

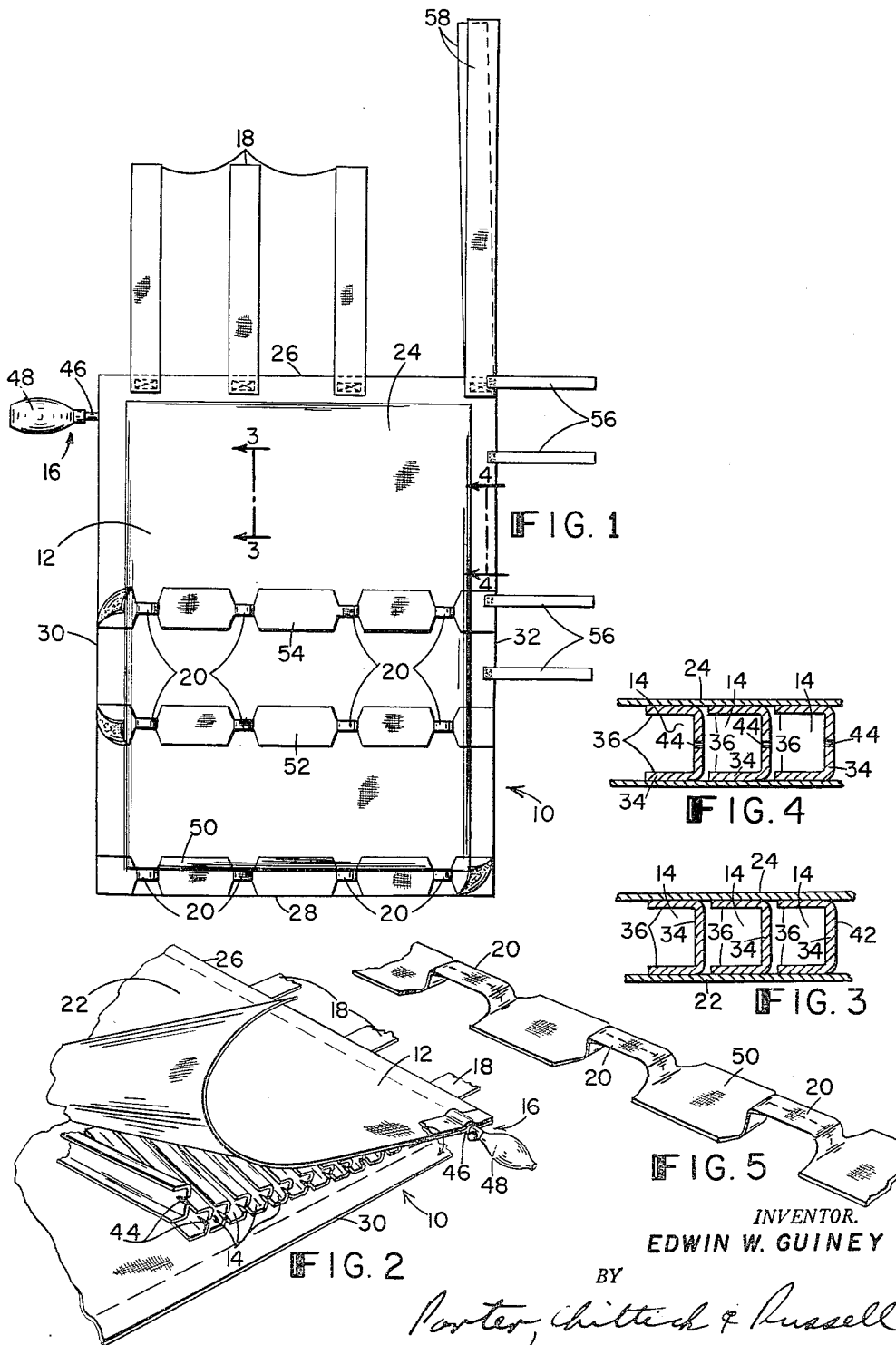
Jan. 22, 1963

E. W. GUINEY
PNEUMATIC SPLINT

3,074,398

Filed May 18, 1959

3 Sheets-Sheet 1



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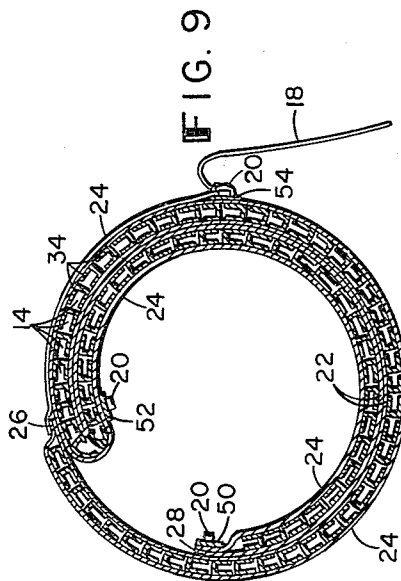
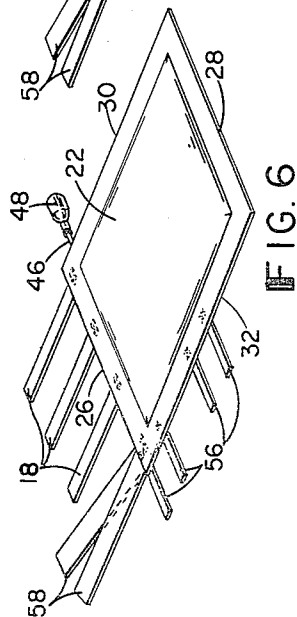
