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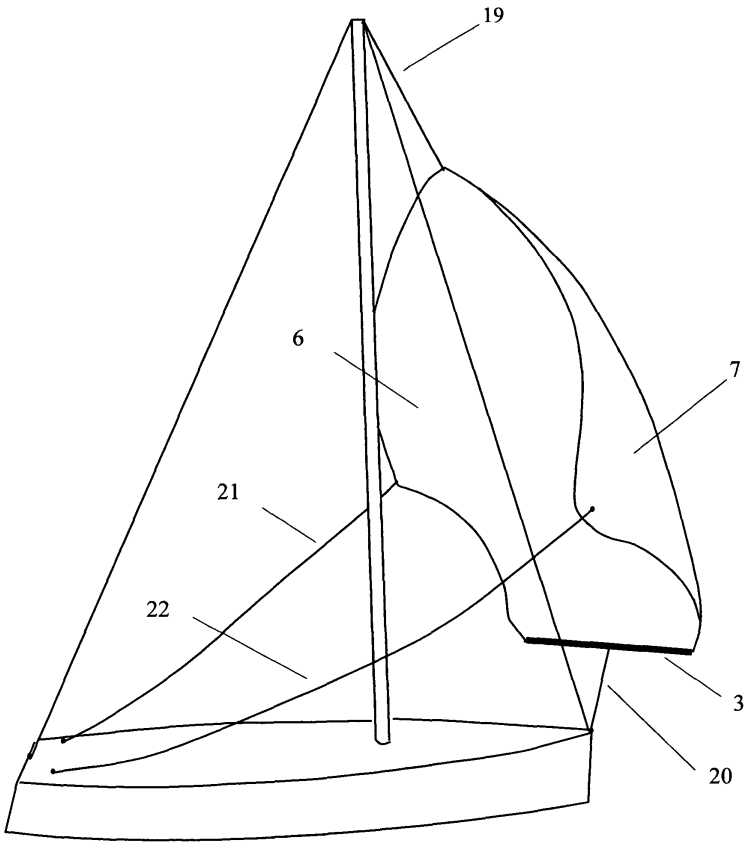
(71) Applicant: **Simons, Michael John**
Middlesex HA4 8SX (GB)

(72) Inventor: **Simons, Michael John**
Middlesex HA4 8SX (GB)

(54) Sail for sailing vessels

(57) A sail for sailing downwind comprising a centre section (1) whose lower edge is attached to a lower spar (3), and two wing sections (6 and 7) which extend outward from each side of the centre section to increase the width of the sail significantly beyond that of the centre section. The sail may optionally have an upper spar (2), and a peaked upper part (25) joined to the centre and wing sections. It may be supported by a halyard (19) and be attached to the bow by a strop (20) and the wing sections may be attached to port and starboard sheets (21 and 22) to control the angle of the sail to the wind, the whole sail assembly being approximately symmetrical about a vertical centre line on which lie the halyard and strop attachment points. Compared with spinnakers and cruising chutes of the prior art, the sail offers advantages in ease of deployment and trimming, and is self-gybing.

FIGURE 6



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Description

[0001] The invention relates to a sail for sailing boats, and particularly to a sail for sailing downwind.

[0002] Modem sailing vessels are normally fore-and-aft rigged with three-sided sails as in the Bermudan sloop rig. Such rigs are efficient when sailing upwind or across the wind, but often do not provide enough sail area when sailing with the wind behind, or downwind, in light or moderate breezes.

[0003] To increase sail area, a special downwind sail may be used. Known downwind sails include spinnakers, cruising chutes or asymmetric spinnakers, and poled-out foresails. All these have drawbacks.

[0004] Spinnakers are very effective, but require a strong spinnaker pole with two or three pole control lines, and are complicated to set up. In use, they require careful trimming and constant attention, and gybing requires transfer of the pole to the other side of the boat. They are suitable for fully crewed racing boats, but not for a cruising yacht with limited crew.

[0005] Asymmetric spinnakers are used on fast racing vessels, and are also used as "cruising chutes" on cruising yachts. They are less effective when the wind is astern, when they require poling out with a long pole, and gybing, when the direction of the wind changes from one side of the stem to the other, requires transfer of the sail to the other side of the boat.

[0006] Twin foresails poled out on opposite sides can be used when the wind is astern, but are not effective when the wind comes over the quarter or more abeam.

[0007] Square sails suspended from an approximately horizontal spar have been used since ancient times and provide stable and versatile downwind performance. However the spar extends the full width of the sail, and must be substantially rigid, which makes it too long, bulky and heavy for convenient use on a modem sailing vessel.

[0008] The above mentioned types of sail are widely known in the art and history of sailing. A useful overview of known types of sail, including the above, may be found in the book "Sails and the way they work", 2nd edition, by Derek Harvey, publ. Adlard Coles Nautical, London, 2002, while ancient designs of sail may be found in "Ships and Seafaring in ancient times" by Lionel Casson, publ. British Museum Press, London, 1994.

[0009] The invention provides a sail for convenient downwind use which achieves stability by use of a spar or spars but whose novel design allows the spar or spars to be substantially shorter than the width of the sail and also light in weight. The sail of the invention is effective at wind angles from abeam to dead astern, is relatively simple to deploy compared with a spinnaker as it requires no separate pole and pole control lines, it is found to fly stably without need of careful trimming, and does not require a special gybing manoeuvre as the wind crosses from one side of the stem to the other. It thus combines stability and versatility with ease of use in a way not achieved by previously known downwind sails.

[0010] The sail of the invention comprises a centre section whose lower edge is attached to, or capable of being attached to, a lower spar, the sides of the centre section being defined by imaginary lines drawn in the plane of the sail perpendicularly to the ends of the lower spar. Outside the centre section are two wing sections which extend outward from the port and starboard sides of the centre section respectively to increase the width of the sail significantly beyond the length of the lower spar. The top of the sail is capable of being attached to a halyard to raise the sail, the mid part of the lower spar is capable of being attached directly or indirectly to a line or strop to attach the sail to the deck or an extension thereof, and the wing sections are capable of being attached to port and starboard sheets to control the angle of the sail to the wind.

[0011] The sail optionally may be attached to an upper spar which lies substantially above and approximately parallel to the lower spar, and the whole sail assembly, which is flown in front of the forestay, is approximately symmetrical about a vertical centre line drawn between the halyard attachment and the strop attachment points.

[0012] In one embodiment an upper spar may be attached to, and effectively form, the upper edge of the sail, while in other further and preferred embodiments the top of the sail may be peaked and an optional upper spar attached within the body of the sail below the peak.

