone **28**, which is of substantial length; and it is at this zone of the envelope that its walls **11**, **12** are sealed to one another only by the initial heat seal seam **26**. As suggests itself, it is at this medial zone that the toe and heel opening are formed when the splint is completed and operatively applied to the limb.

Completion of the splint involves the folding of its similar halves about the central transverse zone **28**, to the position shown in FIG. 9, and, finally, heat sealing in superposed relation to one another the margins of the envelope halves opposite those of the slide fastener-bearing halves.

The top of the folded envelope is of course left open, and its margins opposite the slide fastener **22** are sealed longitudinally downwardly from the splint top in a special lap seal, of the type depicted in FIG. 10, along a length terminating substantially coextensive with the lower termini of slide fastener tapes **18**, **19**. This affords the heel opening **16** of the splint **10**.

The lap seam seal in question, specially designated **33**, is (FIG. 10) such that the respective double ply margins of the two halves of the folded envelope **25** are overlapped in opposite directions onto one another and heat fused together along the relatively wide seal line **34**. This method of lapped seaming is desirable in that it affords a joint at the upper extremity of the heel opening **16** which is particularly resistant to initiation of a tear. The reversely lapped seam **33** is also practical due to the fact that the press type of equipment employed in fabricating the splint **10** is best adapted to its formation, in view of the folded bottom instep zone at **28** extending across the envelope **25**. Furthermore, the seam **33**, as a whole and throughout

its length above the heel opening, is much more strongly resistant to splitting, tearing or rupture under inflating pressure than is a simple unidirectional lap or abutting of the envelope halves.

It is seen by reference to FIGS. 3 and 10 that, as partially or wholly inflated orally at one or both of the members **20**, **21**, the envelope **25** presents, between its relatively inelastic outer wall sheet **11** and its relatively more flexible inner wall sheet **12**, the inflated chamber portions or spaces **13** which wholly surround the injured limb when the splint is operatively applied, these spaces being intercommunicated at the medial or bottom instep zone **28** of the splint by the communicating chamber portion **36** which appears in FIG. 3. This feature permits instant equalization of the pressure throughout the splint **10** whether only one or both of the valved means **20**, **21** are employed.

Of course, the invention contemplates changes in the method of producing the splint, and consequently in the splint itself, which will occur to those having ordinary skill in the art. For example, it may be practical to commence the forming operations by using, rather than individual outer and inner wall sheets or panels **11**, **12**, a single blank of a gauge of transparent sheet stock suitable to the purpose, and folding such sheet along a longitudinally extending center line to bring similar halves thereof into horizontal register, as described above and as contemplated in certain of the claims to follow. This would permit elimination of the initial horizontal heat seal at **26** along the integral folded margin of the resultant double-walled envelope. Other possible changes will also suggest themselves.

It it seen that the invention affords an improved, orally inflatable splint which may be quickly and easily applied to a fractured limb without unduly disturbing the latter, the splint being transparent walled to permit full inspection of the injured member. The toe and heel openings at **15**, **16**, respectively, enable such facilitated application without removing the patient's boot, yet still provide for a much smaller volume to be orally inflated than would be the case if the splint structure were made sufficiently large to totally encase the ski boot.

The improved and reversed arrangement of the tapes of the slide fastener **22** provides for adjustable connection of the splint halves along this zone to accommodate different sizes of boot; and the fastener automatically locks in any adjusted position.

The limb-encasing portions of the air chamber **13** are intercommunicated at the transverse bottom instep space **36** for the automatic equalization of inflation pressure throughout the air chamber space of the splint, which is of value when both inflating members **20**, **21** are utilized. Finally, the mode of seam-sealing of the splint halves affords maximum strength to resist initial tear or commencement of a split or rupture at the seaming under any foreseeable internal pressure.