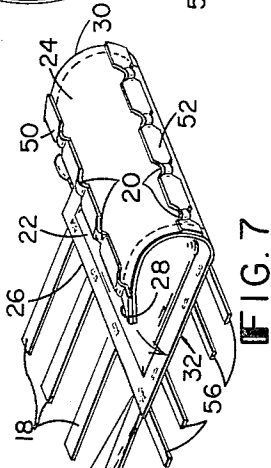
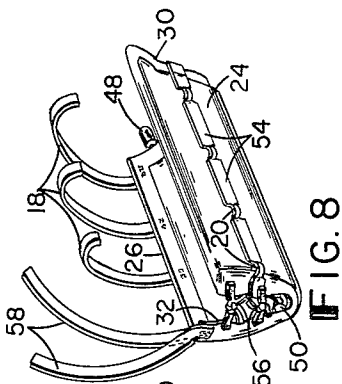
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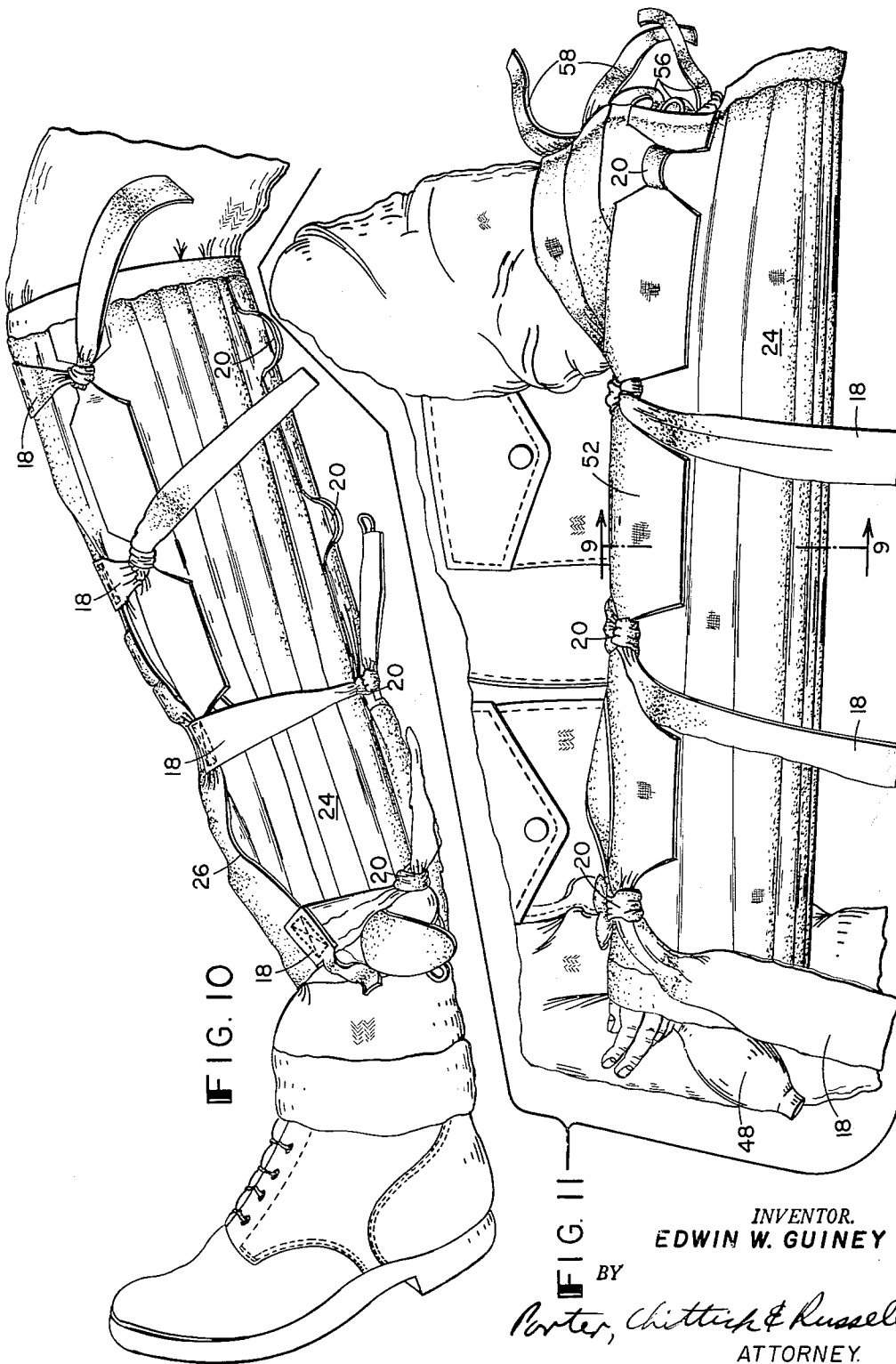
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3 Sheets-Sheet 3



