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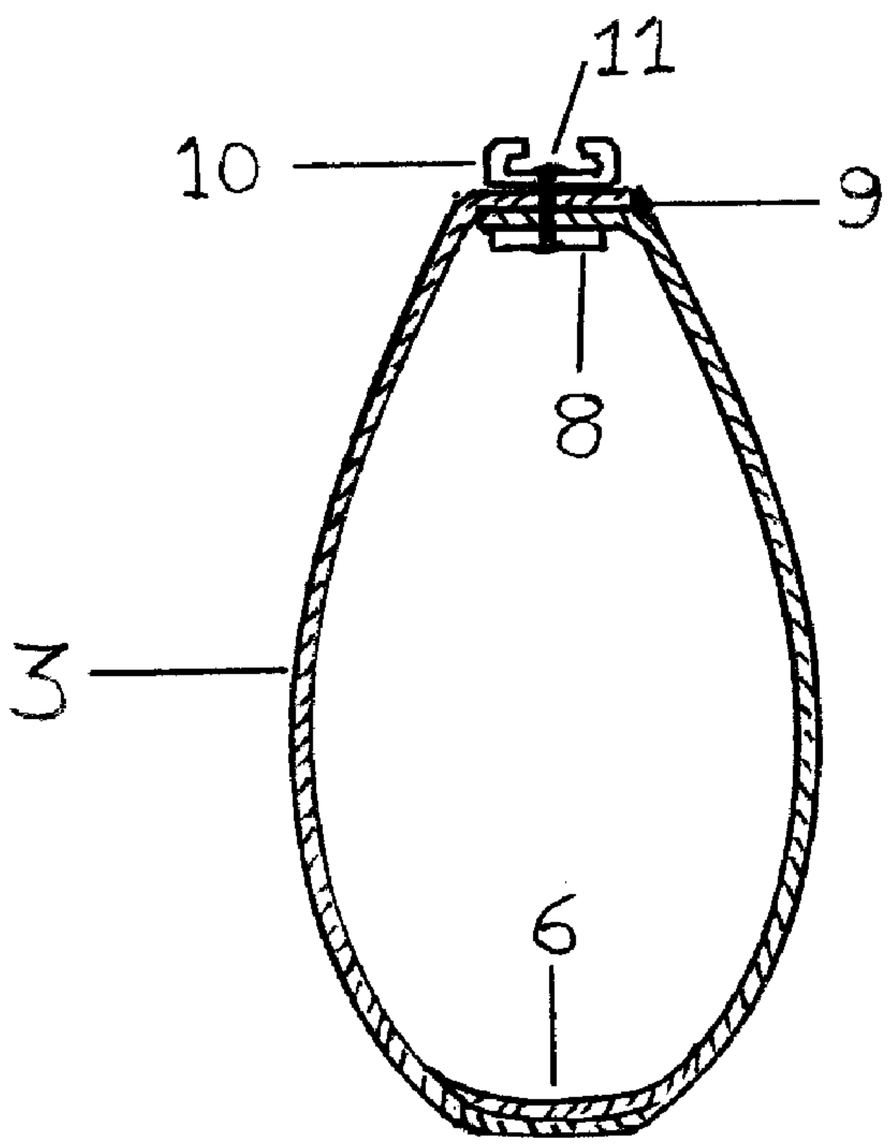
(54) Titre : PROCESSUS DE FABRICATION DE MATS, D'ESPARS OU DE COLONNES DE PLASTIQUE ARME
(54) Title: A PROCESS FOR MANUFACTURING FIBRE REINFORCED PLASTIC MASTS, SPARS OR COLUMNS



(57) Abrégé/Abstract:
This is a process for laminating spars, masts or columns using fibre reinforced plastics such as carbon fibre/epoxy, using a concave or "U" shaped female mould. After curing, the "U" shaped section is removed from the mould and clamped so that the flanges meet or overlap and can be bonded and/or fastened together to form a closed section with the finished surface on the outside.

