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AT BE CH DE ES FR GB GR IT LI LU NL SE(71) Applicant: Levy, Zadok H.
114 Hagolan Street
Tel-Aviv(IL)(72) Inventor: Levy, Zadok H.
114 Hagolan Street
Tel-Aviv(IL)(74) Representative: MacGregor, Gordon et al
ERIC POTTER & CLARKSON 14 Oxford Street
Nottingham, NG1 5BP(GB)

(54) Collapsible structure convertible to a load-supporting device.

(57) Various structures, such as a stair, bridge, table, ladder, or stretcher can be folded to a compact configuration for transportation and/or storage but rapidly extended for deployment as a rigid, load-bearing device. The structures include a plurality of rows of rigid plates (1) hinged together about mutually perpendicular axes. If all of the plates are in a common plane and a force is applied perpendicular to the hinge axes, the plates can fold up to a compact form. When one or more of the rows of plates is swung perpendicular to a further row of hinged plates, the configuration becomes rigid and capable of supporting a load.

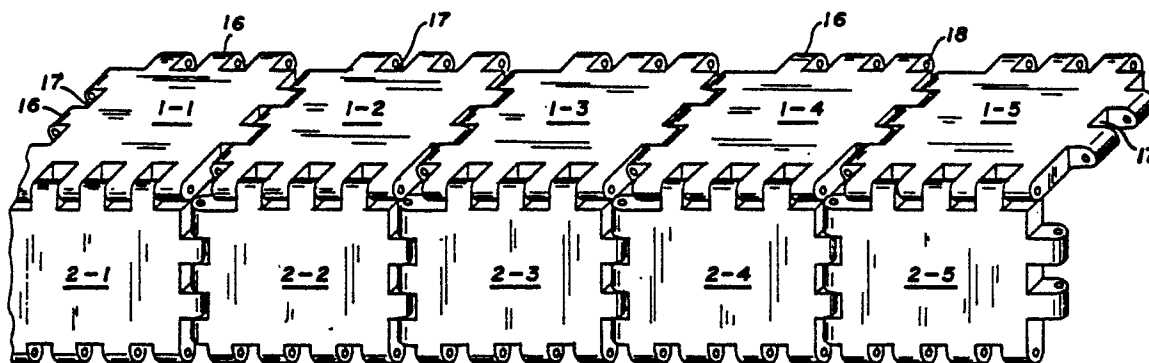


FIG. 1b

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COLLAPSIBLE STRUCTURE CONVERTIBLE TO A LOAD-SUPPORTING DEVICE

DESCRIPTION

This invention relates generally to hinged structures which can be readily folded into a compact form and which, after having been opened, can be converted into a load-supporting configuration.

Various forms of rigid structures are required for different purposes, e.g., as tables, stretchers, beds, beams, ladders, bridges, scaffolds, stages, docks, ramps, etc. These load supporting structures are usually manufactured in factories and transported to the sites at which they are to be used. Alternatively, they may be erected from various pre-fabricated parts at the use sites. Each of these approaches has significant disadvantages. Typically, they require large storage spaces, a way of transporting the unassembled parts and intensive manpower to assemble and erect the structures.

It is thus desirable to be able to construct devices of the type set forth above from foldable elements which are compact and conservative of space, but which can easily and quickly be deployed and converted to a rigid structure. Moreover, the structure in question should be relatively inexpensive, easy to manufacture.

In accordance with the present invention, there is provided a foldable structure having a plurality of plates which may be generally flat and which are hinged together along at least two mutually perpendicular axes. When the thus interconnected plates are made to lie flat, i.e., in a common plane, the hinged plates can be readily folded into a compact configuration. However, if one row of plates is swung on its hinge(s) so as to be out of the plane of the other row or rows of plates, the resulting configuration becomes quite rigid and non-foldable.

The plate members may have any suitable geometrical form, e.g., triangular, rectangular, cylindrical or trapezoidal. Furthermore, the plates may be continuous sheets of material or may be formed as a frame having openings extending through the thickness dimension thereof. It is also to be understood that the area and thickness of the plates is not a critical feature of the folding structures according to the present invention and are to be chosen in accordance with the requirements and size of the final rigid structure to be created when the folded structure is deployed. Likewise, the hinges can be formed in a variety of ways from various available materials.

The folded structures will generally comprise more than a single row and a single column of hinged plates. The number of rows and columns extending parallel to and adjoining each other is also determined in accordance with the ultimate design of the final rigid structure once it is deployed.

It is also contemplated that some form of stabilizing means be provided to maintain the structure in its erect form to prevent inadvertent collapse. The stabilizing means may typically comprise lengths of cables, rods, hinge pins, ropes, cords, springs, etc.

The general principles of the invention will be described in connection with an explanation of the construction of various utilitarian structures including a bridge, a table and a ladder.

Reference is now made to the accompanying drawings in which like numerals in several views refer to corresponding parts.

Figure 1(a) illustrates a basic unit of the structure according to the present invention in its flattened, unfolded form;

Figure 1(b) shows the structure in Figure 1(a) in its rigid form;

Figure 1(c) shows schematically how the basic unit of Figure 1(a) may be collapsed into its folded form;

Figure 2(a) illustrates a portable bridge when half folded into its compact and half opened flat;

Figure 2(b) is a perspective view of the collapsible bridge when shown in its erect, rigid form;

Figure 3 illustrates a foldable, collapsible table in its erect, rigid form;

Figure 4 illustrates a foldable ladder in its erect, rigid form; and

Figure 5 - 8 illustrate a stretcher configuration for transporting non-ambulatory personnel.

Referring first to Figure 1(a), there is illustrated the basic structure from which the principles of the various other embodiments described herein will be explained. It is seen to include a plurality of plates arranged in two rows of five columns each and identified by numerals 1-1, 1-2, 1-3, 1-4 and 1-5 in row 1 and numerals 2-1, 2-2, 2-3, 2-4 and 2-5 in row 2. Each of the plates is illustrated as being generally rectangular with all four edges being notched to create a pattern of spaced teeth 16 separated by grooves 17. As will be apparent from the following description, the plates need not be rectangular. Each of the teeth 16 has a longitudinal aperture 18 passing therethrough for receiving a hinge pin as at 19. It is to be further noted that the

teeth on one edge of each plate are configured to mate with the grooves on the adjacent plate such that, when the pin 19 is inserted through the aligned apertures 18, a hinge connection results.