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3,074,398

PNEUMATIC SPLINT

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This invention relates to immobilization of injured extremities and more particularly to an all purpose inflatable splint capable of being used to immobilize any extremity.

Whereas splints in general are as old as medicine itself, modern warfare and civil defense, as well as the predictable violence of certain phases of modern life such as automobile accidents, have focused attention on the need for a compact, portable, easily applied device to be used for emergency splinting before moving a casualty. In forward combat areas, at the scene of civilian disasters or accidents, the availability of adequate splinting can be crucial. The standard wooden, metal and plaster of Paris splints used for permanent splinting are obviously too heavy and bulky for such emergency situations, while the portable splints currently used, such as the wire mesh and wood, are not compact and require additional padding to prevent pressure sores or ulcers.

Various inflatable fabric splints and bandages, with and without metal supports and appendages, have been devised but generally their applicability has been limited to one or another part of the body. The metal parts required with some previous designs necessarily increased the weight and bulk of these splints and also interfered with possible eventual X-raying of the splinted member. Most important, none of the designs employed previously could attain the required rigidity without some additional supporting means such as stiff inserts or lacing.

The purpose of emergency splinting in both a forward combat area and in a civilian emergency situation is to prevent further damage to the tissues surrounding the fracture; to prevent shock; and to alleviate pain. The reduction of fractures at the level of emergency splinting is of secondary importance to proper immobilization.

