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(54) Improvements in sails.

(57) A sail is provided which is made of a relatively stiff sheet material, as compared to conventional sail-making materials. The stiffness of the sheet material permits areas of roach in the sail to be supported without any battens or the like in view of the property of the material to resist simultaneous curvature of the material in a direction transverse to the curvature of the sail when the sail is being used.

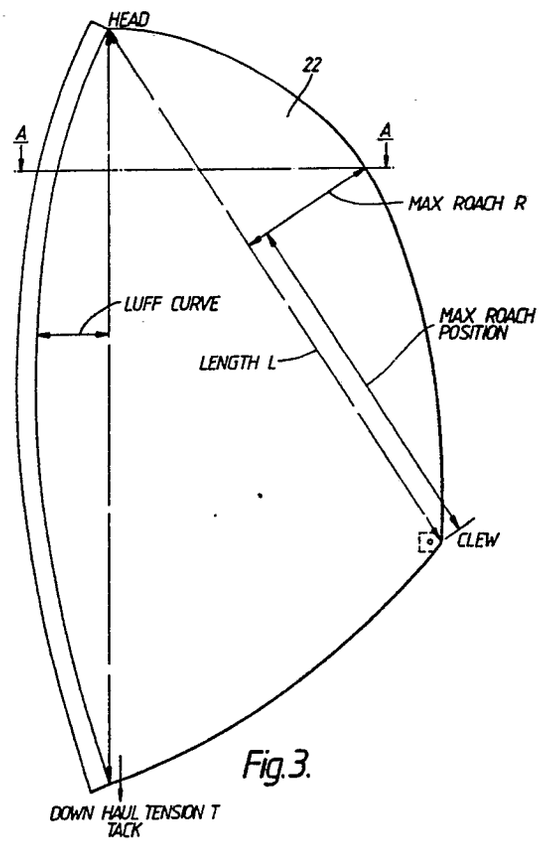

Fig.3.

EP 0 375 111 A1

IMPROVEMENTS IN SAILS

This invention relates to sails for wind-driven sailing craft such as those referred to as windsurfers.

Traditionally, sails have been made from woven material made up of a number of panels of such material to enable curvature or fullness to be built into such sails so that they can then adopt, in use, the required aerofoil shape. Many modern sail making materials include woven fabrics which are laminated to thin films of continuous synthetic plastics materials which function to seal the woven material to thereby make it impermeable to air and minimize stretch of the woven fabric.

An important consideration in the selection and design of sails and sail making materials has been the desirability to keep the weight as low as possible whilst improving the overall aerodynamic efficiency. This objective has tended to lead to extremely complex and elaborate designs of sails, many of which are characterized by being of a relatively light-weight material comprised of a large number of individual sail panels sewn together to form a composite having the required shape whilst generally improving the strength and flexibility of the sail.

An example of such a technically complex sail is shown in European patent application no. 0249427 which discloses a sail made with threads which run in the direction of principal stresses. The sail is comprised of a laminate made of the threads bonded to a film material, such as polyester film of the type sold under the Trade Mark Mylar.

Another example is shown in European patent application no. 0224729 in which a sail cloth is structured to resist stress developing in the corners of the sail at the foot and at the head thereof. The sail comprises an arrangement whereby the warp yarns radiate in directions coincident to the centre of stress in the sail.

It will be appreciated that such technologically complex sails can be difficult and expensive to manufacture and this may not always be economically justified in circumstances where the user of the sail is, for example, inexperienced or does not necessarily wish to engage in competitive racing activities.

Another way in which sails have improved in performance has been to increase the relative size of sails by building areas of roach (as hereafter defined) into the sail, such as in the leach in an area beyond the straight line between the head of the sail and the clew. Roach is the extra sail area which lies outside of the normal lines of tension in a sail. Areas of roach can be particularly significant in providing a longer curved aerofoil section to thereby give increased drive and also provide extra sail area to enable larger sails to be used without needing longer masts and booms and other rigging hardware. However, with conventional sail making materials, such areas of roach usually need to be supported, in use, otherwise they tend to hinge about the tension lines in the sail, such as the tension line between the head and the clew so that the roach area simply "flops" off to leeward of the sail, thereby losing the effectiveness of the extra area of the sail provided by the roach and increasing the drag of the sail.