[0013] By way of example, each wing section may extend beyond the imaginary lines which define the centre section by a distance which is between one third and one and a quarter times the width of the centre section, and typically the total width of the sail may be rather more than twice the length of the lower spar.

[0014] In preferred embodiments of the invention the upper parts of the wing sections are significantly wider and of greater area than the lower parts, where the upper part is approximately that portion of the wing section above the sheet attachment point and the lower part is approximately the portion below it. Furthermore, in these preferred embodiments, curvature in a direction orthogonal to the main plane of the sail is introduced by darts, pleats, shaped panels, and other methods known in the sailmaker's art so as to produce cup-like sections in the perimeter of the upper part of the sail to catch the wind and produce lift. It has been found that the combination of greater width and curvature in the upper part of the sail combined with reduced width and little or no curvature in the lower part of the sail is helpful in causing lift, both upward and laterally outward in the windward wing section in particular, allowing the sail to fly well and to extend its width well outside the width of the spar(s). This is further illustrated in Figures 2 - 7.

[0015] The sail may be made of known sailmaking fabrics and composite materials, including nylon cloth as commonly used in spinnakers. Attachment points and reinforcing panels may be provided as known in the art of sailmaking. Control lines may be provided in the sail, such as perimeter lines analogous to leech lines, which

may be elastic, to control the tension in the outer edges of the sail, or downhaul lines to restrain the fabric of the sail during hoisting or lowering. Reefing means may be provided, for example with reefing points or eyes, or by roller reefing round or within the lower spar.

[0016] Spars for the sail may be made of suitable materials including metals and composite materials including glass or carbon fibre reinforced composites. They may be of tubular or other suitable cross section to minimise weight. They may have a degree of flexibility but should have sufficient rigidity to keep the centre section of the sail extended during use. For convenience, the spars may be capable of being reduced to shorter length sections when not in use. The sail may be attached to each spar at two or more points using appropriate attachment methods including sleeves, bindings, lacings, clips or shackles, or it may be attached by a continuous sleeve around the spar. One or more of the spars may consist of an inflatable tube. If more than one spar is present, they may be of similar lengths, or one may be longer than the other if required. Generally, when the sail is deployed, the spars will be approximately parallel to each other, and approximately horizontal, subject to the effects of wind and sheeting tension. The spars may be straight, or may have a degree of curvature.

[0017] In preferred embodiments of the invention described above, where the top of the sail is peaked and an optional upper spar attached within the body of the sail below the peak, it is found that the upper parts of the sail are substantially self-supporting when filled with the wind, so the loads on the upper spar are light, and it may be of particularly light construction, and may be considered to be similar in some respects to a batten.

[0018] Under some manifestations of this embodiment the upper spar may not be required to be present at all, the sail employing just the single, lower, spar.

[0019] If required, the sail may also have a lower section which is attached to and extends below the lower spar, and this lower section may be attached by a line or lines to the deck or an extension thereof.

[0020] To allow easier handling and stowage of the sail when lowered, it may have a pocket built in adjacent to the lower spar, into which the fabric of the sail may be pushed. The pocket may extend the length of the lower spar, and may have a closure device such as a zip fastener or hook and loop fasteners such as Velcro® along its mouth. Open mesh or netting material may be employed in the structure of the pocket to allow water to drain from it.

[0021] Further details and further aspects of the invention are illustrated by means of drawings shown in Figures 1 to 8, whose detailed descriptions are given below. Figures 1, 2, 4 and 5 show plan views of sails according to the invention when laid flat on a horizontal surface, Figures 3 and 6 show schematic side views of sails of the invention deployed on a sailing boat, Figure 7 depicts the wind flow which provides lift to the wing sections of the sail, enabling them to fly well outside the ends of the spar(s), and Figure 8 illustrates provision of a pocket adjacent to the lower spar.

[0022] The invention is illustrated by reference to Figure 1, which depicts the sail laid out flat, in which the centre section 1 has an upper edge attached to upper spar 2 and a lower edge attached to lower spar 3. The sides of the centre section are defined by imaginary lines 4 and 5 drawn perpendicular to the ends of the lower spar, and the wing sections 6 and 7 extend outward from the sides of the centre section to increase the width of the sail significantly beyond the length of the lower spar. Sheets to brace the sail against the pressure of the wind may be attached at sheet attachment points 8 and 9, and a halyard to raise the sail may be attached by suitable means to the midpoint of upper spar 2, and a strop attached to the deck or to a deck extension may be attached by suitable means to the midpoint of lower spar 3.

[0023] As in a preferred embodiment of the invention discussed above, the upper parts of wing sections 6 and 7 are wider and of greater area than the lower parts, where the upper part is approximately that portion of the wing section above the sheet attachment point and the lower part is approximately the portion below it. The mean width of the upper part of the whole sail may by way of example be between 25% and 75% greater than the mean width of the lower part. In a further preferred embodiment the edge of the upper part defines a convex curve and the edge of the lower part defines a sigmoid shape as illustrated.

[0024] Figure 2 illustrates how curvature may be built into the wing sections of the sail. The features of the sail are as described for Figure 1, but when the sailcloth is laid out flat, darts 10 are introduced into the fabric so that when the edges of the darts are sewn together, the sail becomes curved in the dimension orthogonal to the plan view shown thus providing hollow or cup-like profiles in the regions adjacent to the darts. The darts may be introduced by appropriate cutting of the panels of sailcloth from which the sail is made. The hollow or cup-like profiles allow the wind to provide lift, both upward and laterally outward in the windward wing section in order to keep the sail extended. Preferably the curvature should be greater in the windward wing, to improve lift, and less in the leeward wing so as to reduce drag, and this may be achieved by providing some elasticity in the perimeter 11 of the wing sections either by the nature of the sailcloth used or by incorporating elastic leech lines in the perimeter.

[0025] The sail may also be provided with one or more downhaul lines 12, the downhaul line being optionally laced through cringles or grommets 13 let into the sail so that the sail may be kept restrained by pulling in the downhaul line as the sail is lowered. Provision for reducing the area of the sail in stronger winds may be made by providing reefmg attachments or eyes or cringles 14 in the sail on or near the imaginary lines between the ends of the spars. Reinforcing patches (not shown) may be added to strengthen the sail near the reefing attachments or

cringles. Reefmg lines (not shown) may be led from the reefing attachments or cringles to a fastening point 15 near the end of the lower spar beneath each reefing attachment or cringle. The sail may be reefed by pulling the reefing lines so as to pull the reefing attachments or cringles down towards the fastening points and then securing the reefing lines by appropriate means such as cleats or clamps.