A PROCESS FOR MANUFACTURING FIBRE REINFORCED PLASTIC MASTS, SPARS OR COLUMNS

ABSTRACT

This is a process for laminating spars, masts or columns using fibre reinforced plastics such as carbon fibre / epoxy, using a concave or "U" shaped female mould. After curing, the "U" shaped section is removed from the mould and clamped so that the flanges meet or overlap and can be bonded and / or fastened together to form a closed section with the finished surface on the outside.

A PROCESS FOR MANUFACTURING FIBRE REINFORCED PLASTIC MASTS, SPARS OR COLUMNS

SPECIFIC

This process relates to the production of light, high strength columns, masts or spars such as but not limited to those used in the sailboat industry, using fibre reinforced plastics such as carbon, Kevlar® and glass fibres, impregnated with a bonding resin such as epoxy or polyester.

In general, fibre reinforced masts or spars such as those used in the sailboat industry are wound or moulded around a male mould or mandrel and require finishing on the outside which is labour intensive and therefore expensive.

Alternatively, they are hand laid-up as two or more separate parts using female moulds and later bonded longitudinally to form the closed section, a time consuming process that requires careful control to produce reliable bonded joints. In addition, both methods usually employ vacuum bagging and heat curing in large ovens or autoclaves further adding to the cost of production.

In another method described in Patent Document EP-A-O 396 269, Howlett, Ian, C. (GB), 7th Nov. 1990, the aft face of the mast, with side flanges, are first moulded in a female mould with removable sides. After curing, the mould sides are removed to expose the exterior faces of the flanges, and mast-shaped male forms are placed inside the cured section. The remainder of the mast is then moulded around the male forms and the exposed flanges to complete the closed section. This method seems even more complicated than those previously described and I am not aware of any manufacturer using this process.

My single concave or "U" shaped female mould method overcomes many of these problems by enabling the part to be moulded using any of the conventional lay-up techniques and makes it easy to vary the thickness, orientation and composition of the moulding without affecting the outside dimensions of the finished part. The cross-section of the concave female mould required that will ultimately produce a closed finished section of the desired shape can be easily pre-determined by calculation, trial and error, or more usually a combination of the two.

The single join required to produce the closed section is also relatively easy to effect and can be done in a number of different ways, some of which are illustrated here.

In addition, before the cured part is clamped closed and bonded, inserts and backing plates can be bonded or fastened to the inside of the section to absorb localized loads that might be caused by fittings and fastenings such as spreaders, tangs, tracks or sheaves in the case of sailboat masts. Additional pieces such as conduit for wiring can also be added at this stage.

If a coloured gel-coating is used against the mould surface, the part will not require painting and in the example illustrated will need only a small amount of finishing work along one edge of the bonded joint. Alternatively, a sail track or similar, that is to be fastened over the joint, can be so shaped as to hide the unfinished edge further reducing finishing time.

Yet another advantage of this method is that the clamping together of the "U" shaped section pre-stresses the walls thereby increasing their resistance to buckling.

THE DRAWINGS

In the drawings, Fig. 1 shows the cross section of a female mould for a typical sailboat mast in which 1, is the mould, (typically glass reinforced plastic) and 2, is a plywood brace/stand which allows the mould to be turned on its side to facilitate application. The part 3, with turned in flanges 4 & 5, and a material overlap 6, is applied to the mould through the opening 7. After partial or complete curing, an aluminum or similar strip 8, is bonded to the underside of the right flange 5, which is lower than the left flange 4, by an amount equal to the intended thickness of the part.

Fig. 2 shows the cured part 3, removed from the mould with the flanges clamped together to form a closed section. A bonding agent such as epoxy, 9, has been applied between the flanges, and an aluminum or similar sail track 10, has been fastened 11, with suitable fasteners such as pop-rivets or self-tapping or machine screws, through the flanges to the aluminum strip 8, on the inside, pulling the joint closed and creating both a chemical and a mechanical bond. In this example, the double thickness created by the overlap 6 on the leading edge, is balanced by the double thickness of the bonded flanges on the trailing edge to create added stiffness in the fore and aft axis. Added stiffness in the athwart-ship axis may also be created during the moulding stage by introducing an overlap on the sides or by adding a narrow layer or layers of unidirectional fibres in that area.