To counter this problem sail makers have conventionally supported such areas of roach by, for example, inserting battens into the sail at spaced intervals in batten pockets sewn into the sail cloth, the battens being relatively stiff compared to the stiffness of the sail cloth to thereby prevent bending of the sail in the area of roach about the tension line of the sail. Battens have also been used to stretch out wrinkles in sail cloth.

Another way of supporting areas of roach in a sail is disclosed in German Offenlegungsschrift no. 3531121 wherein instead of using battens there is shown a system whereby rigid edge pieces are fixed to the sail and are used to support the areas of roach. This can have the advantage that larger areas of sail can be supported relatively simply.

A different type of sail construction is shown in European Patent Application No. 0056657 which discloses a sail which has a preformed three dimensional shape as a result of thermoforming a plastics sheet over a caul or mold. The plastics sheet may be laminated to a woven material to impart strength and flexibility to the sail. The teaching of No. 0056657 makes the important acknowledgement that there is only a limited class of commercial materials suitable for making sails, which must normally be flexible, stretch resistant and light-weight. In use, the sail assumes the required shape without the need to rely on tensioning of the luff, leech and foot of the sail in order to give it fullness, the necessary three-dimensional curved shape to give it thrust under sailing conditions. Battens may be bonded to the sail either during or after the thermoforming process in order to support the areas of roach.

Because the above described sails have necessarily tended to be constructed from very flexible, lightweight and "floppy" materials it has always been necessary to support areas of roach in some way or other either by battens, edge pieces or the like. The presence of such supports in the sail nevertheless increase the overall weight of the sail and the cost and complexity of its construction.

Furthermore, even though a sail may be designed to be aerodynamically very efficient, such as in E.P. 0056657, nevertheless the presence at regular intervals of discontinuities in the airfoil caused by the presence of the sail battens and batten pockets does tend to increase the drag of the sail and decrease the efficiency of air flow over the sail during use of it.

The present invention aims at a simplification and improvement in sails in these various respects and to that end is based upon the realization that it is possible to make sails having areas of roach which do not necessarily have to conform to the elaborate and technically complex designs as heretofore known. The invention discloses that similar objectives can be realized by an appropriate selection of those materials which would not otherwise be considered suitable for sailmaking and such materials can in fact be used to construct a sail which will perform adequately and cost substantially less than conventional sails.

According to the invention, there is provided a sail having one or more areas of roach, the sail being made wholly or primarily of sheet material, which material is adapted to assume in use a curved shape to provide draft or camber for the sail, but which material resists significant simultaneous generally transverse curvature of the sail such that the one or more areas of roach are supported wholly or primarily by the sheet material when it curves during use of the sail.

As will be appreciated, therefore, the invention uses the concept of the sheet material of the sail being of such a character in the sense that it is relatively stiff or rigid as compared to conventional sail making materials, that when the sail curves in use it will provide its own inherent support for the or each area of roach. Conveniently, the sheet material is a synthetic plastics film having the characteristic that it resists simultaneous bending about two planes which are each transverse to the other. Materials of this kind are generally quite rigid or stiff so that they would not normally be considered suitable for sail making.

Typically, therefore, the present invention provides a sail made from a sheet material having a tensile modulus of at least 100kg/mm^2 (as measured by ASTM D882) the material being of synthetic plastics. Tensile modulus (TM) may be defined as :

$$TM = \frac{\text{TENSILE STRESS (kg/mm2)}}{\text{STRAIN}}$$

More importantly, however, the sheet material must have the characteristic that it is less "floppy" than conventional sail making material and behaves like a sheet of paper when curved i.e. it tends to resist curvature in a direction transverse to the first direction of curvature.