[0026] Figure 3 illustrates how the sail may be deployed on a sailing boat. The boat has a mast 16, supported by a forestay 17, a backstay 18, and by shrouds on either side (not shown). The sail is suspended from the mast 16 by a halyard 19, attached to the upper spar 2. Lower spar 3 is attached to the deck by a line or strop 20, and the sail is rigged in front of the forestay. A port sheet 21 and starboard sheet 22 are attached to the corresponding wing sections of the sail, and the sheets may be led to turning blocks 23 and 24 towards the stem of the boat, and thence to cleats or winches (not shown). The sheets are led outboard of the mast's shrouds. In use, the shape and position of the sail may be controlled by adjusting the length of the strop 20, the tension in the halyard 19, and the tensions and deployed lengths of the sheets 21 and 22. The strop 20 may optionally be attached to a forward extension of the deck in the form of an extendable boom or bowsprit (not shown).

[0027] Figure 4 illustrates a sail of the invention which has a peaked upper part 25 which is contiguous with the centre section 1 and with the port and starboard wing sections 6 and 7. The sail may be attached by suitable means to the upper spar 2, and may be held up by a halyard which is attached to the sail at an attachment point 26 near its peak. Curvature in a direction orthogonal to the main plane of the sail is built into the top and wing sections by means of darts such as at 10 as described above. Port and starboard sheets may be attached at sheet attachment points 8 and 9. The imaginary lines 4 and 5 denote the sides of the centre section. Reefing means and downhaul lines, as described in figure 2, may also be present but are not shown in figure 4.

[0028] Figure 5 illustrates a plan of a sail of the invention similar to that of Figure 4 but with curvature given to the top and wing sections by shaping the horizontal panels of sailcloth. The upper edges of five of the panels are cut away towards the ends (as at 27) so that when the edges are sewn together, curvature is produced in the upper perimeter of the sail. The halyard attachment point (26), sheet (8,9) and lower spar (29) attachment points are shown, and the ends of an optional upper spar may be attached at points 28.

[0029] Figure 6 illustrates a sail as described in figure 5 deployed on a sailing boat. In this example, no upper spar is present. The sail is held up by the halyard 19 which is attached to the sail at the peak of the upper part. The lower spar 3 is secured to the hull near the bow by means of a line or strop 20 and the port and starboard wing sections 6 and 7 are attached to sheets 21 and 22 and the sheets may be led to turning blocks towards the stem of the boat, and thence to cleats or winches, as described for Figure 3. As described for Figure 3, the strop 20 may optionally be attached to a forward extension of the deck in the form of an extendable boom or bowsprit (not shown). Other features of the boat, and control of the shape and position of the sail, are as described for Figure 3.

[0030] Figure 7 illustrates how the wind is believed to flow within a sail of a preferred embodiment of the invention, as shown by the deflection of a thin strip of chiffon fabric held at various points near a fan-blown model sail. A beam wind is represented by the broad arrow 30, and the wind flow within and around the sails by curved arrows such as 31. A stagnation zone represented by the hatched area 32 is found to exist and the airflow to leeward of it flows strongly aft and leeward, while to windward the airflow is to windward and predominately downward. A strong downward flow exits the sail from its narrower regions below the sheets, indicated at 33. It is believed that the reaction to this strong downward flow provides the lift which extends the wing sections of the sail upwards and outwards.

[0031] Figure 8 shows a sail as illustrated in Figure 4 which is fitted with a pocket 34 just above the lower spar 3. The pocket shown comprises a layer of netting fastened or stitched to the main sail fabric at its port, starboard and lower edges. Its upper edge forms a mouth to the pocket and the pocket is formed by the space between the layer of netting and the layer of sail fabric to which its edges are fastened. That part of the sail which lies above the pocket when deployed may be pushed into the pocket when the sail is lowered. The upper edge of the pocket may then optionally be closed by fasteners including zip fasteners or hook and loop fasteners such as Velcro®. Such a pocket arrangement allows for convenient stowage and control of the sail when lowered.

[0032] Other sails, and particularly a mainsail, may be used in conjunction with the sail of the invention.

[0033] The sail of the invention may be used on sailing vessels of various sizes, from model yachts to small dinghies to large yachts, and the size of the sail will be appropriate to the size of the vessel. In the case of a yacht of length 30ft (9.15m), the dimensions of a sail of the invention might be, by way of example and without limiting the scope of the invention, width of upper and lower spars, and centre section, 10ft (3.05m); height between upper and lower spars, 17 ft (5.2m); maximum width of the upper part of the wing section, 8ft (2.4m) beyond the edge of the centre section, and mean width of the lower part of the wing section, 3ft (0.9m) beyond the edge of the centre section. The total height of the sail might be 25ft (7.6m), and the maximum width 25ft (7.6m). Such a sail, including upper section, might have an area of approximately 440ft^2 (41m^2). In the case of a 14ft sailing dinghy, the sail might have spars of length 4ft (1.2m), a sail height and width of 11 ft (3.4m), and an area of about 80 ft^2 (7.4 m^2).

Claims

1. A sail which can be flown in front of the mast and forestay of a boat, the sail having a centre section whose lower edge is attached to, or capable of being attached to, a lower spar, the sides of the centre section being defined by imaginary lines drawn in the plane of the sail perpendicular to the spar at each of its ends, the sail being **characterised by** two wing sections which extend outward from the port and starboard sides of the centre section respectively to increase the width of the sail significantly beyond the length of the spar, the top of the sail being capable of being attached directly or indirectly to a halyard to raise the sail, the lower spar being capable of being attached directly or indirectly to a line or strop to attach the sail to the deck or an extension thereof, and the wing sections being capable of being attached to port and starboard sheets to control the angle of the sail to the wind.

2. A sail according to Claim 1 which is substantially symmetrical about its vertical centre line and in which the halyard and strop attachment points lie on or close to the vertical centre line.

3. A sail according to Claims 1 or 2 wherein the wing sections are substantially free of supporting structures such as rods or battens and whose lateral extension when deployed is brought about by the action of wind pressure and wind flow within the sail.

4. A sail according to any of Claims 1 to 3 wherein each wing section extends beyond the imaginary lines defining the centre section a distance which is greater than one third the width of the centre section.

5. A sail according to any of Claims 1 to 3 wherein each wing section extends beyond the imaginary lines defining the centre section a distance which is greater than two thirds the width of the centre section.

6. A sail according to any of Claims 1 to 5 wherein the upper edge of the sail is attached to, or capable of being attached to, an upper spar.

7. A sail according to any of Claims 1 to 5 wherein the upper part of the sail is peaked or rounded, the peak lying on or near the vertical centre line of the sail, and the sail is attached to, or capable of being attached to, an upper spar which lies below the peak and substantially above and approximately parallel to the lower spar.