Fig. 3, is an example of a simple clamp that can be made from plywood and 2"x 4" (50mm x 100mm) lumber and used to clamp the cured "U" shaped part into the required closed section. It consists of a fixed base and side 12, and a pivoting side 13, which pivots on the bolt & nut 14 and is opened and closed by means of a threaded screw 15, turning in a metal tubing 16. A series of the clamps are arranged at equal intervals along the length of the cured part and are held together longitudinally by the 2"x4" (50mm x 100mm) lumber 17, which comprises the base and the jaws. A bonding agent is applied to the flanges and the cured part 3, is clamped shut evenly along its length until the flanges 4 & 5, are fully overlapped at which point the exterior track can be positioned and fastened.

Fig. 4 shows an alternative method of bonding, whereby the flanges 18 & 19 are not designed to overlap but instead are inserted into a pre-formed extrusion 20, with or without a bonding agent 21, and then through fastened with suitable fasteners 22, such as pop-rivets or self-tapping or machine screws. An added advantage of this method is that the edges of the flanges require no further finishing.

Fig. 5 shows a method of bonding non-overlapping flanges when no exterior attachment is required. Layers 23, of the same or similar material as the part are applied across the flanges 18 & 19, and after curing are rounded off at the edges 24, to provide a smooth finish.

CLAIMS

1 In a process for manufacturing a fibre-reinforced plastic part selected from the group consisting of masts, spars and columns, using conventional fibre-reinforced plastic moulding techniques such as hand lay-up or automated machinery applications, and conventional materials such as dry or pre-impregnated fibres and hot or cold cure resins, or any combination thereof, the improvement comprising moulding and curing the part (3) in a concave female mould (1) as an open or U-shaped section and subsequently clamping, bonding and fastening (8, 9, 10, 11), or bonding or fastening alone, said section into a closed portion.