The size and thickness of the plates 1-1, 1-2, etc., are not critical and the plates themselves can be fabricated from a variety of materials, such as metals, plastics, etc. Furthermore, the hinges can be fabricated from a variety of materials and can assume various shapes. When the basic structure is laid flat as shown in Figure 1(a), it is possible to fold the intercoupled plates along the hinge lines as shown in Figure 1(c). However, and with reference to Figure 1(b), when one row of plates is rotated out of the plane of the adjacent row of plates, the assembly becomes rigid and capable of supporting a load without further folding.

With the principle illustrated by Figures 1(a) through 1(c) in mind, consideration is directed to Figures 2(a) and 2(b) which illustrate a configuration of a collapsible, foldable structure which, when deployed, can function as a bridge whereby personnel or vehicles readily traverse a stream or the like. While the Figure 2(a) shows the structure partially accordion folded, it is obvious that the structure can also be rolled in a spiral configuration to render it compact. Again, the bridge comprises a plurality of plate members 30 hinged to one another and having side flaps 31 and 32 also secured by hinges to the side edges thereof. Again, the hinges are illustrated schematically by the symbol indicated by numeral 33 in Figure 2(a). This figure also shows the bridge configuration in a partially flattened, partially folded form prior to being erected. Once the structure is totally unfolded and laid flat, by rotating the trapezoidal side flaps 31 and 32 out of the plane of the plates 30, and generally at right angles to the plates 30, the structure becomes rigid and will assume a curvature dictated by the shape of the side plates 31 and 32. To maintain the structure rigid, a stabilizing means, such as at cable 33, may be joined between the end flaps on opposite ends of the bridge configuration. Appropriate tension may be obtained in the cable by including a turn-buckle (not shown).

The principles of the present invention can be applied in implementing a folding cot or table as best seen in Figure 3. Here, a plurality of rigid plates 35 have side flaps 36 and 37 joined thereto by hinges having teeth 16 and grooves 17 meshed with one another and joined by a hinge pin (not shown). Likewise, adjacent side flaps 36 are hinged together along the transverse edges thereof as at 38. The reader can readily visualize how this structure can be laid flat by rotating the side flaps 36, 90° from the position illustrated in Figure 3 so that the side flaps 36 lie either in the plane of the plates 35 or directly beneath it. Then, by folding the

plates 35 so as to rotate about the hinges 38, the assembly can be collapsed into a compact configuration. In this arrangement, it is not a requirement that a hinge extend continuously the entire width of the structure, the hinges 38 between flap segments providing the axis of rotation for folding. When the assembly is unfolded, laid flat and then the side plates 36 are rotated out of the plane of the plates 35, a rigid structure results. Again, it may be found expedient to provide a latching mechanism to stabilize the rigid configuration against collapse. The latching arrangement is seen to include a first pair of linkages 39 and 40 pivotally joined between the side plates 36 and the top plates 35 at one or both ends of the structure and coupled to a second pair of linkages joining plates 35 to side plate 37 by a spring 41.

Figure 4 illustrates a collapsible, foldable ladder which may be used to ascend to or descend from a predetermined height. Again, the structure is seen to include a plurality of plates 42, each having a central opening 43 formed through the thickness dimension thereof and side flaps 44 and 45 individually joined thereto by hinges. The side plates 44 and 45 themselves also include hinges 46 joining adjacent side plates to one another. As before, this construction permits the side flaps 44 and 45 to be rotated inwardly toward one another beneath and parallel to the plane of the apertured plates 42, allowing accordion folding of the assembly about the side flap hinges 46. However, when the side flaps 44 and 45 are rotated to a position at an angle to the plane of the plates 42, the structure becomes rigid and self-supporting so that it can be placed against a building or other structure as a ladder with the lower edges of the apertures 43 defining the ladder's steps. No transverse hinges are required between adjacent plates 42. Again, a suitable latching arrangement 47 may be utilized to maintain the side flaps in their perpendicular orientation relative to the plates 42.

Figures 5 - 8 illustrate the principles of the invention as applied to a stretcher 110 for transporting sick or injured persons.

It is seen to include a pair of articulated poles 112 and 114 having handle grips 116 on the opposed ends thereof. The poles 112 and 114 are made to pass through pole receiving loops 118, 120, 122 and 124 sewn along the side edges of a generally rectangular fabric sheet 126. Alternatively, the fabric sheet may be attached along its longitudinal edges to the articulated poles by other means, such as screws, wedging in dove-tail grooves in the pole, Velcro (Regd. T.M.) fasteners or other suitable means.

The articulated poles 112 and 114 are seen to include a plurality of segments 128, 130, 132 and 134 which are joined together in an end-to-end relationship by means of hinges 136, 138 and 140. While four such segments are illustrated, those skilled in the art will appreciate that a greater or fewer number of hinged segments can be utilized. As can perhaps best be seen in the view of Figure 6, each of the hinges is provided with a pin 142 which comprises an axis about which the adjacent pole segments swing relative to one another. The hinges further include cooperating stop means 144 - 146 which limits the rotation about the axle 142 to 180° or less. It is to be further noted from Figure 6 that adjacent hinges are oriented so as to operate in opposite directions. That is to say, when the stretcher is being unfolded, segment 134 swings in a clockwise direction relative to segment 132 whereas segment 132 rotates in a counterclockwise direction with respect to segment 130. It is contemplated, however, that the hinges can be configured so that adjacent hinges may rotate in the same direction, depending upon the desired folding design selected for the stretcher.

Another observation to be made in the view of Figure 6 is that during a folding or unfolding manoeuvre of the stretcher, the hinge axes 142 are oriented in alignment with a plane passing through the two articulated poles 112 and 114. Once fully extended, however, the poles 112 and 114 may be rotated by the porters 90° about their own longitudinal axis within the pole receiving loops 118 - 124 of the fabric sheet 126 such that the hinge axes 142 will no be perpendicular to the plane defined by the two parallel articulated poles 112 and 114. With the hinge axes thus oriented, the articulated pole segments are prevented from folding or collapsing against one another because any tendency to fold is restrained by the inelastic fabric sheet 126.