A basic object of the invention is, therefore, to sufficiently immobilize the injured extremity so that further damage to surrounding tissue will not occur during transportation of the casualty to medical facilities. The prevention of shock, and the alleviation of pain to the injured person are also dependent upon sufficiently rigid splinting.

It is also an object of this invention to provide a lightweight splint which can be compactly and easily carried, and when necessary can be safely parachuted or even thrown into inaccessible places. A further object of the invention is to provide a splint of sufficiently simple application that can readily be used by non-medical personnel and in certain cases, can be successfully applied by the injured party himself.

Another object of this invention is to provide a splint which requires no additional padding or bandaging for its safe and effective use. An important object of the present invention is to provide a single splint which can be used in the treatment of any fracture of the arms or legs including ankle and knee as well as tibia and femur, forearm and humerus. Still another object of the invention is to permit the splinted wound to be X-rayed by eliminating or minimizing metallic parts of the bandage.

A further object of this invention is to provide a splint which when necessary can serve effectively both as a tourniquet and for immobilization of a wounded extremity. A still further object of this invention is to provide a splint which can be used over and over again; which is readily cleaned; which resists deterioration in use; and

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continues to provide effective immobilization after frequent and hard use.

In the accomplishment of these and other objects of the invention I provide what is essentially an inflatable air pillow body portion formed by sealing two airtight fabric sheets along their edges. Before the sealing, a plurality of adjacent parallel U-shaped channels are placed between the two sheets. The flanges of the channels are sealed to the interiors of the sheets, the webs forming a series of panels which partition the interior air chamber into elongated air cells. When inflated these adjacent, elongated air cells become longitudinally rigid. Straps provided at one edge of the air pillow tie into loops attached to the outside sheet either at the opposite edge or at points intermediate these edges to affix the splint to an extremity. A source of air pressure such as a standard sphygmomanometer valve and bulb is located on an edge of the air pillow near the edge carrying the tying straps.

A feature of this invention is the use of numerous parallel interior fabric panels forming elongated air cells. A single air cell is geometrically defined by the flanges and web panel of one chamber member and the web panel of the channel immediately adjacent the flanges. Forming the cells by using adjacent U-shaped channels adds an extra thickness to the splint where the channel flanges are affixed to the interior of the air tight fabric sheets. The rigidity of the splint is directly caused by the rigidity of the panels which in turn is a function of air pressure exerting opposed forces on opposite sides of a panel separating two cells. Not only do these panels give great strength and rigidity to the inflated splint, but they also tend to equalize any undue pressure on a particular sector of the splint, thus minimizing chances of failure. When the splint is wrapped around an extremity the individual inflated air cells therein readily conform to the contours of the extremity enclosed by the splint and may be compared to closely fitting staves.

Another significant feature of this invention is that fabric straps or ties are used with fabric loops to secure the splint instead of the conventional buckles or snaps. Not only are ties more readily adjustable but there is less chance of mechanical failure due to broken or bent buckles. If additional rigidity is required, a still further feature is that a rigid object such as bayonet or shank of a ski pole may easily be inserted under the tying straps after the splint is in place. Moreover, the absence of metal parts makes the splint radiolucent and greatly facilitates X-raying of the splinted extremity. With the exception of the metal valve on the sphygmomanometer bulb there are no metal parts on the splint, thereby materially reducing the chances of the splint body abrading on itself or the splinted extremity.

An additional feature of the present splint is the unique way in which it can be folded over itself so that it can be applied not only to fractures of the leg which require a larger splint but also to those of the lower arm; and even to fractures of the elbow and ankle which require splinting at approximately a right angle. This is accomplished by the placement of additional straps on an edge of the splint adjacent to but at right angles to the tying straps. When the splint is folded these extra straps are tied together to form a kind of pocket at the end of the splint wherein an elbow or ankle can be placed and secured.

Another feature of the invention is that it not only gives adequate splinting for emergency management of a fracture, but also exerts a diffuse pressure which serves to retard edema or enlarging hematoma, particularly under the area where a battle dressing would be placed. An additional feature of the invention is that if necessary, it can serve as a tourniquet. Moreover, since the pressure of the splint is diffusely applied both above, below

and on the wound, venous and arterial flow may both be blocked.

