United States Patent

[11] 3,557,733

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[32] Priority **Nov. 8, 1967**
[33] **France**
[31] **127,318**

[54] **APPARATUS FOR CHANGING THE CURVATURE OF A SAIL**
14 Claims, 54 Drawing Figs.

[52] U.S. Cl. **114/102,** 114/39
[51] Int. Cl. **B63b 35/00,** B63h 9/06
[50] Field of Search 114/39, 102, 105

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Primary Examiner—Trygve M. Blix
Attorneys—Robert E. Burns and Emmanuel J. Lobato

ABSTRACT: Present invention is concerned with a boat having a sail, and means for acting positively on the curvature of the battens, whereby the curvature of the sail is controllable, two sets of fitting means being located on said sail surface and lines fixed to fitting means of one set and running in fitting means of the other set.

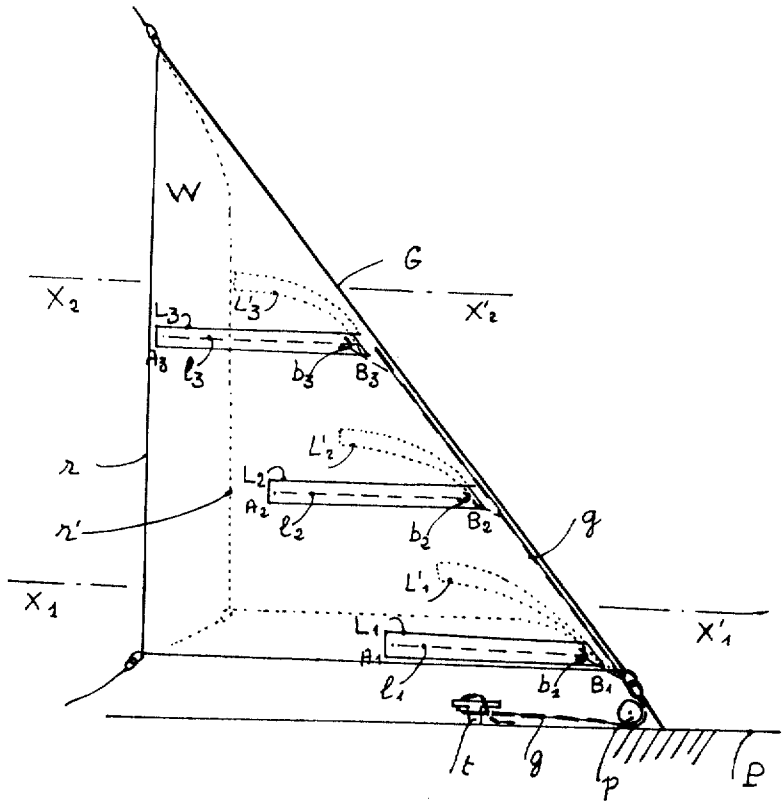
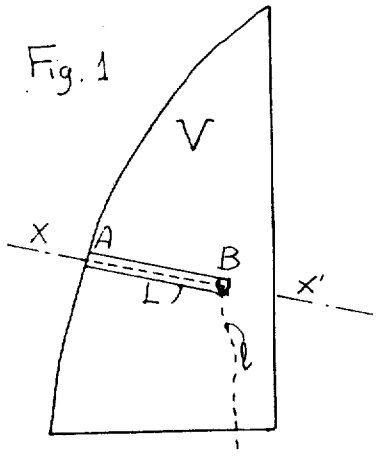
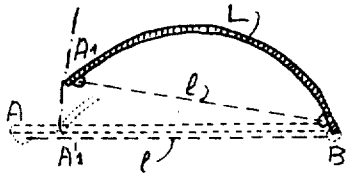


Fig. 1





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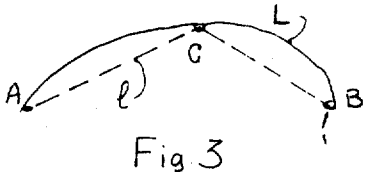

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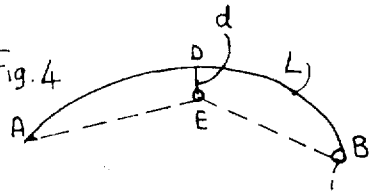

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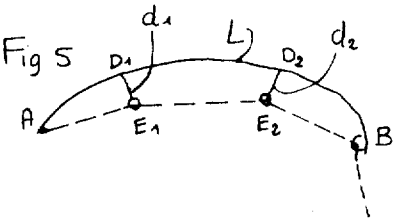