8. A sail according to any of Claims 1 to 5 wherein the upper part of the sail is peaked or rounded, the peak lying on or near the vertical centre line of the sail, and no upper spar is present.

9. A sail according to any of Claims 1 to 8 wherein the upper parts of the wing sections are significantly wider and of greater area than the lower parts of the wing sections, where the upper part is approximately that portion of the wing section above the sheet attachment point and the lower part is approximately the portion below it.

10. A sail according to Claim 9 wherein an imaginary line joining the port and starboard sheet attachment points crosses the sail at between one third and two thirds of the height of the sail, and the mean width of the upper wing section is at least 1.3 times the mean width of the lower wing section.

11. A sail according to any of Claims 1 to 10 which is shaped in the upper parts of the wing sections to provide curvature in a direction orthogonal to the main plane of the fabric, thus providing a cup- or bowl-like shape to catch the wind and provide lift, the upper part being defined as in Claim 9.

12. A sail according to Claim 11 in which the lower parts of the wing sections have no curvature, or substantially less curvature, in a direction orthogonal to the main plane of the fabric than the upper parts, the upper and lower parts being defined as in Claim 9.

13. A sail according to any of Claims 1 to 12 in which the perimeter of the wing sections has a degree of elasticity either by the nature of the sailcloth used or by incorporating elastic leech lines in the perimeter, the degree of elasticity being sufficient to allow variation of the curvature in the wing section by varying the tension of the sheet connected thereto.

14. A sail according to any of Claims 1 to 13 which is provided with one or more downhaul lines, the downhaul line being optionally laced through cringles or eyelets let into the sail so that the sail may be kept restrained by pulling in the downhaul line as the sail is raised or lowered.

15. A sail according to any of Claims 1 to 14 having reefing line attachments or eyes or cringles in the sail on or near the imaginary lines defining the centre section so that the reefing line attachment points may be fastened close to the ends of the lower spar to reef the sail when required.