The fabric of the present invention is non-irritating to wounds. Therefore it is a further feature of my invention that no additional padding abutting the flesh is required, decreasing the weight and bulk of the equipment to be carried, and also decreasing the length of time required to apply the pneumatic splint. Moreover, nylon has proven its durability in life vests and life rafts; it is easily cleaned; both characteristics permitting the same splint to be used over and over again.

The fabric splint when not inflated can readily be folded into a compact package. It is another feature of my invention therefore that this small and light weight splint can be included in a standard first aid kit or can be easily transported in a case attached to a belt. Still another feature of the present splint is that it can be inflated using a standard sphygmomanometer bulb, or adapted to be used with any convenient source of air or gas pressure.

Other objects and features of the invention will become apparent from a more detailed description with the aid of the accompanying drawings in which:

FIG. 1 is a plan view of an inflatable splint completely spread out showing various ties, an air pressure source connected, and loop-forming strips sealed to the splint body with ends peeled away to show how they are attached;

FIG. 2 is a cutaway view of an edge of the splint showing the placement of panels formed by U-shaped fabric channels between the two airtight fabric sheets and also showing the areas to be sealed at the edges of the sheets;

FIG. 3 is a partial cross-section taken on the line 3—3 of FIG. 1 showing portions of the partitioning panels as formed by the channels;

FIG. 4 is a partial end view of the edge of the channel members shown in FIG. 2 illustrating slits cut in the web panels of the channel members;

FIG. 5 is a detail view in perspective of part of one of the strips prior to being cemented to the outside of the splint and forming loops thereon;

FIGS. 6, 7 and 8 show how the splint is to be folded for application to forearm and elbow or foot and ankle;

FIG. 9 is a cross-sectional view of the inflated splint in place on an injured limb; taken on line 9—9 of FIG. 11;

FIG. 10 shows the splint in use in position on a leg; and

FIG. 11 shows the splint folded as indicated in FIGS. 6, 7 and 8 in use on a forearm and elbow.

In its general organization the splint 10 comprises a substantially rectangular air pillow 12 partitioned inside into a plurality of parallel, adjacent, elongated air cells 14 which become rigid when inflated; air inflating means 16; and straps 18 and loops 20 for fixing the pillow 12 to an injured extremity.

The air pillow 12 is formed by two substantially rectangular airtight fabric sheets, an inner sheet 22 and an outer sheet 24, placed one on top of the other and sealed together at the two shorter edges 26 and 28 and two longer edges 30 and 32.

However, prior to the sealing of sheets 22 and 24 at their edges, a plurality of U-shaped fabric channel members 34 are placed between the two sheets as shown in FIG. 3. These channels 34 are placed parallel to the shorter edges 26 and 28 of the sheets 22 and 24. As will be seen in FIG. 2 flanges 36 of channel members 34 are sealed to inner surfaces 38 and 40 of the inside and outside sheets 22 and 24, the channel web panels 42 thus partitioning the interior of the air pillow 12 into the elongated air cells 14.

The channel members 34 are long enough to abut the inner margins of the sealed edges 30 and 32. Each air cell 14 is thereby made a discrete, distinct entity, which shares a common vertical panel 42 with the cell immediately adjacent on each side. However, if the isolation of the cells 14 was complete, separate inflating means would be required for each cell. Therefore, in order to

use one air input source 16 and to permit the flow of air between adjacent cells 14, holes 44 are provided in each of the web panels 42. These holes 44 can take the form of slits cut in the web panels 42 at each end of channel 34 where the channel abuts the sealed margins 30 and 32 as shown in FIGS. 2 and 4.