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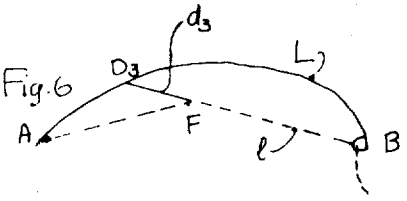

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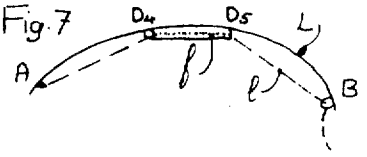

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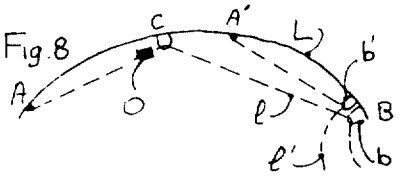

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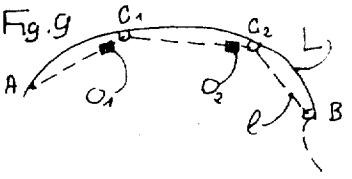

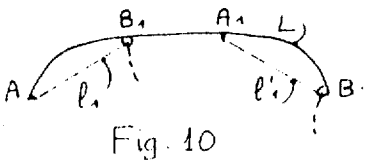

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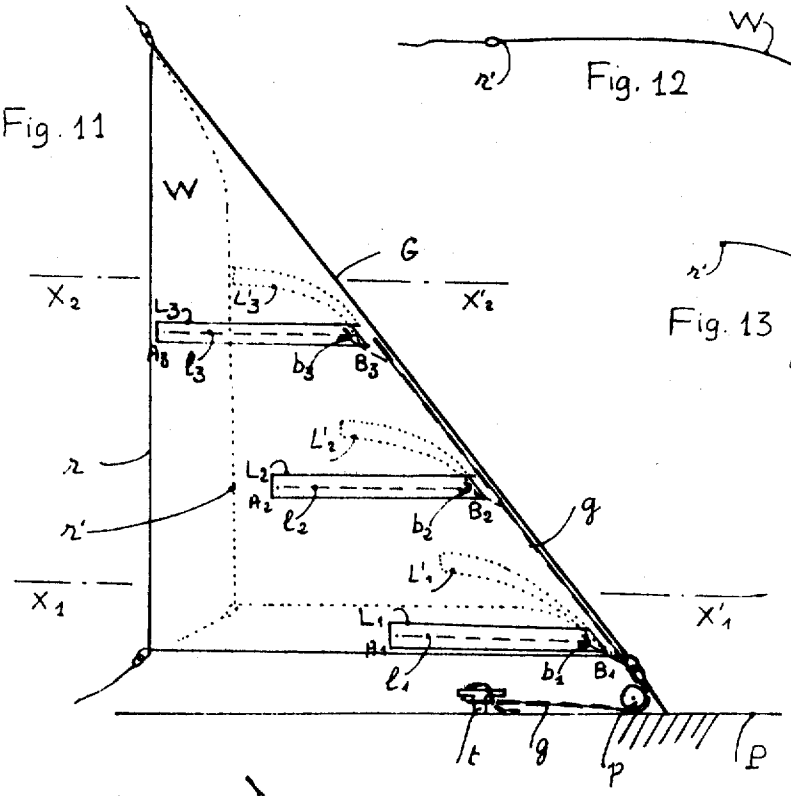

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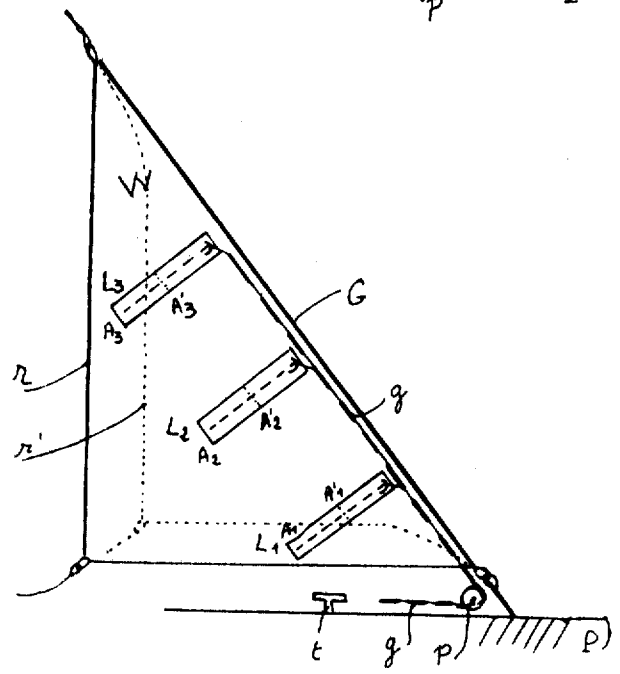