2 A fibre reinforced plastic mast, spar or column, when produced by the process according to claim 1.

FIG 1

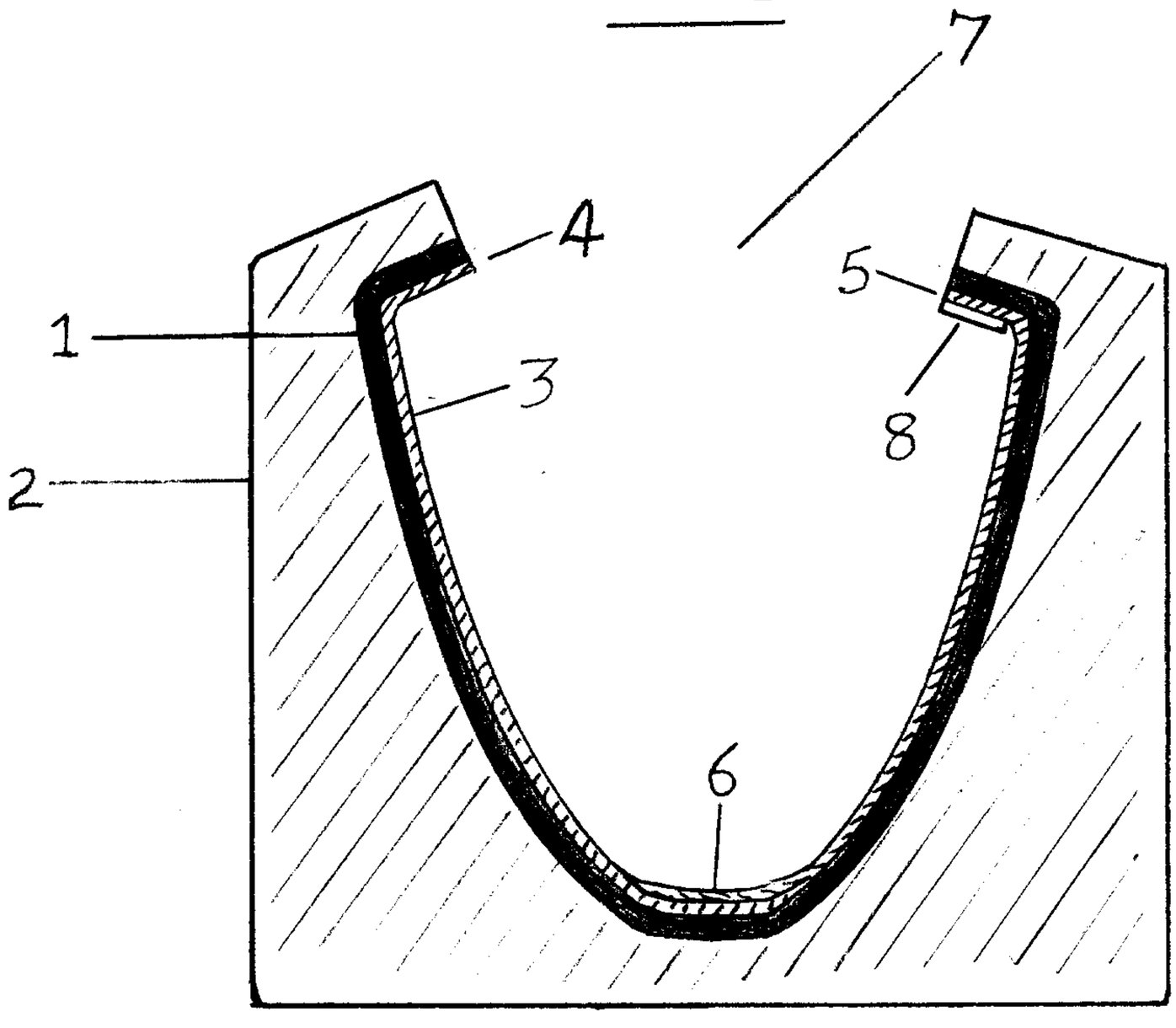


FIG 2

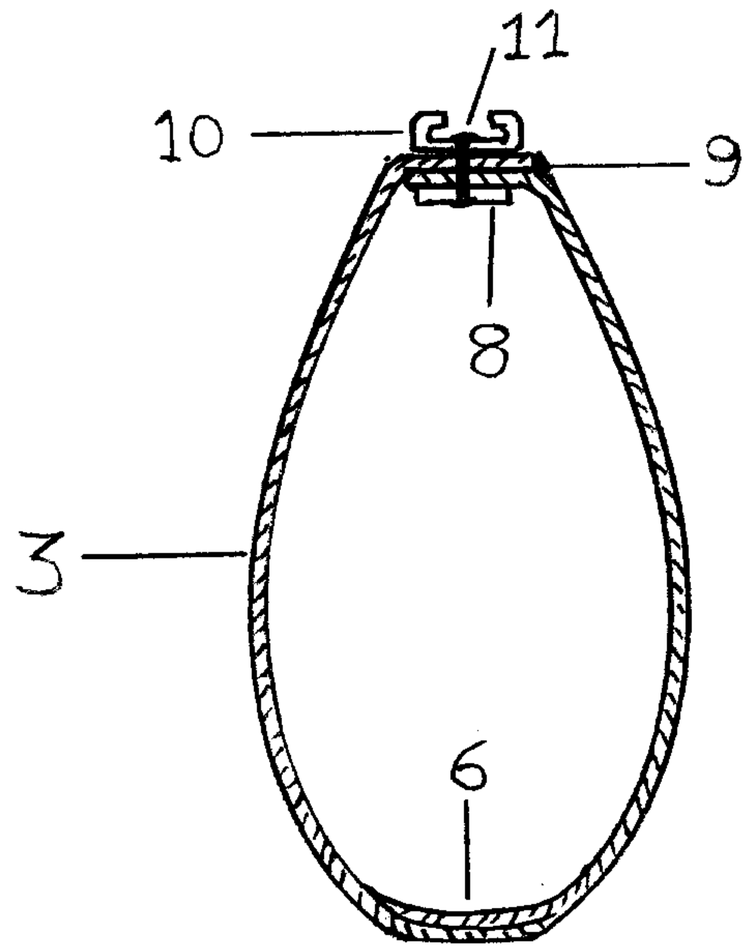


FIG 3