Once the channel members 34 are in place, the inner and outer sheets 22 and 24 are sealed at the inside faces 38 and 40 respectively along their longer edges 30 and 32 and along their shorter edges 26 and 28 except at one corner on longer edge 30 where air inflating means 16 comprising a suitable tube 46 designed to fit a standard sphygmomanometer 48 is inserted and secured between them. While any of the well-known heat sealing techniques can be employed to seal the sheets 22 and 24 along their edges, cementing with standard Navy rubber life raft cement is easier and should withstand the rigors of military and emergency civilian usage somewhat better.

Because the segmented air pillow 12 thus formed is to be wrapped around an extremity, the size of sheets 22 and 24 is dictated by the length and girth of human limbs. For adults it has been found convenient to use sheets measuring approximately 20" x 26", although of course, in other applications these dimensions could be changed, for example for use on children. The potential widespread utilization of the splint is demonstrated in part by the fact that the sheets 22 and 24 can be made from any flexible airtight fabric. Neoprene coated nylon used for life rafts and the like has been found to have the required characteristics and has the additional virtue of being waterproof.

In applying splint 10 the injured extremity is placed across the inner sheet 22 thereof between and parallel to its shorter edges 26 and 28, the splint then being wrapped around the limb and secured by tying straps 18 attached at edge 26 to loops 20 near the other edge. The fabric straps 18, which may be made of cotton twill tape, are cemented or sewn to the shorter edge 26 near the inflating means 16. Although any number of straps 18 may be used it has been found generally sufficient to have three, approximately 6" long.

Along the shorter edge 28 opposite the straps 18 a strip 50 made of the same fabric as the sheets 22 and 24 is cemented to form the loops 20 corresponding in number and placement to the straps 18 already described. As can be seen most clearly in FIG. 5, the raised or loop portions 20 of the strip 50 are reduced in width to facilitate insertion of the straps 18. To provide adjustability of tying and more general application another loop strip 52 parallel to the first is placed just beyond the center of the longer edges of the outer sheet 24; and a third loop strip 54 may be placed between these two permitting a still greater selection of tie points.

Smaller cotton twill ties 56 are sewn or cemented along a longer edge 32 of the outer sheet 24, spaced between the loop strip 52 and the narrow edge 26 of the sheet 24 to which the straps 18 were attached. These smaller ties 56 may be of any even number, no more than four being necessary, as they are designed to be tied to one another over a foot or elbow when the splint 10 is to be placed in such a position as to immobilize limb members at a right angle. The actual function of these ties will be explained below.

Apart from the distinctly improved construction of this splint 10 in terms of simplicity, compactness and economy, of equal importance is the facility with which even an untrained person can apply it to an extremity. For example, as is shown in FIG. 10, a fracture of the lower extremity may be immobilized by placing the injured limb across the partially inflated splint 10 bisecting its longer edges 30 and 32. With the inner sheet 22 next to the limb, the splint is wrapped around the leg so that the strap bearing edge 26 overlaps or meets the loop bearing edge 28. The straps 18 are then tied through whichever of the corresponding loops 20 on strips 50, 52 or 54 per-

mit the most secure fastening. Note in FIG. 10 that all the lops in one strip are not necessarily engaged as the tapering of the leg may make desirable the use of some loops 20 on strip 52 further from the edge 28. The secured splint can now be fully inflated. The sphygmomanometer bulb 48 and its associated valve are operated manually in the usual fashion until the air chamber is filled to the desired rigidity, the inner web panels 42 becoming substantially perpendicular to the sheets 22 and 24 as shown in FIG. 9. The splint can be applied in a similar fashion to other fractures of the leg or arm.

If, however, it is to be used on the forearm, lower tibia, elbow or ankle, a significant feature of the splint is the manner in which it can be folded so as to accommodate and immobilize the right angle bend of elbow or ankle as shown in FIG. 11. To accomplish this FIGS. 6, 7 and 8 show how the splint 10 is folded in upon itself and the corresponding ties 56 are tied to each other so as to form a pocket. The elbow is then placed in the pocket, the lower arm extending along the length of the cupped splint. The three straps 18 may now be tied through corresponding loops as previously described, but a pair of larger straps 58 which are secured to edge 26 are used to anchor the splint in place by being wrapped and tied around the upper arm near the elbow. As previously described the splint is then inflated until firm. To accommodate the lower leg or ankle, the folded and tied splint is slipped over the heel and wrapped in a similar manner.