To support the litter free of the ground, there is provided on the endmost segments 128 and 134 of each of the articulated poles 112 and 114 a folding leg as at 148. The leg is preferably ring-shaped and is coupled to the pole segment by a hinge 150 whose pivot axis extends generally parallel to the pole segment to which it is affixed. The legs 148 are ring-shaped to accommodate attachment to standard racks designed into transport vehicles such as ambulances and helicopters.

With reference to Figure 7, to provide lateral support for the legs 148 and to maintain the spacing between the articulated poles 112 and 114 when the stretcher is unfolded for use, a pair of transversely extending bar-like linkages 154 and 156 may be pivotally joined to the hinged legs 148 at pivot point 152. Linkages 154 and 156 cooperate with the legs on the opposed side of the litter and

may be jointed at their other ends to one another or, alternatively, to a centre stop member 157 to form an over-centre latch. The articulated poles 110 and 112 are maintained in a spread condition when the linkage assembly is pushed to the "open" position. When the linkage arrangement is pulled in the "close" direction beyond their point of alignment and with the poles 110 and 112 being rotated so that the hinge axes 142 are perpendicular to the direction of an applied force, the stretcher can be completely collapsed and folded to a length approximately one-fourth its fully unfolded or extended size, assuming, of course, that four pole segments are hinged together in the manner illustrated. Where the poles are each of a greater number of equal length segments, the folded lengths will be correspondingly reduced.

Figure 8 illustrates the stretcher poles in their completely folded condition such as when it is being stored or transported. The fabric 126 is not shown in Figure 8 in order to better view the structural members and hinges when folded.

In an actual stretcher made in accordance with the present invention, in its unfolded or extended condition, it has an overall length of 82 inches, a width of 22 inches and a height of 6 inches. When folded, however, as in Figure 8, the length become 20.8 inches, it width 7 inches and its height 5-1/2 inches, a size that can readily be carried on a backpack. By fabricating the poles from extruded aluminium and by using aluminium hinges, the stretcher weights only 10.5 pounds. Tests also have revealed that only six seconds are required to fully deploy it from its folded condition and seven seconds are required to refold it. To open the stretcher from its folded condition, it is only necessary to flip the articulated poles into longitudinal alignment, separate them to the extent permitted by the width of the fabric sheet and then rotate the segmented poles 90° to orient the hinge axes perpendicular to the plane of the fabric sheet. The linkages 154 and 156 may then be pushed in the "open" direction (Figure 7) to deploy the stretcher legs and to maintain the spacing between the articulated poles.

While in the drawings, the poles are shown as being of a circular cross-section, they can also be formed from square tubing. The hinges 136, 138 and 140 may be precast from aluminium and welded to the tubes as indicated. Alternatively, they can be machined or otherwise integrally formed with the tubes.

This invention has been described herein in considerable detail in order to comply with the Patent Statutes and to provide those skilled in the art with the information needed to apply the novel principles and to construct and use such specialized components as are required. However, it is to

be understood that the invention can be carried out by specifically different equipment and devices, and that various modifications, both as to equipment details and operating procedures, can be accomplished without departing from the scope of the invention itself. For example, the hinge plates or pole segments can be of equal or unequal lengths and can be fabricated from a choice of materials including various metals, metal alloys, plastics or wood. Extruded aluminium tubing is preferred for the stretcher embodiment because of its balance of strength and lightweight. The hinges and poles of the stretcher can be made as one unit using a suitable die-mould casting technique. Furthermore, the flexible sheet supported by the articulated poles need not necessarily be a cloth fabric, but may instead be plastic, fiber-reinforced plastic or even rigid plastic segments which are linked together by hinge elements to allow folding thereof. Stated otherwise, the plates need not be rigid but can be flexible as with the stretcher embodiment.

Claims

1. A collapsible structure capable of conversion to a load-supporting device, comprising:

(a) at least first and second rows of aligned plates, each plate having a longitudinal edge and a transverse edge perpendicular to said longitudinal edge;

(b) first hinge means for coupling adjacent ones of said plates in said first row together along said transverse edges of said aligned plates for rotation about an axis aligned with said transverse edges;

(c) second hinge means for coupling adjacent ones of said plates in said second row together along said transverse edges of said aligned plates for rotation about an axis aligned with said transverse edges; and;

(d) third hinge means for coupling said first and second rows of plates for rotation about said longitudinal edges of said aligned plates in said first and second rows, whereby alignment of the axes of said first and second hinge means normal to the direction of an applied force allows folding of said first and second rows of aligned plates and alignment of the axes of at least one of said first and second hinge means parallel to said applied force by rotation of said first and second rows of aligned plates by said third hinge means prevents folding of said first and second rows of aligned plates.

2. The collapsible structure as in Claim 1 wherein said third hinge means is a further row of aligned plates hinged together about parallel axes aligned with the transverse edges of said aligned plates in said first and second rows.

3. The collapsible structure as in Claim 2 wherein said further row of aligned plates each include a central opening therethrough.

4. The collapsible structure as in Claims 2 or 3 and further including brace means for releasably latching said structure in its non-foldable state.

5. The collapsible structure as in Claim 1 and further including a fabric sheet joined between said first and second rows of aligned plates.

6. The apparatus as in Claim 1 wherein said collapsible structure forms a bridge, a table, ladder, or stretcher when converted to said load-supporting device.

7. A foldable structure which can be extended to support a load comprising:

(a) generally flexible rectangular sheet having first and second longitudinal edges;

(b) first and second articulated support members each including a plurality of rigid segments and hinge means joining said plurality of rigid segments in an end-to-end relation said hinge means including a hinge axle which when oriented perpendicular to the direction of an applied force, permits said rigid segments to fold toward or away from an adjacent segment depending upon the direction of said applied force and which when oriented parallel to said applied force inhibits folding of said segments toward or away from its adjacent segment; and

(c) means for securing said first and second articulated support members along said first and second longitudinal edges of said sheet, respectively, while permitting at least limited rotation of said first and second articulated support members about their longitudinal axes whereby said hinge axes can be selectively oriented parallel to or perpendicular to the direction of said applied force.