The present invention has significant advantages over conventional sails in that it eliminates the need for individual battens and batten pockets to support areas of roach, thereby providing a substantial saving in the weight of the sail. Accordingly, even if the sheet material, such as synthetic plastics film material, used to make the sail according to the present invention is heavier and/or stiffer than conventional sail making material, nevertheless the net effect of eliminating the requirement for separate battens and batten pockets can even be a reduction in the overall weight of the sail. This can be particularly important with respect to sails for windsurfers where the user of the sail often has to some extent to support the weight of the sail and minimal weight is a primary performance objective. Additionally, the absence of discontinuities in the airfoil which would otherwise occur if battens and batten pockets were present improves the airflow over the sail of the invention and can thereby help improve efficiency. A further very significant advantage lies in the fact that a suitable material for the sail or at least the major portion of the sail may be entirely transparent such as a transparent polyester film and this further obviates the necessity otherwise to construct a window area in, for example, a windsurfer sail in order for the user of the sail to see where he is going.

In addition, because the relatively labour intensive steps of sewing or bonding batten pockets and the like to the sail is eliminated by the present invention, the overall cost of production of the sail can be significantly reduced. This is further enhanced by the fact that, in order to keep the weight of the sail to a minimum in a conventional sail having battens and batten pockets, relatively sophisticated manufacturing techniques are normally required which are much more expensive than would be the case if one used instead the cheapest and simplest way of producing a batten pocket.

A still further advantage of the present invention is that it eliminates the need for battens to be used to remove wrinkles in the sail, because such wrinkles are not normally present.

The sheet material, typically synthetic plastics film, used in the sail according to the invention is used in at least the areas of the sail which have roach and adjacent areas, such as in the leech. In addition, although it is not essential, the sheet material can be used to constitute the whole of the sail and in many instances it may not even be necessary to provide separate panels and the like which would otherwise have to be joined together by sewing or bonding, so that effectively the sail

can be made of one piece of material without having joints.

According to another embodiment of the invention, it is desirable to provide a luff sleeve for receiving a mast, the luff sleeve being made from conventional sailmaking material having a high degree of flexibility as compared to the sheet material used in the areas of roach, and the luff sleeve is joined to the sheet material either directly or via an intermediate edging strip.

The sheet material is preferably a synthetic plastics film material such as a polyester film having a thickness of at least 100 microns and, desirably, a thickness from between 100 and 300 microns. However, it will be appreciated that materials other than polyester can be used without departing from the spirit or scope of the invention.

The thickness of the material chosen is important since it is a necessary characteristic of the invention that the material should be of sufficient thickness that in the practical limits within which a sail is used, the material can be easily bent or curved to provide draft or camber but, at the same time, resists bending at right angles to the axis of curvature, at least to the extent necessary to support areas of roach. The optimum thickness is therefore dependent on the mechanical characteristics of the material chosen, particularly the tensile modulus when used as a measure of relative stiffness.

The invention is particularly applicable to sails which are used as main sails, i.e. are attached to a mast in sailing craft of all kinds. Additionally, in view of the mass market for windsurfer sails, the invention has special applicability in such sails where a significant saving in cost can be envisaged, since the usual requirement to provide battens and batten pockets collectively constitute a major component of the total cost of manufacturing such sails.

Another advantage of a sail according to the invention is that it is relatively easy to rig. Thus, if there is for example a luff sleeve at the luff of the sail, the luff can be substantially straight and so it is very simple to insert the mast into that luff. Additionally, a relatively small amount of downhaul tension is only then necessary to spread the sail and thus the rigging load such that the rigging load is not concentrated in particular localized regions as, for example, the line between the head and the clew.

The invention can also be applied to providing roach in the foot of the sail between the tack and the clew. However, generally speaking roach in this area is of less importance than roach provided on the leech of the sail and because of the relatively shorter distance between the tack and the clew than as between the head and the clew, the amount of roach which can be provided and supported in the manner according to the invention tends to be less than for roach provided between the head and the clew.

Because the sail of the present invention can generally be rigged with relatively low downhaul tension it is possible that there may be some twisting of the top of the sail in the area towards the head, particularly in heavy winds and when going windward. Even so, this may well be advantageous since in this way it may be possible to spill excess wind without an overwhelming heeling effect being apparent on the sail craft.

If a synthetic plastics film material is used as the sheet material this could conceivably have the weakness of tending to tear at it's edges in the event that there is a lack of continuity at any edge, by the presence of a small nick or cut. However, this should not normally occur since the leech of the sail according to the present invention is not subject to the same localized tension as would often be the case with a conventional sail. Even so, it may be desirable to strengthen the edges of the sail with the object of preventing or inhibiting tearing.