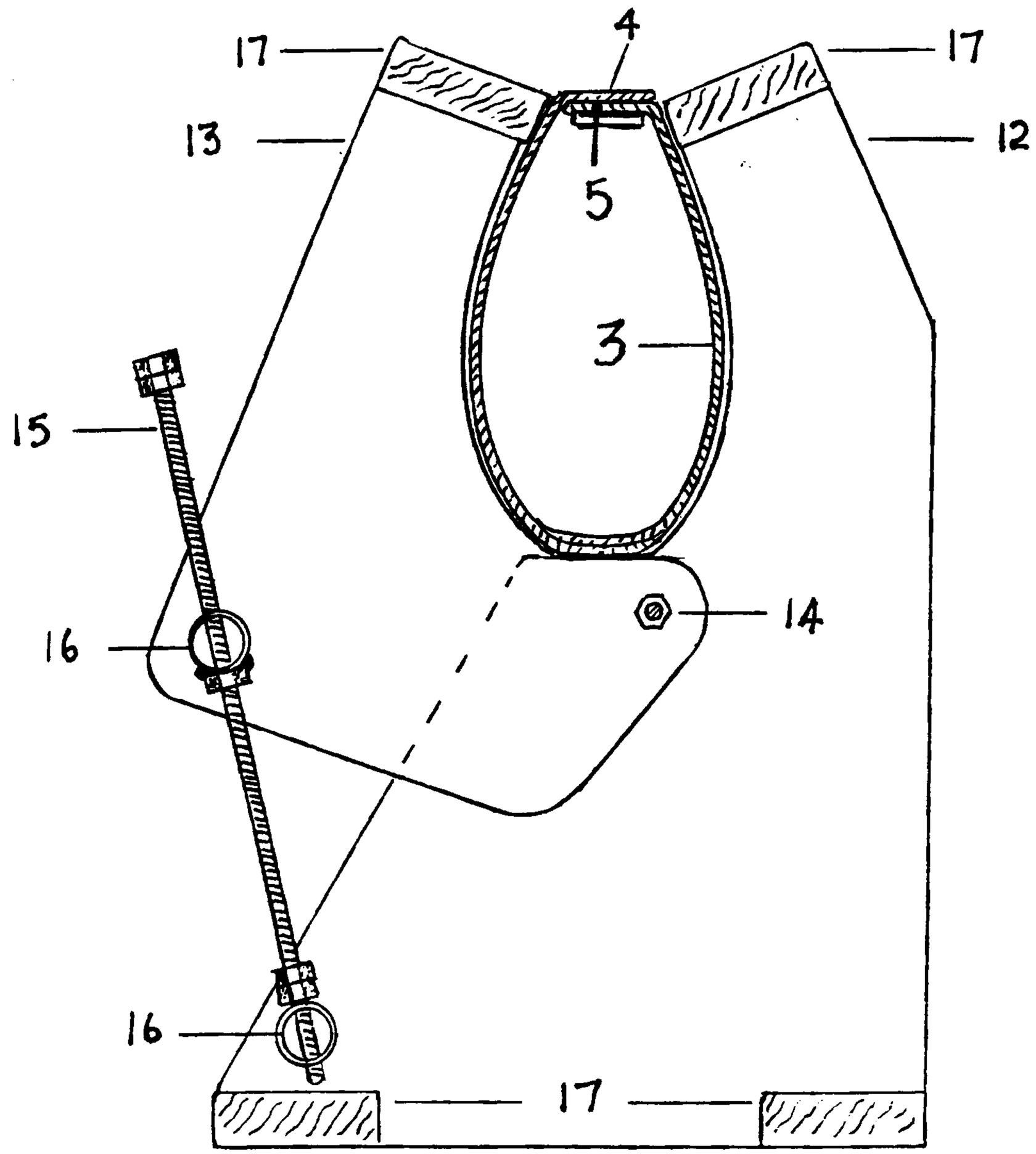


FIG 4

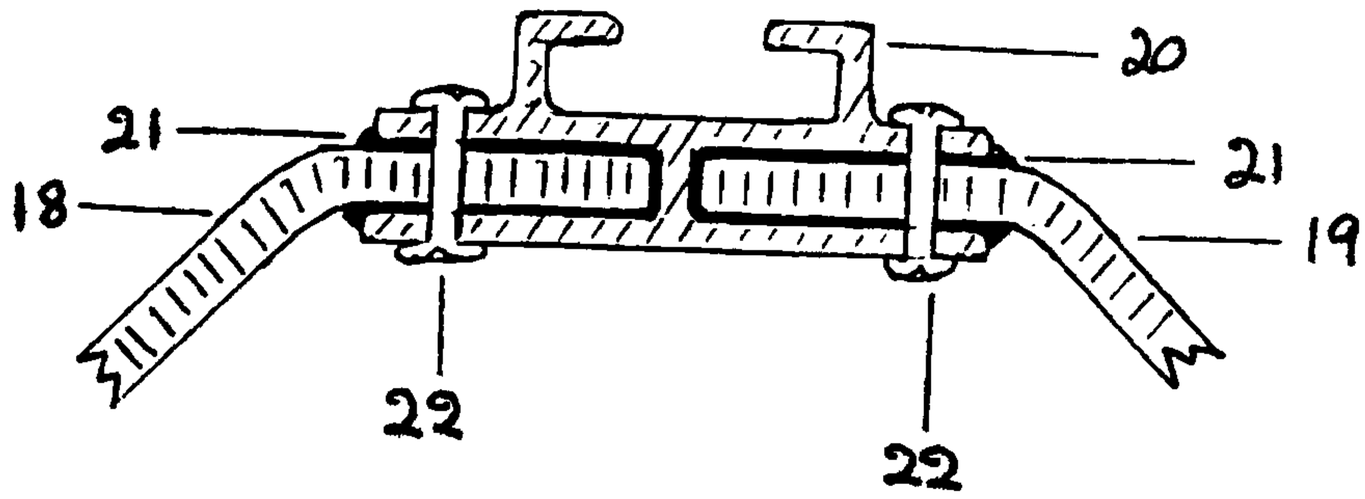
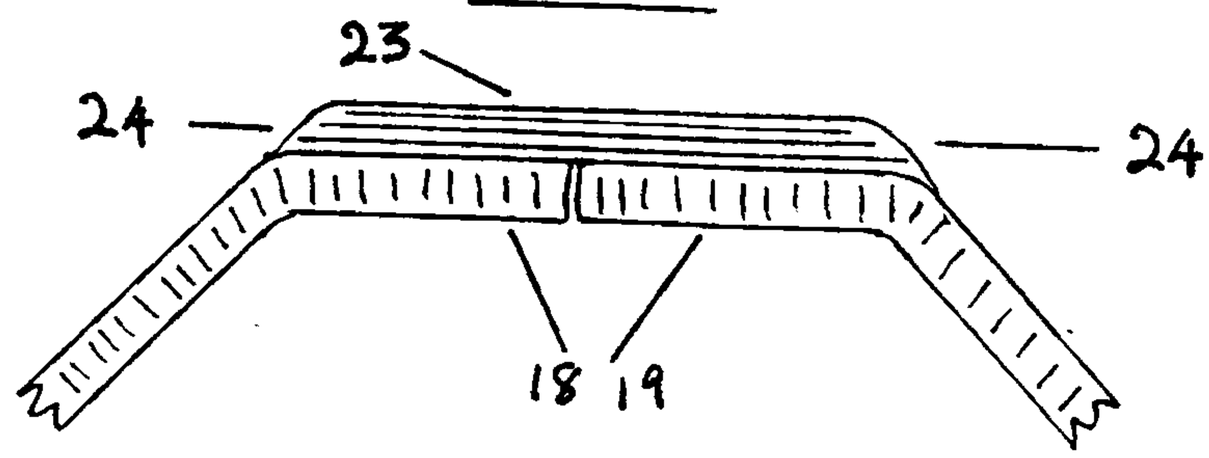