8. A folding stretcher for facilitating the transport of non-ambulatory patients, comprising:

(a) a pair of articulated poles, each including at least one hinge disposed at a location effectively dividing said articulated poles into a plurality of foldable section, said hinge allowing the pole sections joined thereby to fold together about a hinge axes through a predetermined angle; and

(b) a generally rectangular, flexible, fabric having opposed side edges thereof secured to said poles allowing rotation of said poles whereby said hinge axes can be oriented perpendicular to the plane defined by said parallel articulated poles whereby a load can be carried on said fabric without folding said poles and allowing folding of said sections relative to one another when said articu-

lated poles are rotated so that the hinge axes are oriented parallel to the plane defined by said parallel articulated poles.

9. A collapsible/extensible structure comprising:

(a) first and second articulated support members, each including a plurality of rigid segments;

(b) a plurality of hinges joining said plurality of rigid segments together in end-to-end relation about a hinge axle, the hinge axles of each of said plurality of hinges being oriented parallel to one another and arranged such that when force is applied only perpendicular to said hinge axles, adjacent segments will rotate relative to one another and when a force is applied only parallel to said hinge axles, adjacent segments will not rotate relative to one another;

(c) a generally rectangular flexible sheet having each longitudinal edge thereof coupled to one of said first and second articulated support members; and

(d) latch means for selectively maintaining said first and second support members in parallel, spaced-apart relation when said first and second articulated support members are rotated to align said hinge axles perpendicular to the plane of said flexible sheet.

10. The foldable structure as in Claim 7 and further including pivotally connected linkage means extending between said first and second articulated support members.

11. The foldable structure as in Claim 10 and further including leg members pivotally joined to said first and second articulated support members and actuated by said linkage means.

12. The foldable structure as in Claim 7, 10 or 11 wherein said foldable structure is a stretcher for transporting a non-ambulatory person.

13. The foldable structure as in Claim 7, 10, 11 or 12 wherein said flexible rectangular sheet is a woven fabric, or is a sheet of plastics material, or is a sheet of fiber-reinforced plastics material.

14. The foldable structure as in Claim 7, 10, 11, 12 or 13 wherein said rigid segments are extruded tubular metal, or plastics.

15. The folding stretcher as in Claim 8 wherein said hinge includes means preventing movement more than a predetermined angle when adjacent segments are rotated away from one another.

16. The folding stretcher as in Claim 8 or 15 and further including hand grips on each end of said pair of articulated poles.

17. The folding stretcher as in Claim 8, 15 or 16 and further including means for latching said pair of articulated poles in parallel, spaced-apart relation.

18. The folding stretcher as in Claim 17 wherein said means for latching includes first and second linkages pivotally coupled at one end there-

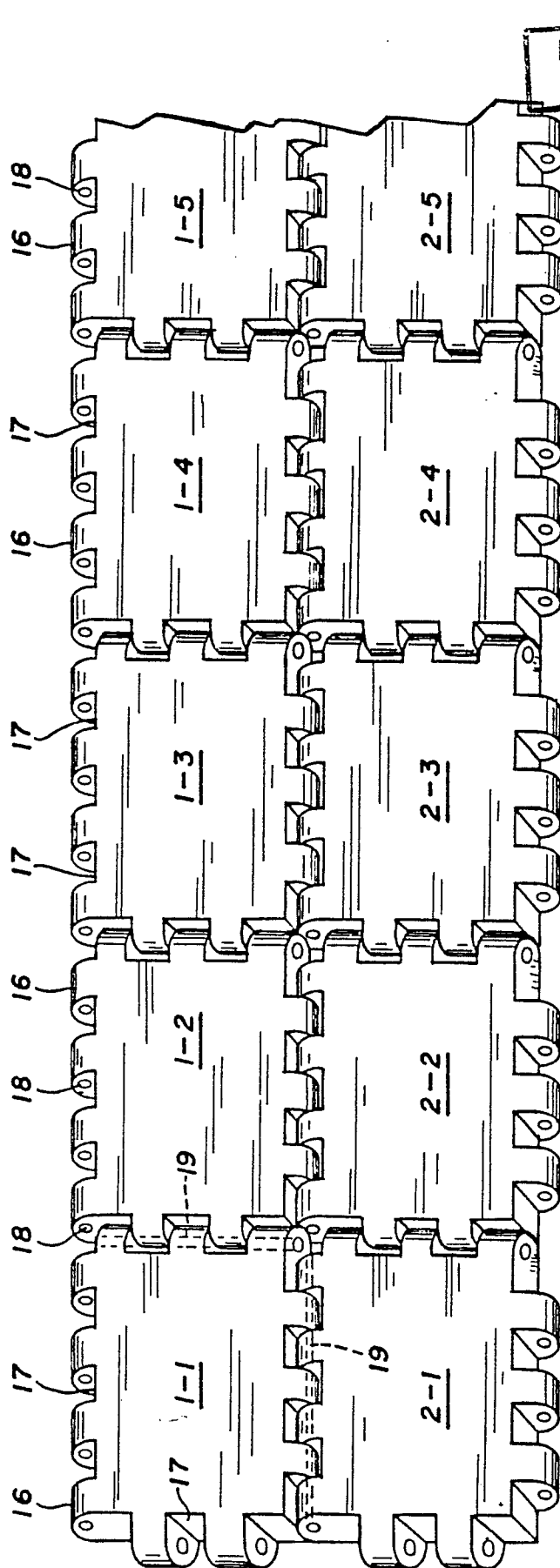
of to a respective one of said pair of articulated poles and pivotally coupled at the other end thereof to an over-centre stop member, the combined length of said first and second linkages and said over-centre stop member, when substantially aligned, being slightly greater than the width dimension of said rectangular fabric, such that the resiliency of said fabric maintains the latching means in its latched state.

19. The folding stretcher as in Claim 8, 15, 16, 17 or 18 wherein said poles are made of extruded aluminium.

20. The folding stretcher as in Claim 8, 15, 16, 17, 18 or 19 and further including foldable legs secured to said pair of poles proximate opposed ends thereof.

21. The structure as in Claim 9 wherein rotation of said first and second articulated support members to orient said hinge angles perpendicular to the plane of said flexible sheet maintains said structure in a rigid, extending condition and/or rotation of said articulated support members orienting said hinge axles in alignment with the plane of said flexible sheet allows folding of said plurality of rigid segments relative to one another.