FIGURE 1

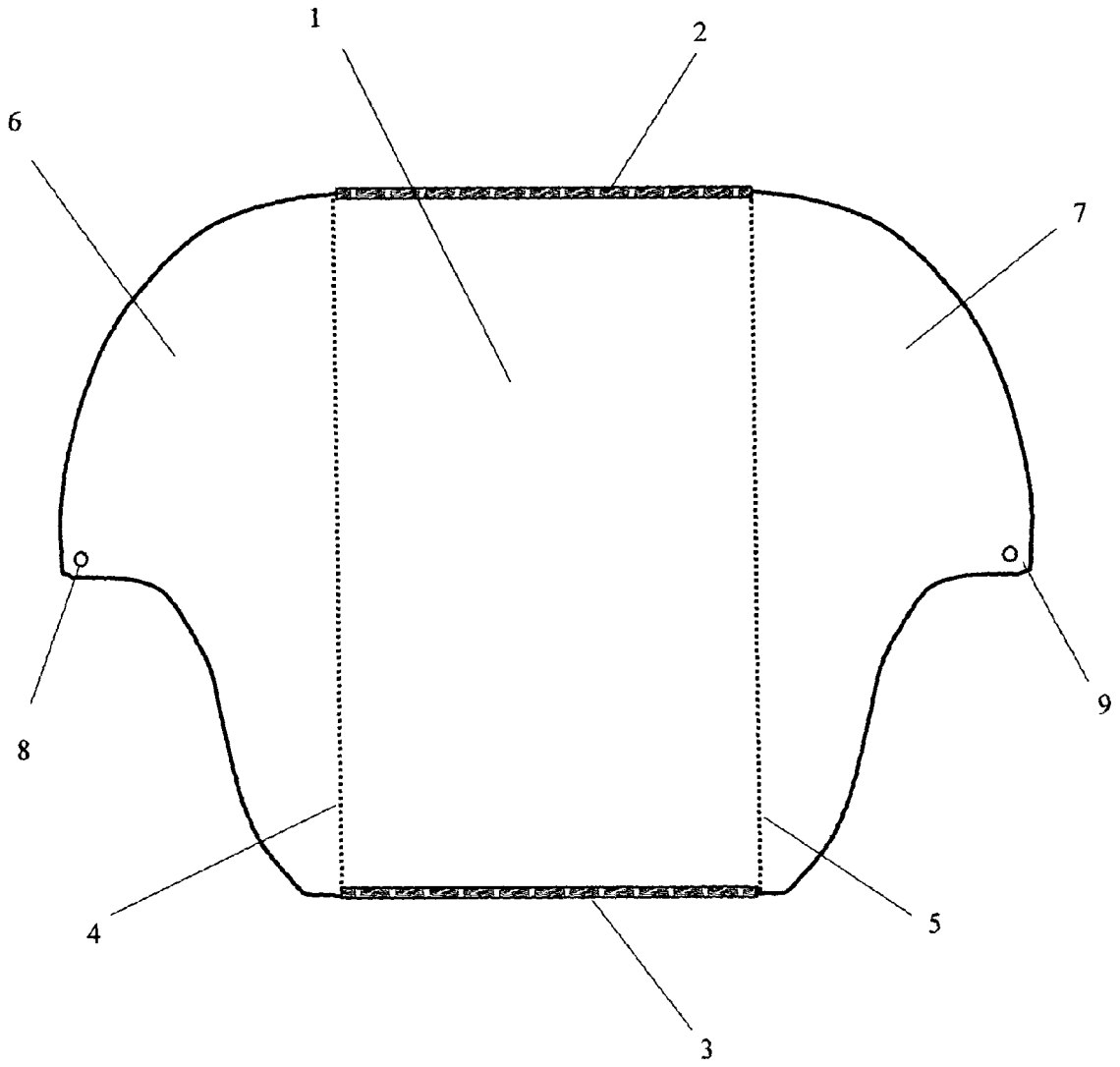


FIGURE 2

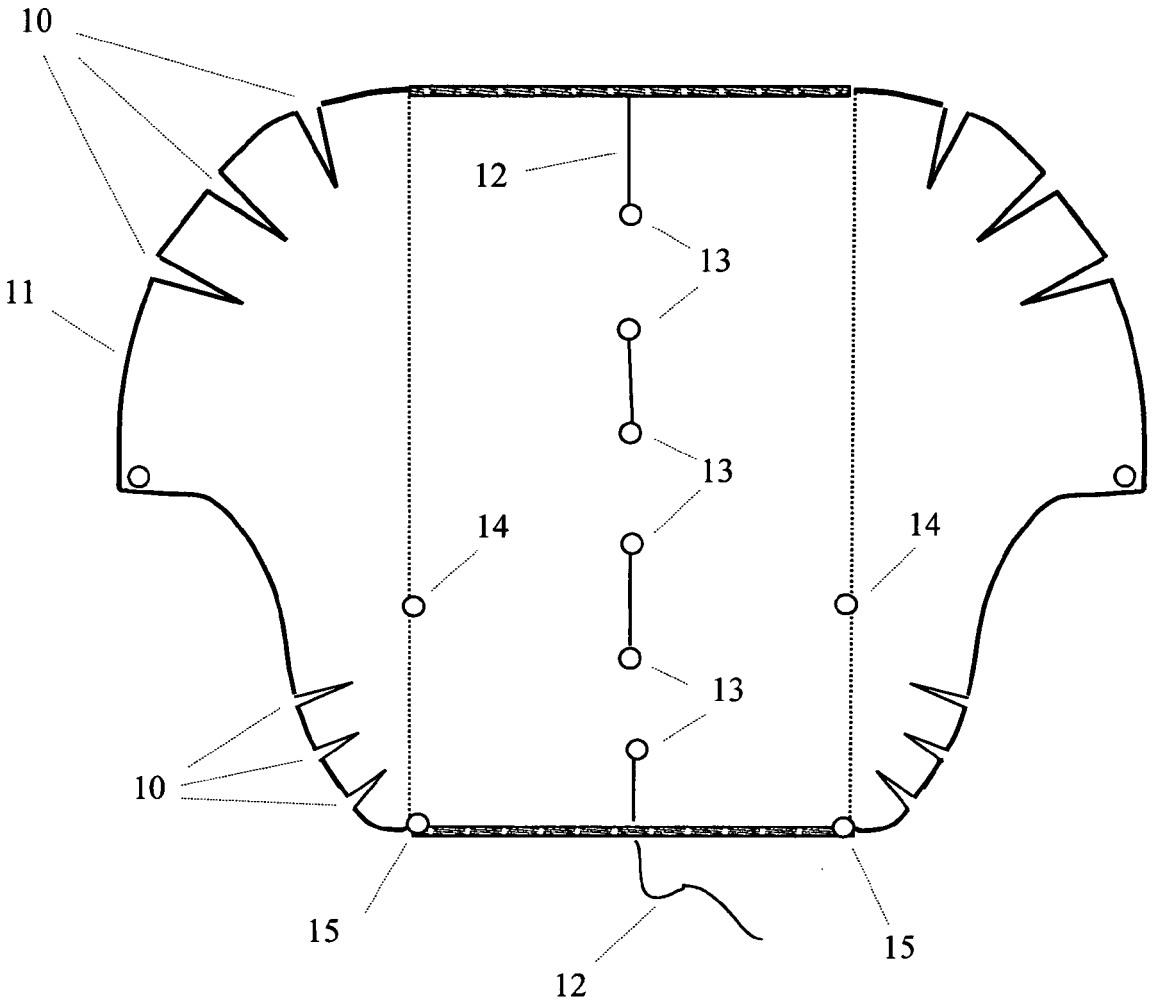


FIGURE 3

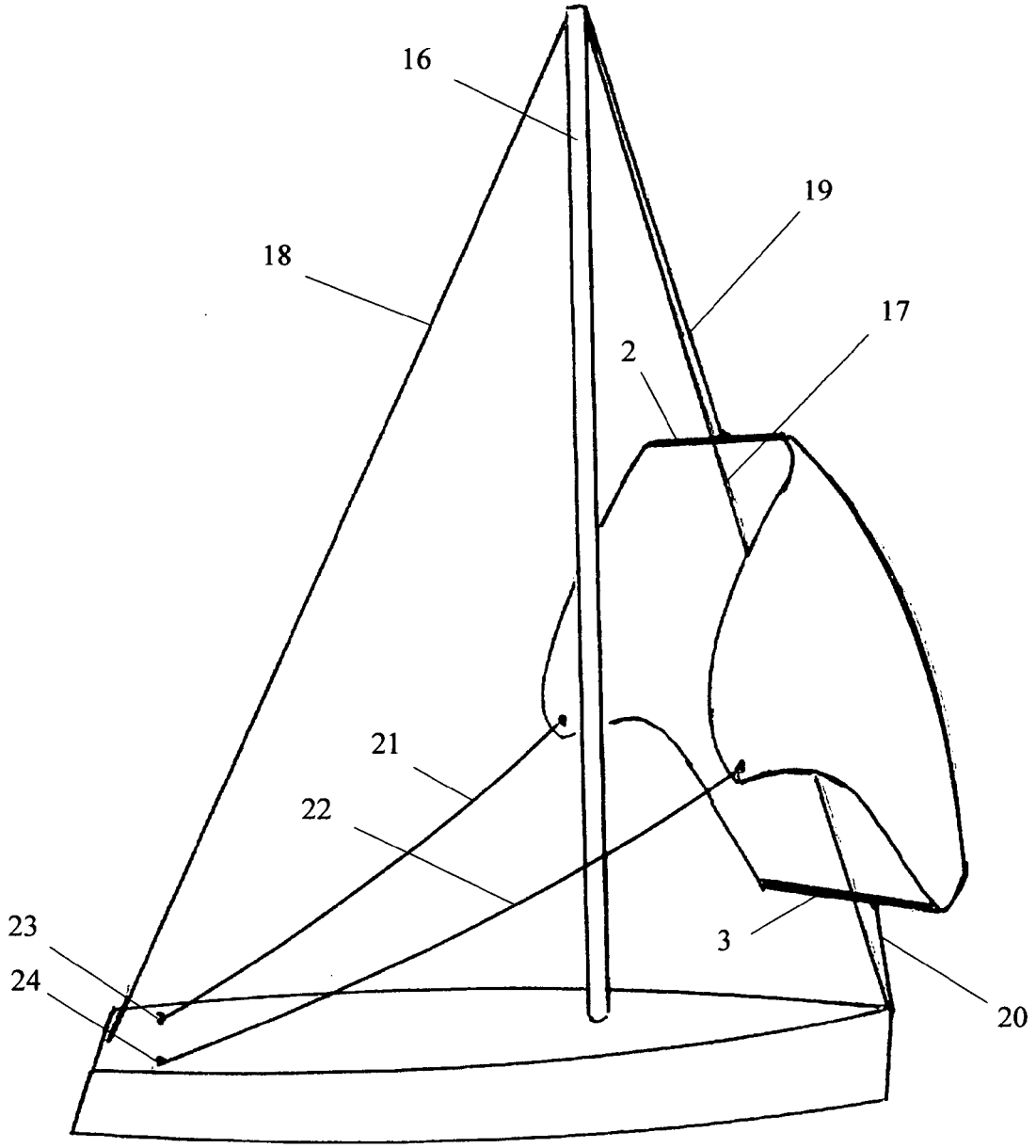