It will therefore be seen that the present invention constitutes a fundamental departure from the conventional sail making art in that instead of choosing the lightest and most flexible material available which is then subjected to elaborate and often technologically complex manufacturing processes, the present invention instead stems from the realization that by approaching the problem from a different angle, by positively utilizing the stiffness and rigidity associated with materials such as polyester films, it is still possible to achieve the same overall objectives but at much lower cost and greater simplicity.

The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a side view of a sail according to the invention;

Figure 2 is a view from the rear of that sail as it would appear when in use and mounted on a mast;

Figure 3 is a diagram of a sail according to the invention showing the terminology employed herein;

Figure 4 is a sectional slice taken on the line A-A of Figure 1; and

Figure 5 is a view from the side and rear of a sail/mast assembly according to another embodiment of the invention.

The sail 10 shown in Figures 1 and 2 is composed of a front panel 12 and a rear one piece panel 14. The front panel is made of flexible polyester cloth with a polyethylene film laminated to it.

The panel 12 is in the form of a luff sleeve which includes a pocket 16 for a mast (not shown). The rear one piece panel is made of a polyester sheet having a thickness of from 100 to 300 microns and the two panels are joined to one another along a line 20.

It will be seen that there are no battens or even pockets for battens to support the roach area 22. This area is supported solely by virtue of the property of the polyester sheet material when it is curved as seen in Figure 2.

Referring to Figures 3 and 4, typical dimensions are:

L ..... 2.5 to 4 metres.
R ..... approximately 50 cm.
D ..... about 20 cm.

It will be understood that the drawings shown in Figures 1 to 4 are simplistic in nature and are intended only to illustrate the concepts used in the invention.

In Figure 5 is a more detailed drawing showing a sail/mast assembly for use in a wind-surfer. In the drawing, a sail shown generally at 30 is comprised of a main panel 31 of a relatively stiff clear ployester sheet material. A luff panel 32 is provided adjacent the main panel 31 and each panel 31, 32 is connected to the other by means of a stitched reinforcing strip 33 in conventional manner. The luff panel 32 is comprised of a laminate of a woven material and a plastics sheet material of conventional construction such that the luff panel 32 has all of the characteristics of conventional sail making material in that it is impervious to air, is very flexible, strong and relatively light-weight.

The luff panel 32 is attached to a luff sleeve 34 which is adapted to enclose a mast 35 in a conventional manner. A wishbone boom 36 is pivotally fixed to a mid-portion of the mast 35 and extends generally outwards and away therefrom. The wishbone boom is generally symmetrical and has a left-hand side boom handle 36a and a right-hand side boom handle 36b.

The main panel 31 of the sail 30 is provided with a reinforcing gusset 37 which carries a metal eye (not shown) by which the free-end of the main panel 31 may be attached by a rope (not shown) to an outhaul 38 on the free end of the boom 36 and by which the camber or draft of the sail 30 can be adjusted.

An edging strip 39 is sewn onto the free edges of the main panel 31 and functions to prevent or inhibit tearing of the sail from the edges.

In Figure 5 the direction of the wind is shown arrowed and as such the sail 30 adopts a full configuration so that it assumes a convex curved shape away from the right-hand side handle 36b of the wishbone boom 36 and towards the left-hand side handle 36a thereof. In this configuration, it will be seen that the left-hand side handle 36a of the wishbone boom 36 is still visible behind the main panel 31, which is transparent, but it is not visible behind the luff panel 32, which is opaque.

Because of the curved configuration of the sail 30 and in particular the part-cylindrical curvature of the main panel 31 the area of roach extending beyond the straight line from the head to the clew is supported as a consequence solely of the relatively stiff characteristics of the material of the main panel 31. It will be appreciated that if a relatively floppy material were chosen for the main panel 31 then the area of roach would not be supported and would tend to flop-off to leeward of the sail 30.

In Figure 5 there is also shown an area of roach which extends beyond a straight line between the clew and the tack and which is also, in part, supported by the characteristics of the sheet material chosen for the main panel 31. However, in this particular instance since the area of roach is small compared to the area of roach beyond the straight line between the head and the clew it will be understood that the beneficial effects of using a relatively stiff or rigid material for the main panel 31 are less significant.