22. The structure as in Claim 9 or 21 wherein said hinges each include stop means for preventing rotation of adjacent rigid segments more than a predetermined angle relative to one another.



Neu eingereicht / Newly filed
Nouvellement déposé

FIG. 1a

Neu singelstich / Einzelstich
Neu voll und wiederholt

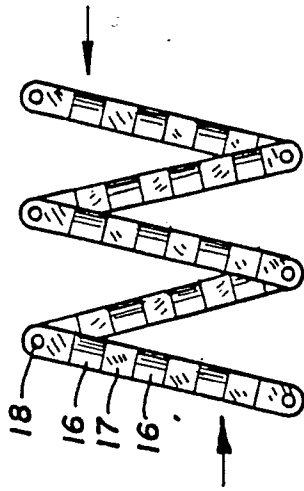


FIG. 1c

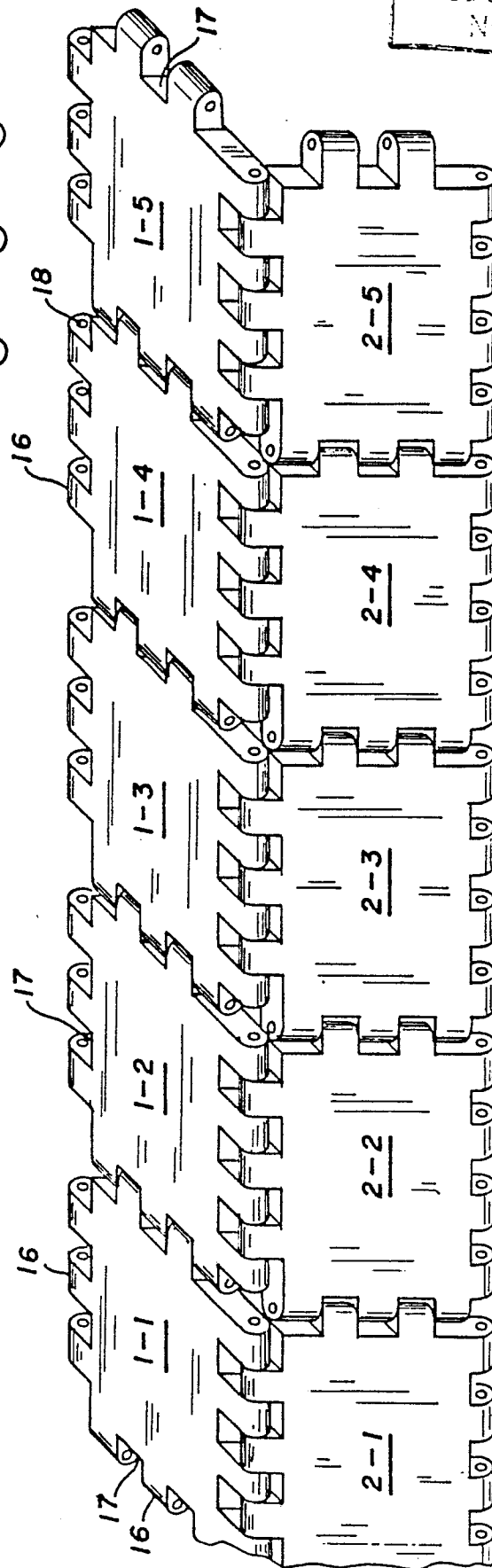


FIG. 1b



Neu eingereicht am 1. 11. 1984
Nouvellement déposé le 1. 11. 1984

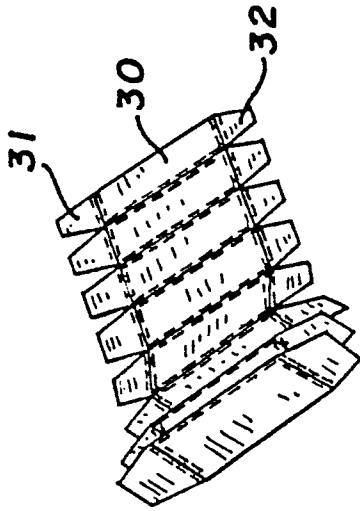