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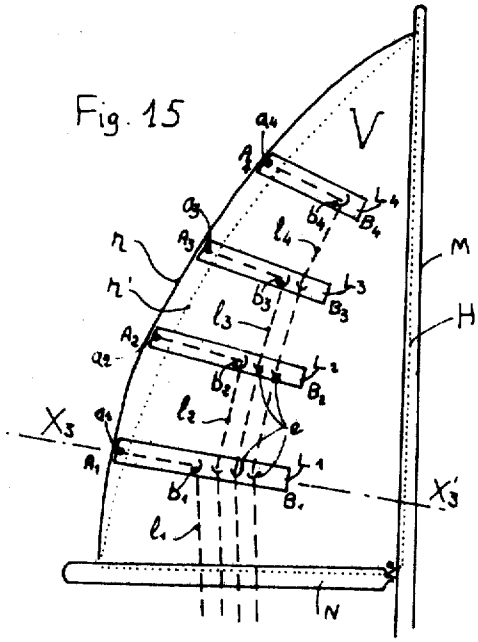

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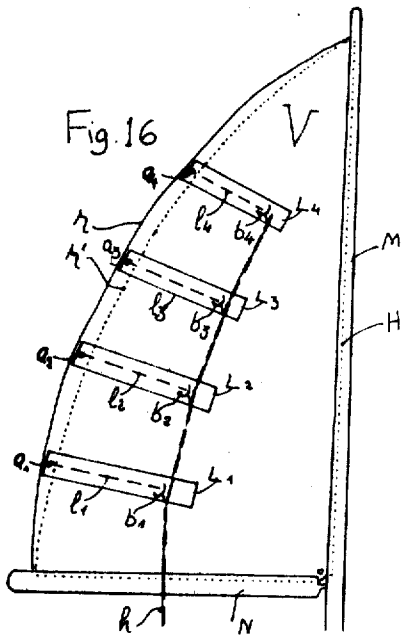

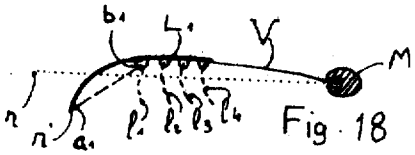

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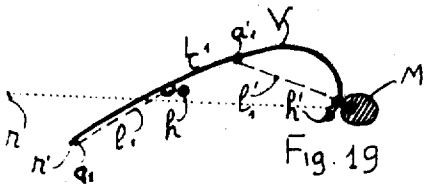

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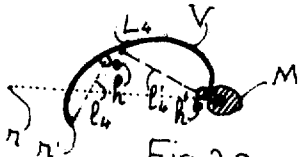

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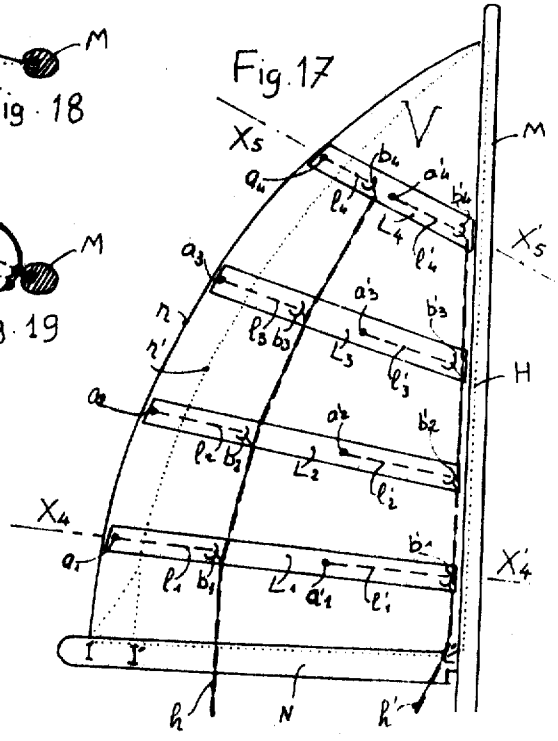