The invention thus provides a relatively simple but elegant solution to the problem of constructing a sail in which areas of roach are necessary or desirable.

Claims

1. A sail having one or more areas of roach, the sail being made wholly or primarily of sheet material, which material is adapted to assume in use a curved shape to provide draft or camber for the sail, characterized in that the material resists significant simultaneous generally transverse curvature of the sail such that the one or more areas of roach are supported wholly or primarily by the sheet material when it curves during use of the sail.

2. A sail according to Claim 1 further characterized in that the sheet material has a tensile modulus of at least 100 kg/mm^2, as measured by ASTM D882.

3. A sail as claimed in claim 1 further characterized in that the sheet material has a tensile modulus of from 350 to 500 kg/mm^2 as measured by ASTM D882.

4. A sail as claimed in any preceding claim further characterized in that it comprises a luff sleeve for receiving a mast, the luff sleeve being made from material having a high degree of flexibility, the luff sleeve being joined to the synthetic plastics film material constituting the remainder of the sail.

5. A sail as claimed in Claim 4 further char-

acterized in that the material of the luff sleeve is woven polyester with a polyethylene film laminated to it.

6. A sail as claimed in any preceding claim further characterized in that the sheet material is a polyester film having a thickness of at least 100 microns.

7. A sail as claimed in any one of claims 1 to 5 further characterized in that the sheet material has a thickness of from 100 to 300 microns.

8. A sail as claimed in any preceding claim further characterized in that the area of the sail made of the sheet material is made in a one piece panel.

9. A sail made from sheet material, the sail having roach extending beyond a straight line joining the head to the clew of the sail, characterized in that the roach has substantially no localized stiffening to support it, and the sheet material has a tensile modulus of at least 100 kg/mm^2 as measured by ASTM D882.

10. A sail as claimed in Claim 9 further characterized in that the sheet material has a tensile modulus of from 350 to 500 kg/mm^2 as measured by ASTM D882.

11. A sail as claimed in claim 9 or claim 10 further characterized in that it comprises a luff sleeve for receiving a mast, the luff sleeve being made from material having a high degree of flexibility as compared to the sheet material, and the luff sleeve being joined to the sheet material constituting the remainder of the sail.

12. A sail as claimed in Claim 11 further characterized in that the material of the luff sleeve is a woven polyester mesh with a polyethylene film laminated to it.

13. A sail as claimed in any of claims 9 to 12 further characterized in that the sheet material is a polyester film having a thickness of at least 100 microns.

14. A sail as claimed in any one of claims 9 to 12 further characterized in that the polyester film has a thickness of from 100 to 300 microns.

15. A sail as claimed in any of claims 9 to 14 further characterized in that the area of the sail made of the sheet material is made in a one piece panel.

16. A sail having a luff and roach in the leech extending beyond a straight line joining the head and the clew of the sail, characterized in that the sail, apart form the region of the luff, is made from sheet synthetic plastics material having a tensile modulus of at least 100 kg/mm^2 as measured by ASTM D882.

17. A sail as claimed in Claim 16 further characterized in that the sheet synthetic plastics material has a tensile modulus of from 350 to 500 kg/mm^2 as measured by ASTM D882.

18. A sail as claimed in Claim 16 or 17 further characterized in that it comprises a luff sleeve for receiving a mast, the luff sleeve being made from material having a high degree of flexibility, the luff sleeve being joined to the sheet synthetic plastics material constituting the remainder of the sail.

19. A sail as claimed in any of Claims 16 to 18 further characterized in that the sheet synthetic plastics material is a polyester film having a thickness of at least 100 microns.

20. A sail as claimed in any one of claims 16 to 18 further characterized in that the sheet material has a thickness of from 100 to 350 microns.

21. A sail according to any preceding claim further characterized in that reinforcing strips are fixed to edges of the sheet material to prevent or inhibit tearing of the sheet starting at the edges.

22. A sail as claimed in any preceding claim further characterized in that it has roach extending downwardly beyond a straight line joining the tack to the clew, the lower edge having no localized stiffening to support that roach.