FIG. 2a

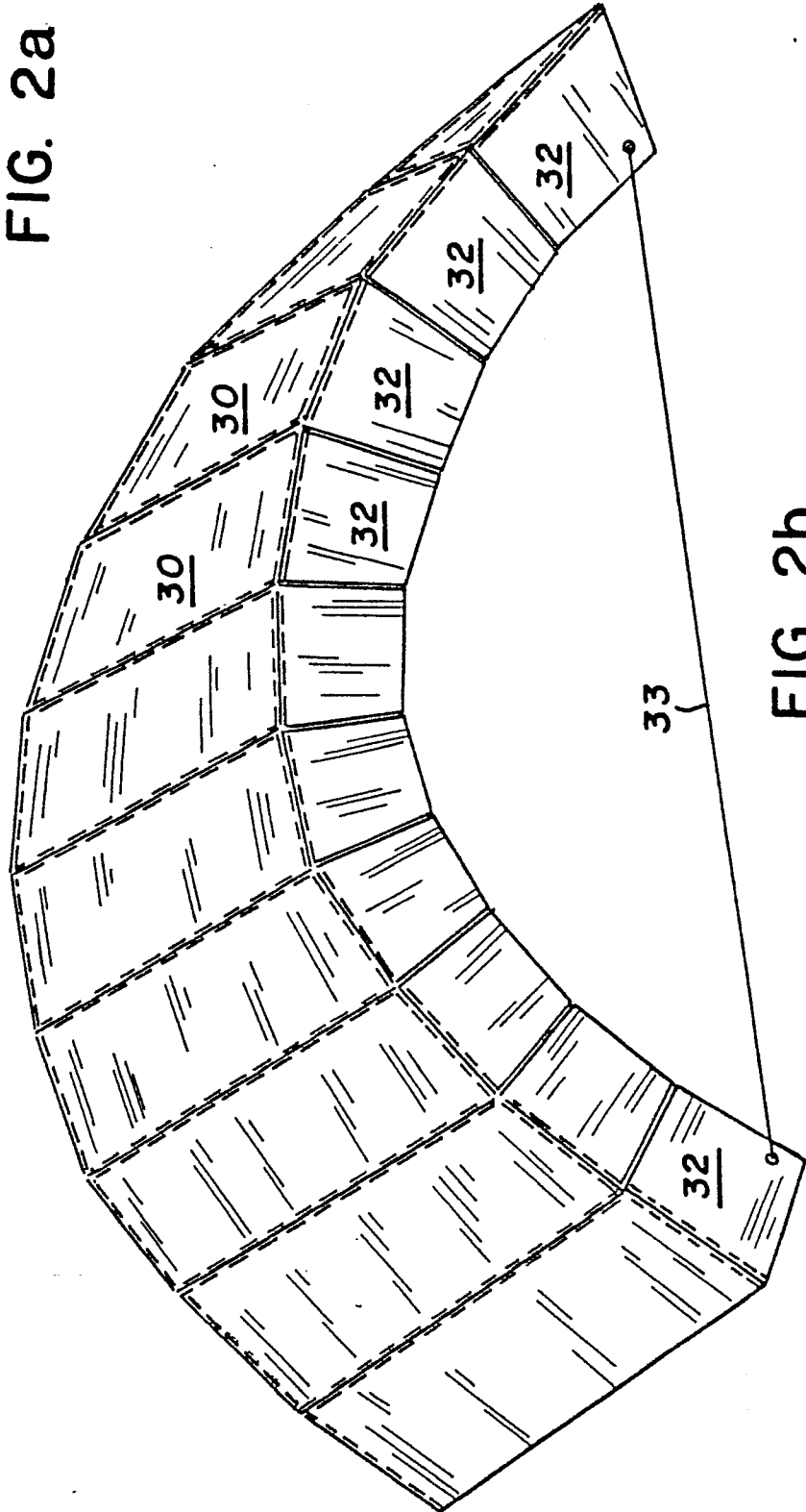


FIG. 2b



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NOT A DESIGN

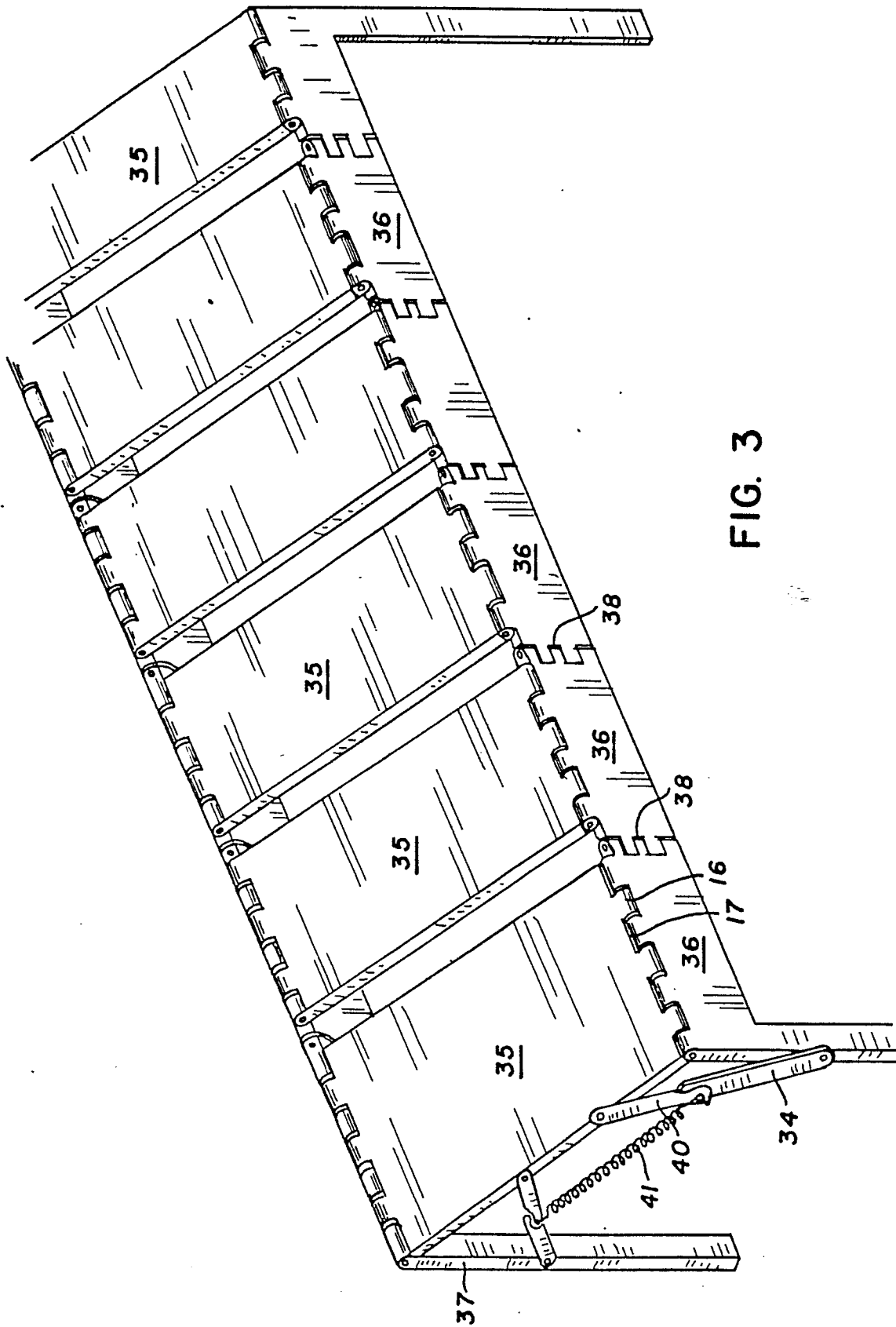


FIG. 3

Neu eingereicht / Newly filed
Nouvel brevet déposé