FIGURE 4

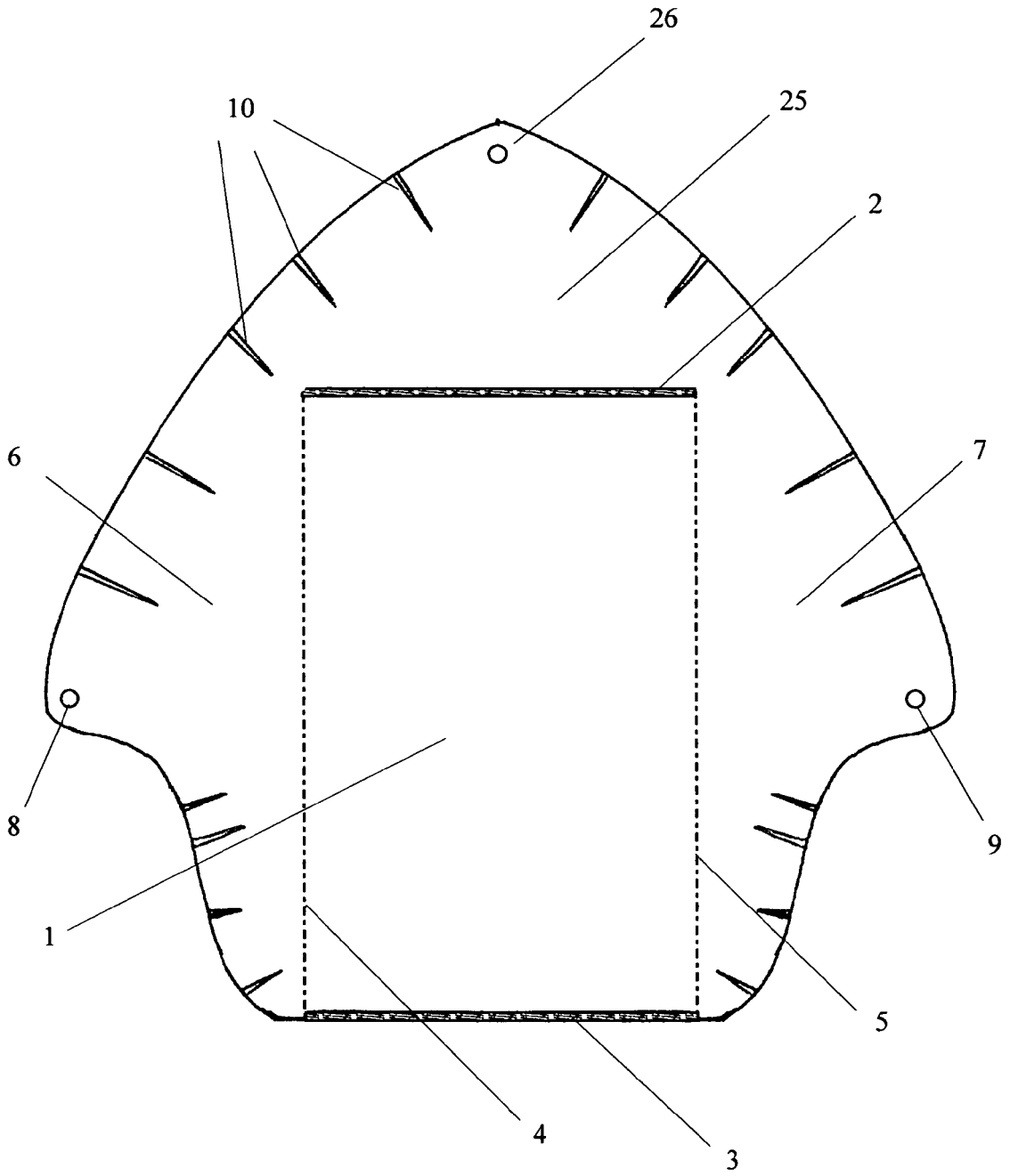


FIGURE 5

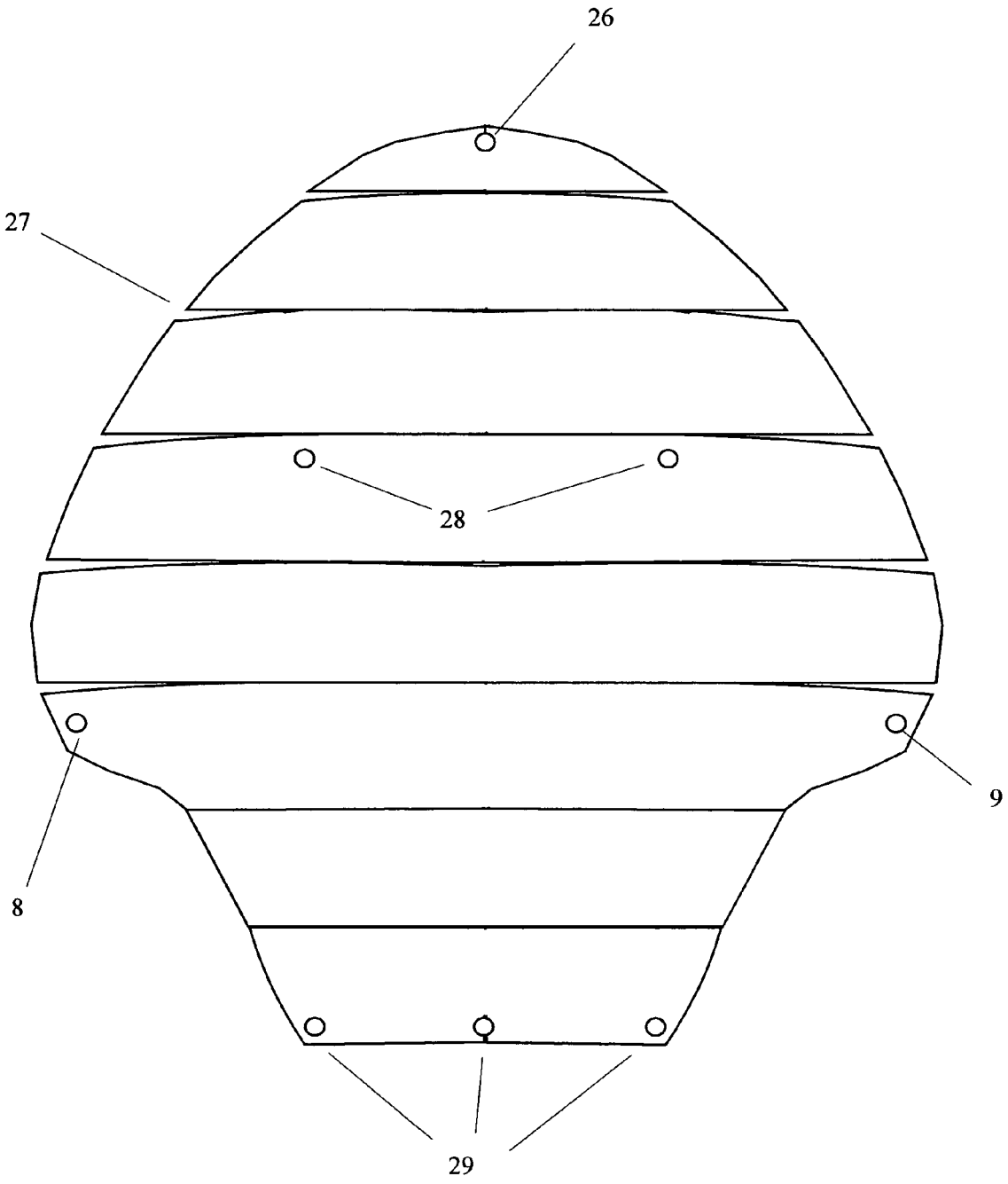


FIGURE 6

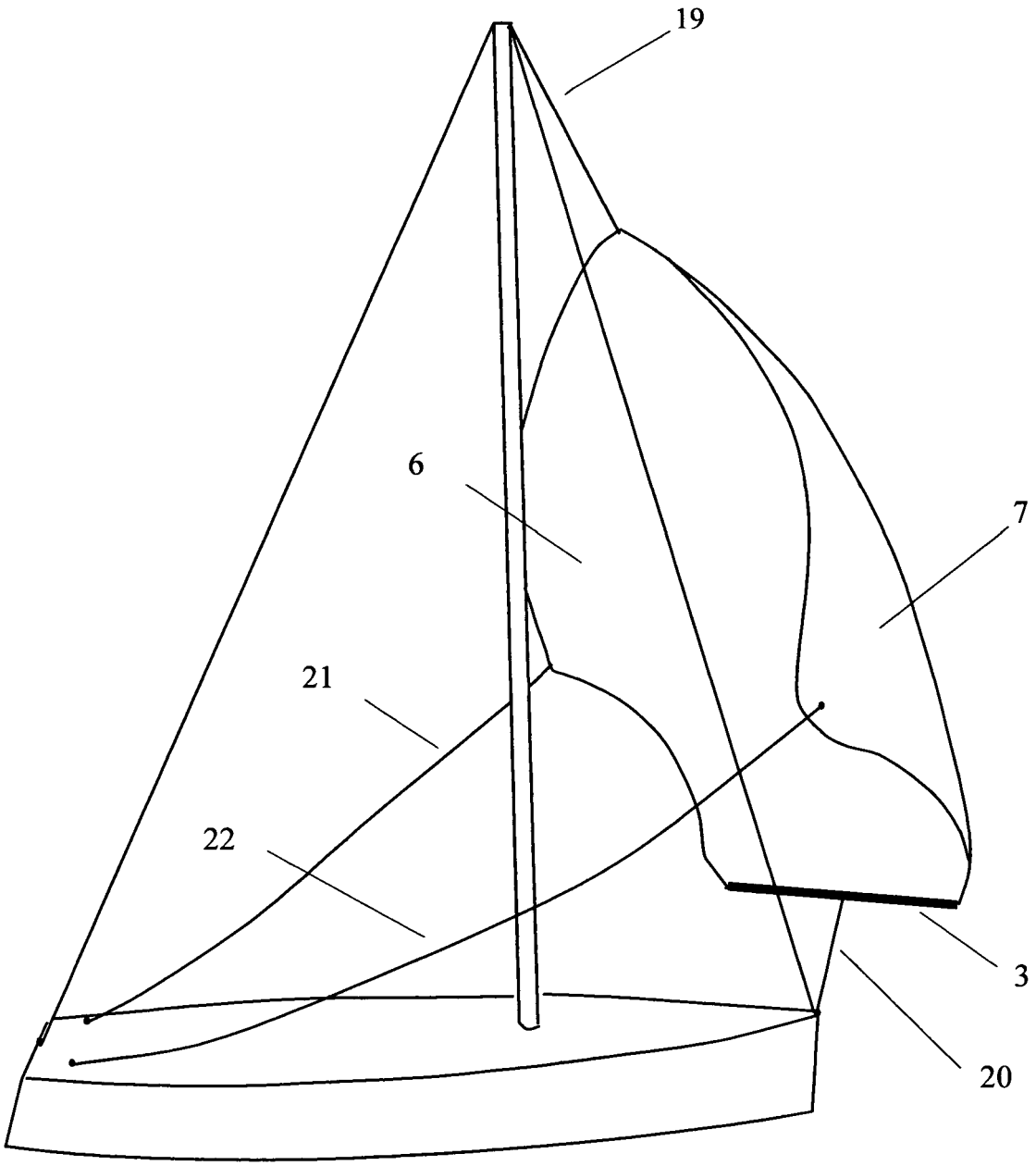