The method of application of splint 10 is sufficiently noncritical that variations may be introduced into the above described procedures without in any way lessening the efficacy of the final splinting. For example, the splint 10 may be entirely uninflated when applied instead of partially so; or the right angle pocket forming ties 56 may be tied after application of the splint rather than before.

The construction of the splint also permits of many variations not only in the dimensions of the splint 10 and the placement of the several loops, straps, and ties; but in the use of other materials of construction or the employment of hooks and eyes, buckles, or laces as fasteners.

To mention a few of the many other possible variations, the panel webs 42 may be slit at either end, or at points in-between, and the air inflating means 16 may be inserted along any edge of the splint 10 or it might be connected to a special valve opening in the outer sheet 24.

Certain minor variations of this preferred embodiment will be apparent to those skilled in the art; and, therefore, it is not my intention to confine the invention to the precise form herein shown, but rather to limit it in terms of the appended claims.

Having thus described and disclosed a preferred embodiment of my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An inflatable splint comprising, a rectangular flexible inflatable body portion wrappable about an injured member, said body portion formed of two sheets of airtight material secured together at their edges and including a plurality of separate flexible reinforcing panels disposed between and attached to said two sheets, inflating means attached to said body portion at one edge thereof, and means attached to said body portion for holding said body portion wrapped about an injured member while said body portion is inflated.

2. An inflatable splint as defined by claim 1 wherein said reinforcing panels are made of fabric.

3. An inflatable splint as defined by claim 1 wherein said reinforcing panels divide the interior of said body portion into a plurality of communicating air cells.

4. An inflatable splint as defined by claim 1 wherein said reinforcing panels have holes for permitting flow of air between adjacent cells.

5. An inflatable splint as defined by claim 1 wherein said body portion has two relatively long edges and two relatively short edges, and said reinforcing panels extend parallel to said relatively short edges.

6. An inflatable splint as defined by claim 5 wherein said means for holding said body portion wrapped about an injured member comprises straps attached thereto along one of said relatively short edges.

7. An inflatable splint wrappable about an injured member comprising two flexible foldable airtight sheets sealed together to form an air chamber, a plurality of flexible foldable parallel planar reinforcing elements disposed in said air chamber, said reinforcing elements formed of sheet material and secured to said two sheets, and means attached to said body portion for inflating said air chamber.

8. An inflatable splint as defined by claim 7 further including securing means for preventing said body portion from unfolding when wrapped about an injured elongated member with said reinforcing elements disposed substantially parallel to said elongated member.

9. An inflatable splint as defined by claim 8 wherein said securing means are straps and loop members attached to said body portion at spaced apart points.

10. An inflatable splint as defined by claim 9 further including a plurality of spaced ties secured to said body portion at right angles to said straps, said ties adapted when tied to each other to immobilize limb members at a right angle.

11. An inflatable splint as defined by claim 7 wherein said reinforcing elements are elongated panels formed with edge flanges which are secured to the inside surfaces of said two sheets.

12. An inflatable splint having a body portion comprising outside and inside sheets made of flexible foldable airtight material, said sheets having edges which are sealed together to form an air chamber therebetween, the edge of each sheet including two opposed edge portions, a plurality of flexible U-shaped channel members disposed inside said chamber parallel to said opposed edge portions, said channel members having edge flanges sealed to the interior surfaces of said sheets and webs forming panels partitioning said air chamber into a plurality of air cells, said webs having openings wherethrough air may move between said cells, a plurality of straps attached to said body portion at one of said opposed edge portions, at least one strip of flexible material attached to said outside sheet at a point spaced from said one of said opposed edge portions, said strip providing loops through which said straps are tied when said splint is wrapped about an extremity, and an air tube attached to said body portion and communicating with said air chamber, where-through air may be delivered to inflate said air chamber.

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