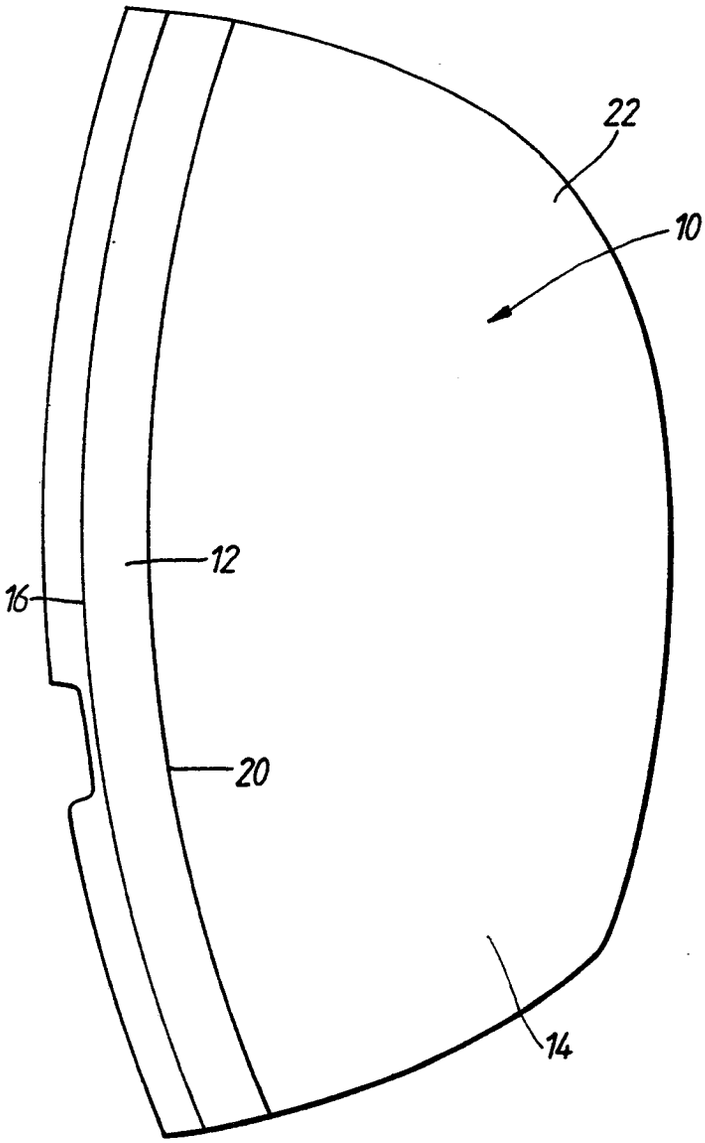

Fig.1.

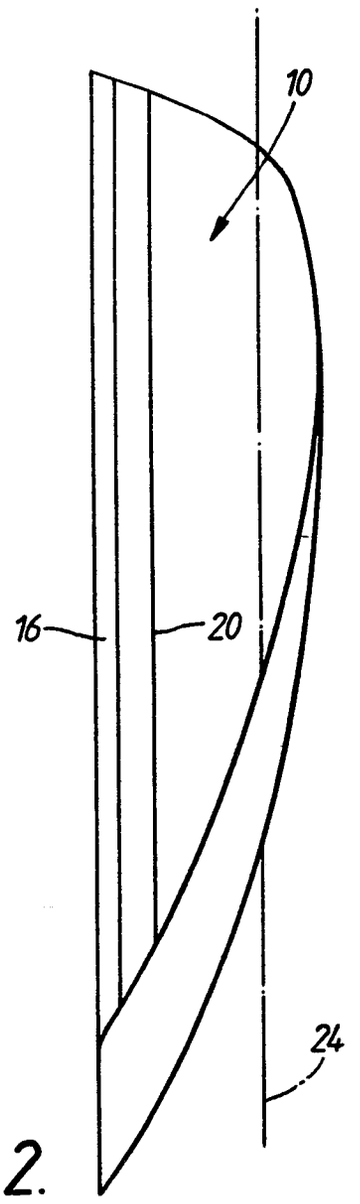

Fig.2.