FIGURE 7

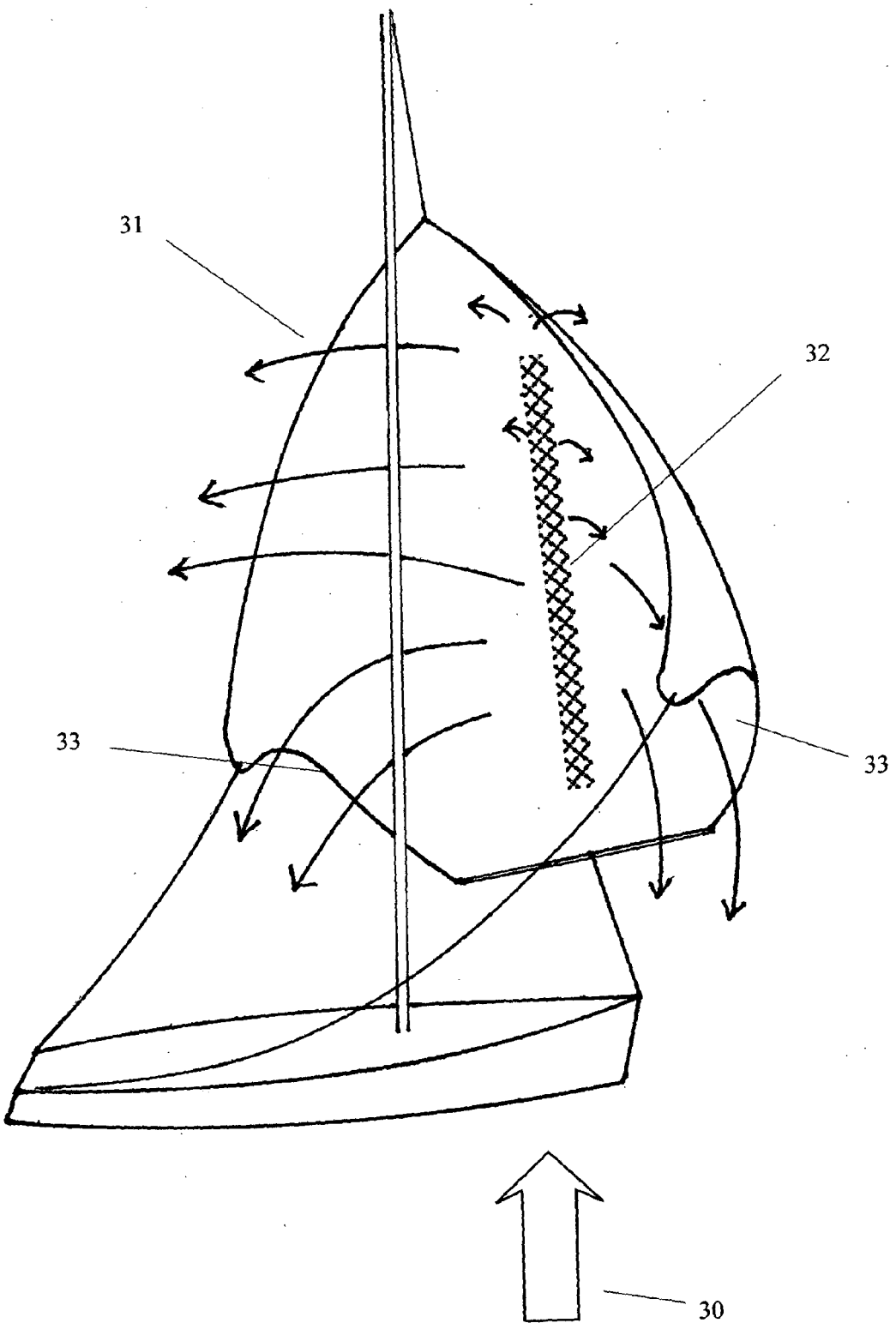
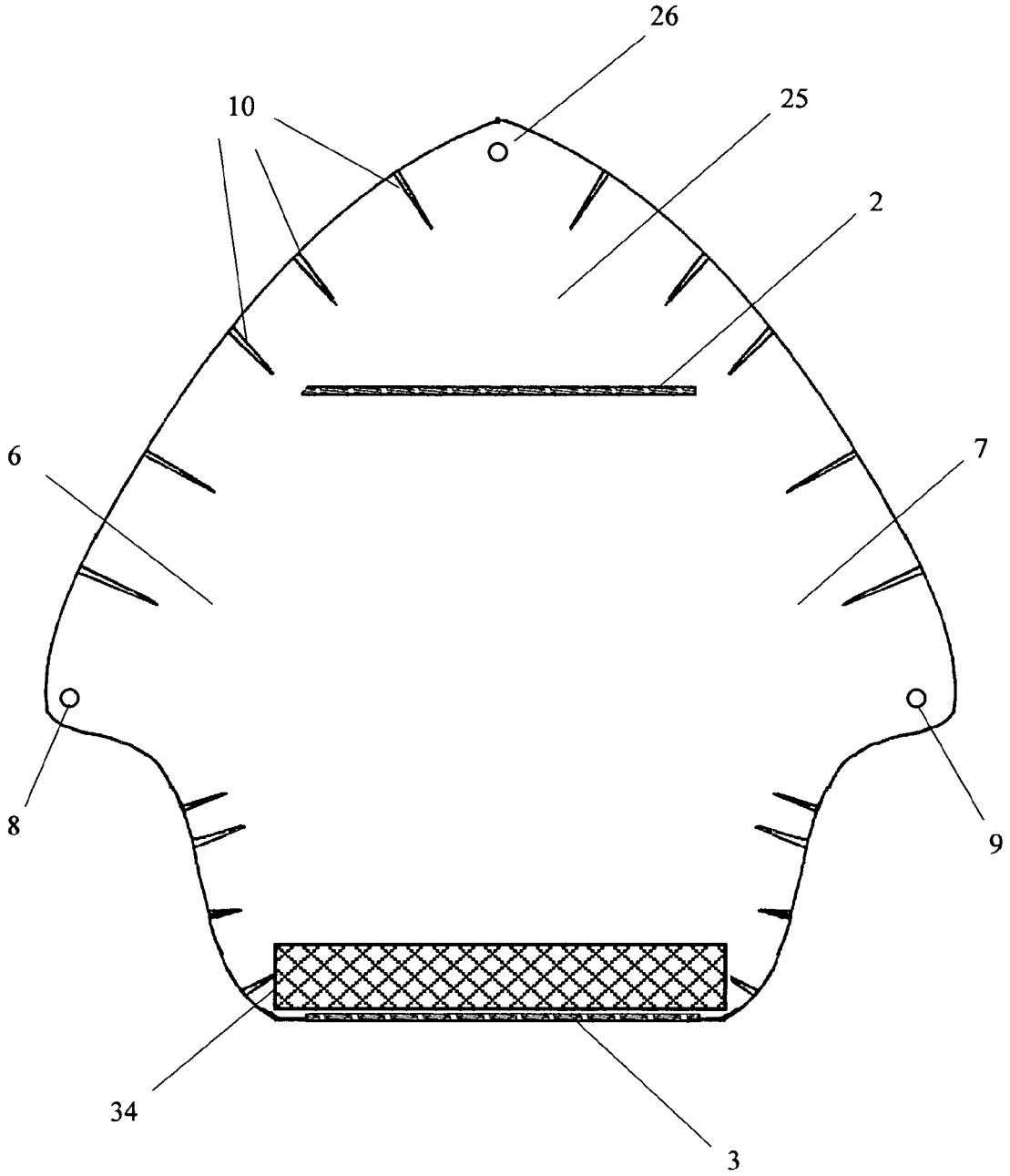


FIGURE 8



REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

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- **Lionel Casson.** Ships and Seafaring in ancient times. British Museum Press, 1994 **[0008]**