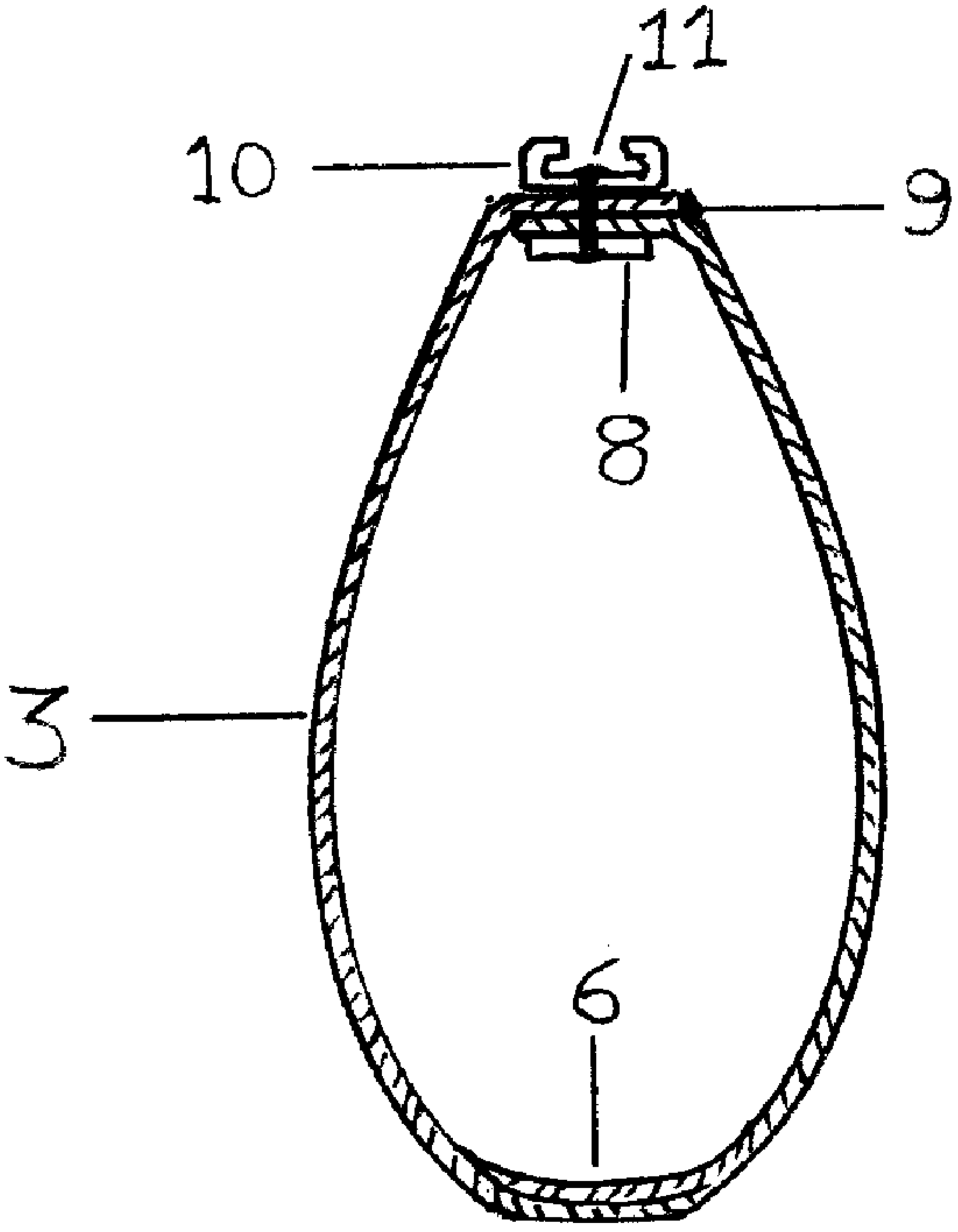


FIG 5

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