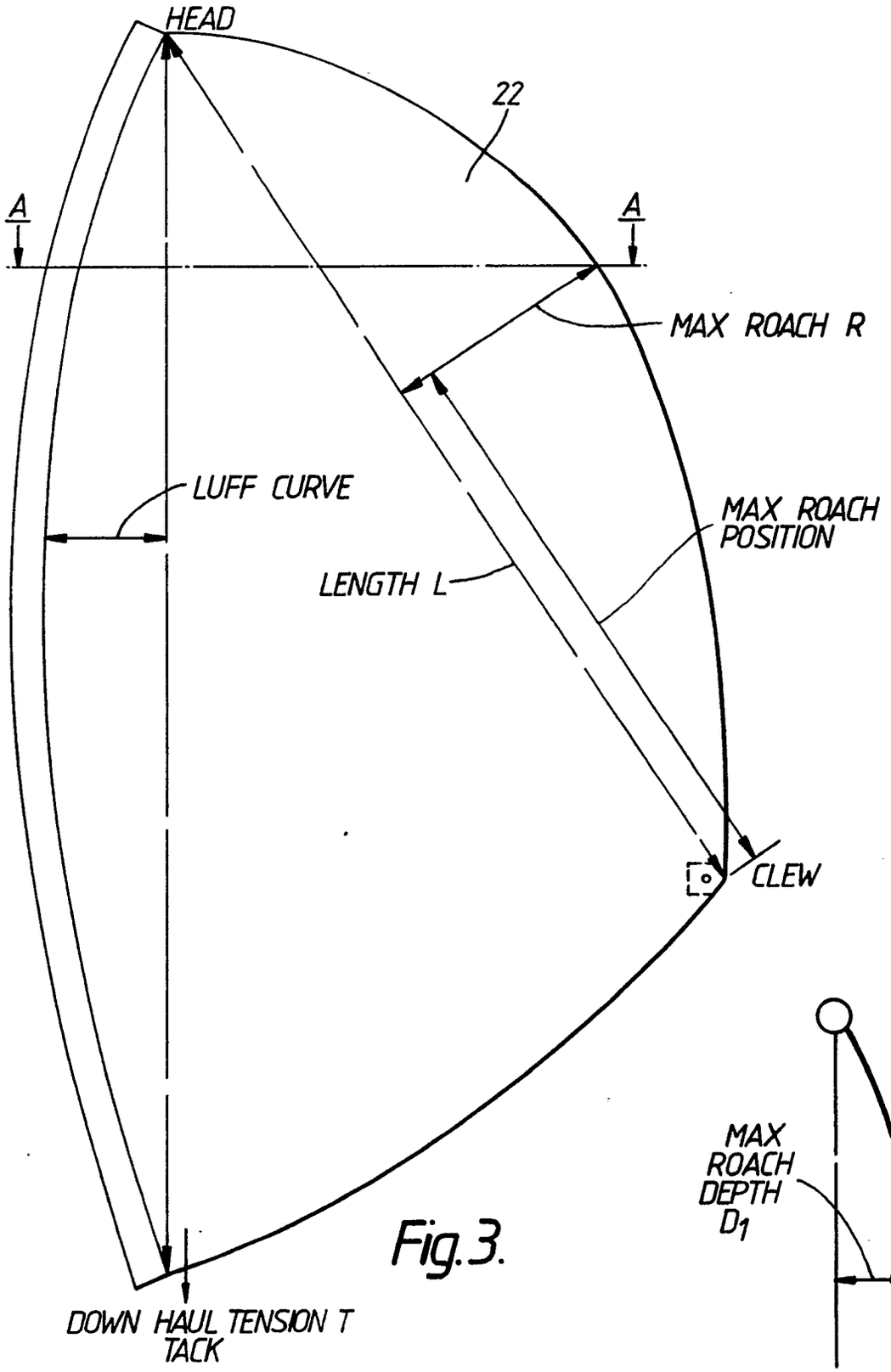
HEAD
22
A
A
MAX ROACH R
LUFF CURVE
MAX ROACH POSITION
LENGTH L
CLEW
DOWN HAUL TENSION T
TACK

Fig.3.

MAX ROACH DEPTH D_1

Fig.4.