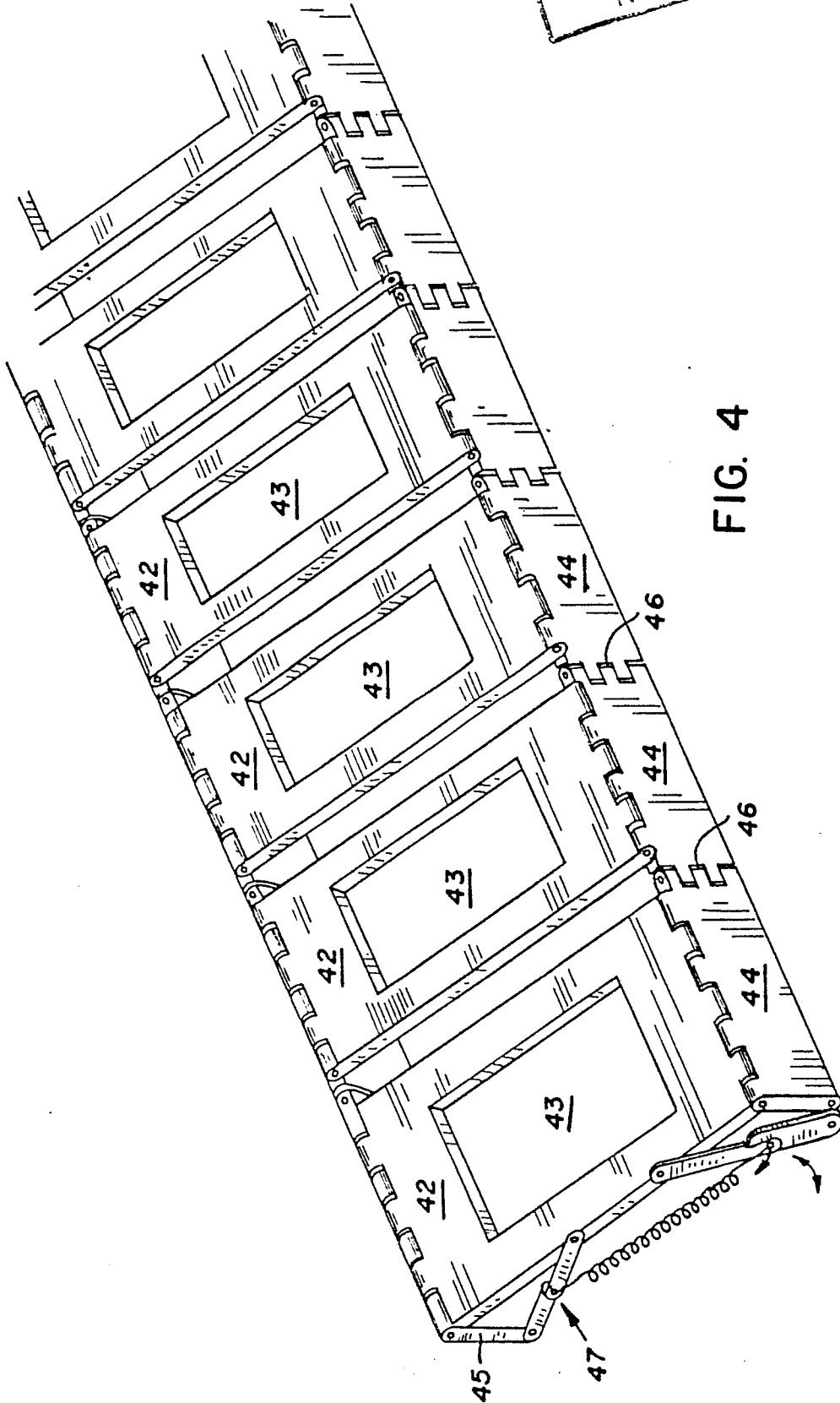


FIG. 4

Neu eingereicht / Newly filed
November 19, 1985

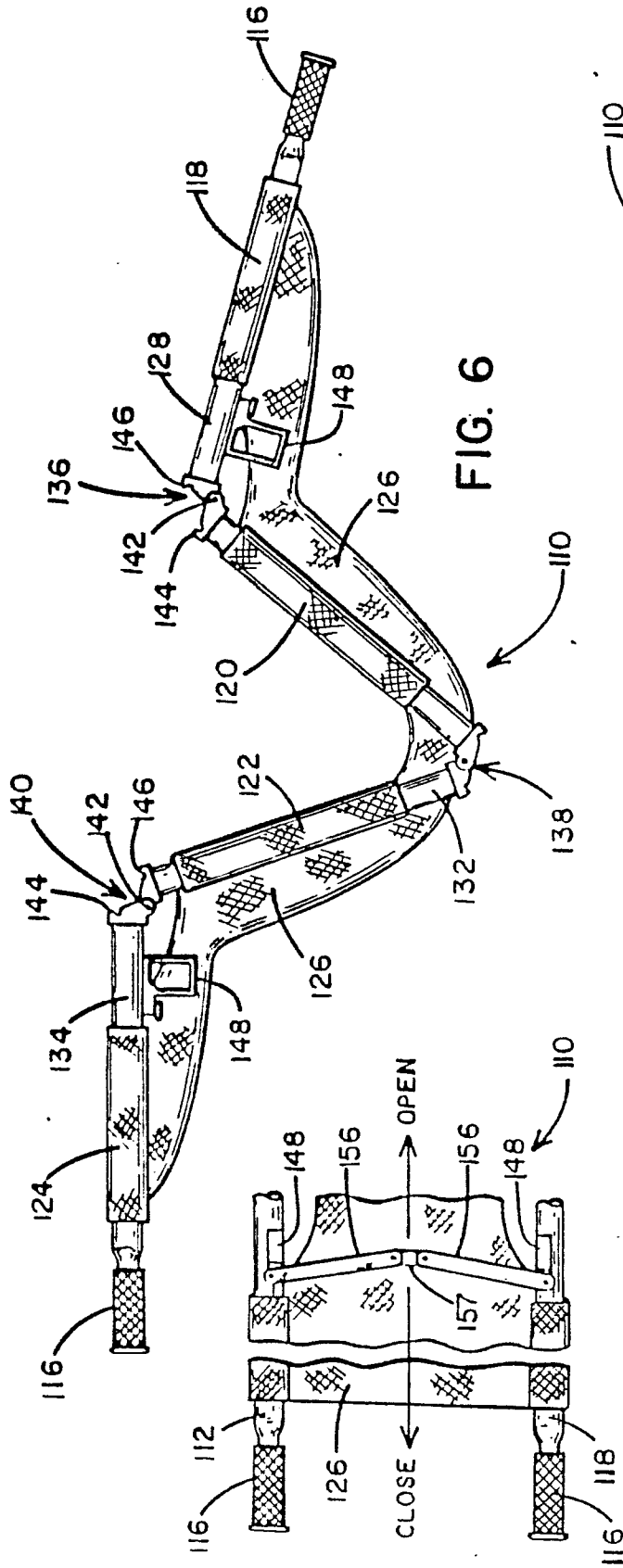


FIG. 5

FIG. 6

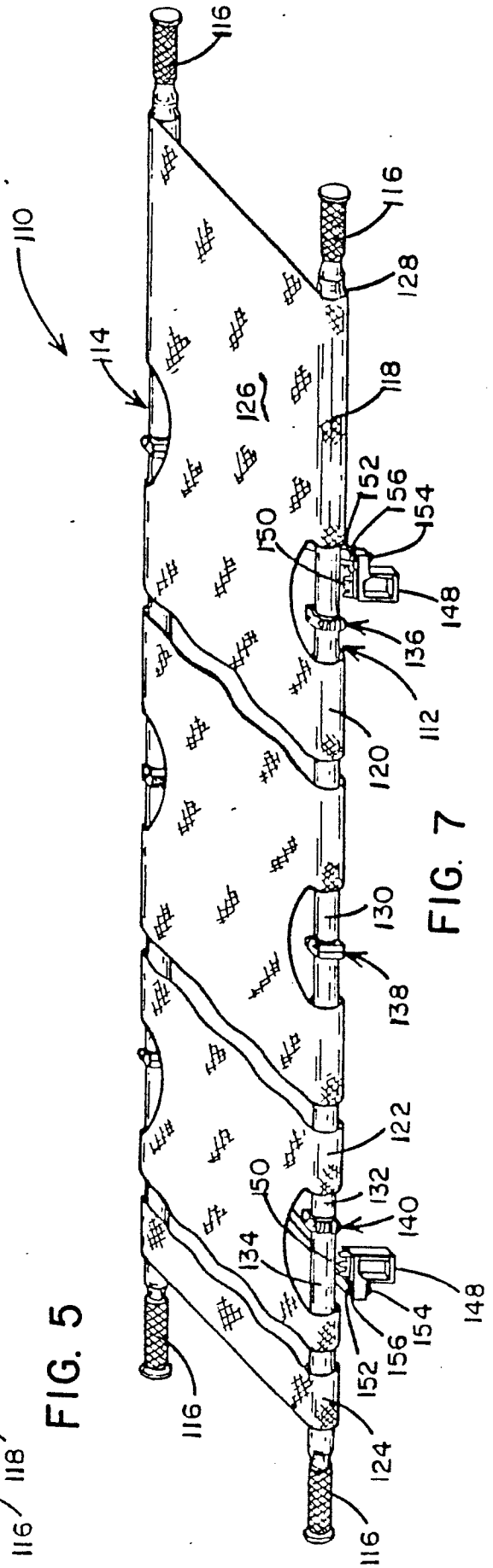


FIG. 7

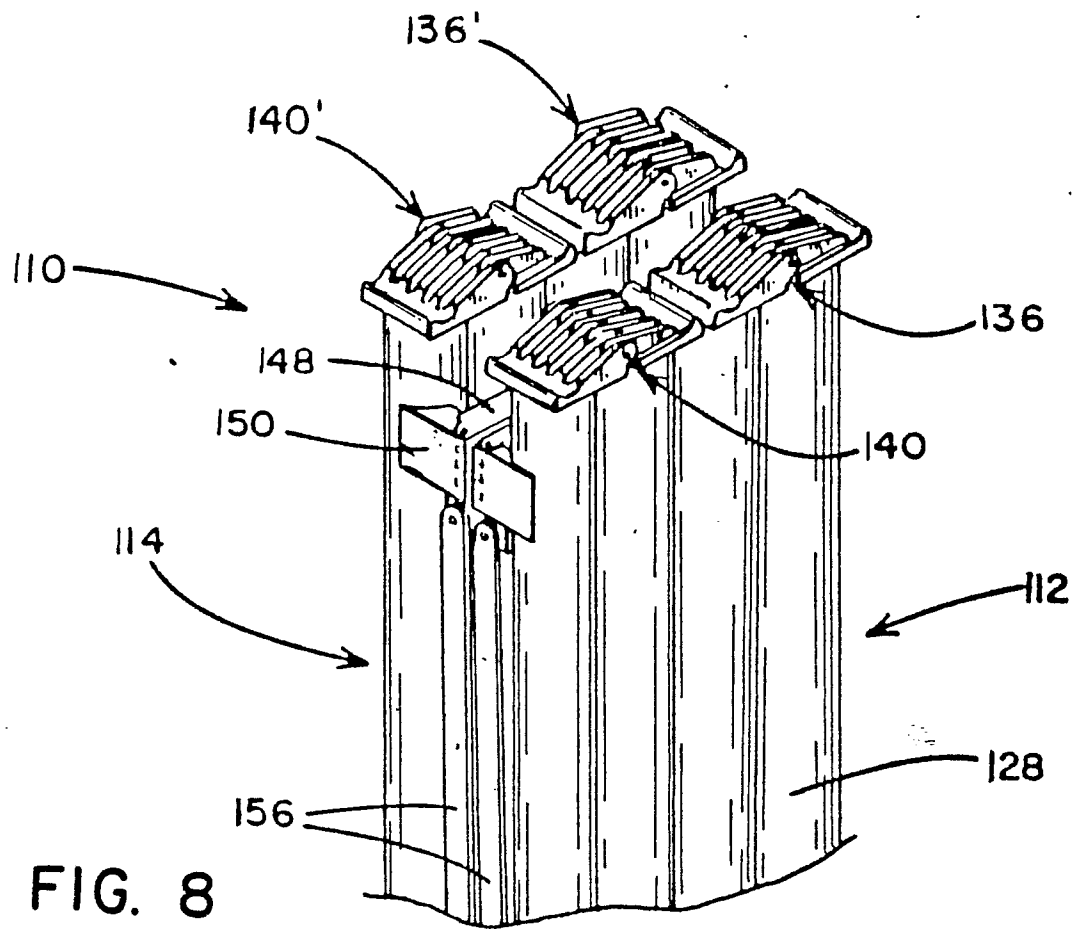


FIG. 8