What I claim as my invention is:

**1.** An air pressure splint to at least partially encase an injured, boot clad human leg, said splint comprising an outer flexible and relatively nonstretchable wall, an inner flexible wall connected by seaming about its perimeter in air-tight sealed relation to said outer wall to coact with the latter in defining double-walled and sealed inflatable envelope means, said envelope means including an air chamber portion in position to surround at least a major portion of the leg and instep, along which chamber portion said envelope means has separable, air-tight margins adapted to be releasably connected together to hold said chamber portion in said surrounding position, releasable, self-locking slide fastener connecting means on longitudinal zones of said respective separable margins extending from adjacent corresponding ends of the latter to termini spaced from the opposite margin ends thereof at a toe portion of the splint, thus to releasably connect the margins together, with the chamber portion of the splint so surrounding the injured leg at the ankle and instep and with a toe receiving opening from the interior to the exterior of the splint between said termini and said opposite margin ends, said envelope means and its chamber portion also providing a heel receiving opening opposite said toe receiving opening and said slide fastener connecting means, said outer and inner splint walls extending continuously and integrally about said injured leg in the area of the splint directly adjacent said opening and said connecting means, and valved inflation means in sealed communication with said envelope means for the inflation of said chamber portion on opposite sides of said connecting means to enable the splint to grip the injured leg.

**2.** The splint of claim **1**, in which parts of said air chamber portion are in direct and open communication with one another in a sub-instep zone between said toe and heel receiving openings.

**3.** The splint of claim **1**, in which said slide fastener connecting means comprises slide fastener elements secured on said respective longitudinal zones and having means operated in the direction toward said toe receiving opening to complete the closure of the connecting means at a point above the toe of the boot, thereby adapting the splint for snug application to boots of substantially differing sizes.

**4.** The splint of claim **1**, in which parts of said air chamber portion are in direction and open communication with one another in a sub-instep zone between said toe and heel receiving openings, said slide fastener connecting means comprising slide fastener elements secured on said respective longitudinal zones and having means operated in the direction toward said toe receiving opening to complete the closure of the connecting means at a point above the toe of the boot, thereby adapting the splint for snug application to boots of substantially differing sizes.

**5.** The splint of claim **1**, in which said envelope means includes similar, individually sealed halves having a reversely lapped seal connection to one another in a longitudinal zone upwardly of said heel receiving opening.

**6.** A method of forming an air-inflatable splint, comprising superposing generally similar walls of sheet material in registered marginal relation to one another, sealing said walls to one another about a substantial part of the marginal length thereof to provide an air-tight splint envelope, applying coacting slide fastener elements to longitudinally spaced zones of one of the sealed wall margins on opposite sides of a longitudinal center zone of the envelope, folding similar halves of said envelope at said center zone of the latter into superposed marginal register with one another, and sealing said halves to one another along margins thereof opposite the slide fastener margin zones.

**7.** A method of forming an air-inflatable splint, comprising superposing generally similar, separate walls of transparent flexible sheet material in registered relation of the respective wall margins to one another, sealing said walls to one another about the marginal length thereof to provide an air-tight splint envelope, applying coacting slide fastener elements to longitudinally spaced zones of one of the sealed wall margins on opposite sides of a longitudinal center zone of the envelope, folding similar halves of said envelope at said center zone of the latter into superposed marginal register with one another, and sealing said halves to one another along margins thereof opposite the slide fastener margin zones.

**8.** A method of forming an air-inflatable splint, comprising superposing generally similar, separate walls of transparent flexible and heat sealable sheet material in registered relation of the respective wall margins to one another, heat sealing said walls to one another about the marginal length thereof to provide an air-tight splint envelope, applying coacting slide fastener elements to longitudinally spaced zones of one of the sealed wall margins on opposite sides of a longitudinal center zone of the envelope, folding similar halves of said envelope at said cen-

ter zone of the latter into superposed marginal register with one another, and heat sealing said halves to one another along margins thereof opposite the slide fastener margin zones for a length approximately coextensive with that of the superposed zones of the slide fastener elements only, thereby providing an opening between the last name margins of the superposed halves to the exterior of the splint, in addition to an opening at said center zone when said slide fastener elements are coactively connected to one another.

9. A method of forming an air-inflatable splint, comprising superposing generally similar, separate walls of transparent flexible sheet material in marginal registered relation of the respective wall margins to one another, sealing said walls to one another about a substantial part of the marginal length thereof to provide an air-tight splint envelope, applying coacting slide fastener elements to longitudinally spaced zones of one of the sealed wall margins on opposite sides of a longitudinal center zone of the envelope, folding similar halves of said envelope at said center zone of the latter into superposed marginal



register with one another, and sealing said halves to one another along margins thereof opposite the slide fastener margin zones by means of a seam comprised of reversely overlapped two-ply edges.

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