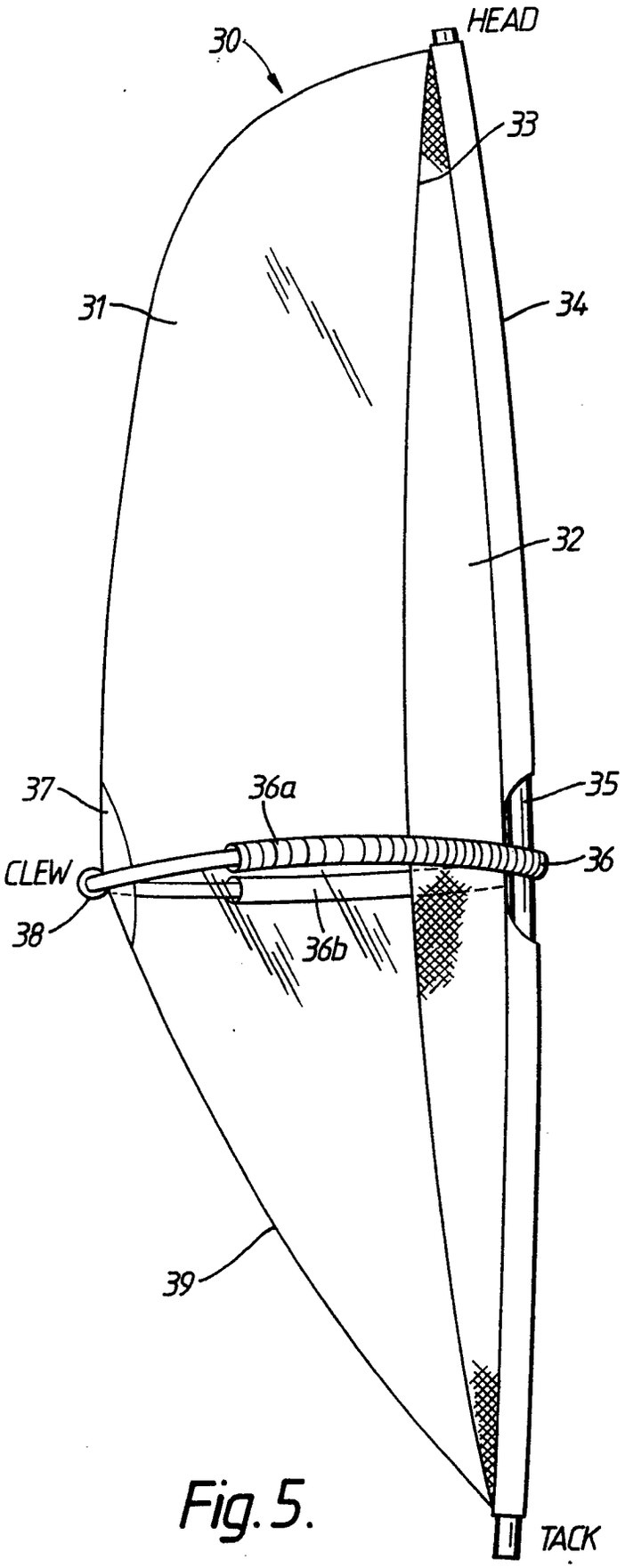

Fig. 5.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 9131

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 224 729 (BAINBRIDGE/AQUABATTEN) * Figure 4 *	1	B 63 H 9/06
A		9,16	
X	US-A-2 909 142 (HOOD) * Figure 1 *	1	
A		9	
X	DE-A-2 501 326 (SCHEFFERLING) * Figures 4-6 *	1	
A		9,22	
A	EP-A-0 056 657 (NORTH SAILS) * Page 2, line 1 - page 3, line 35 *	1,4,8, 11,15, 18,22	
A	EP-A-0 249 427 (SOBSTAD) * Column 12, lines 16-51 *	1,5,12, 16	
A	DE-A-3 531 121 (PASCHER) * Column 1, line 46 - column 2, line 35; figures 1-5 *	1,9,16	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	FR-A-1 149 799 (DEBARGE) * Figure 2 *	21	B 63 H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13-03-1990	HUNT A.E.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

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