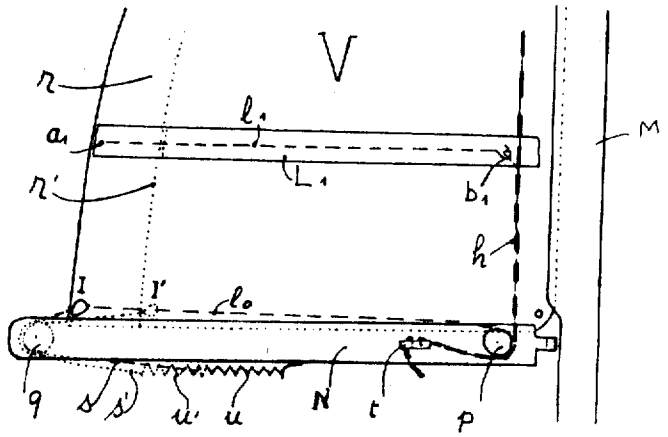

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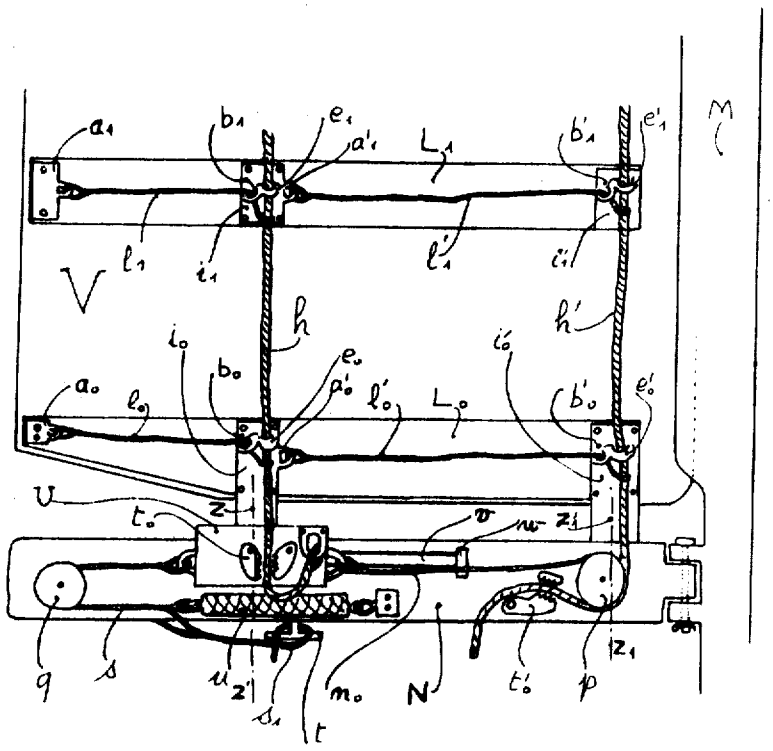

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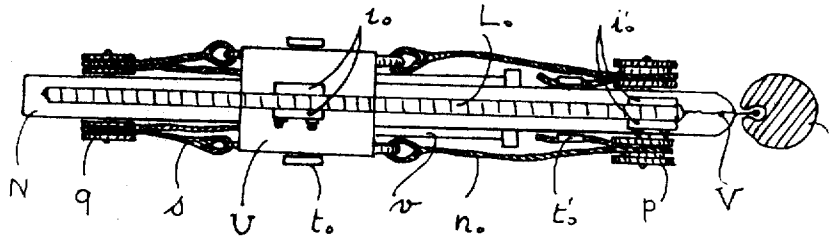

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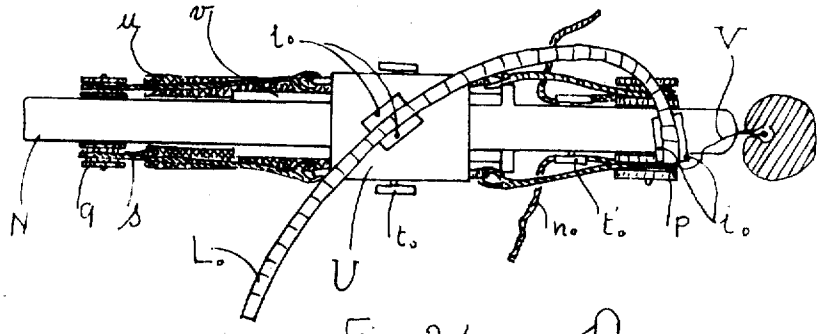

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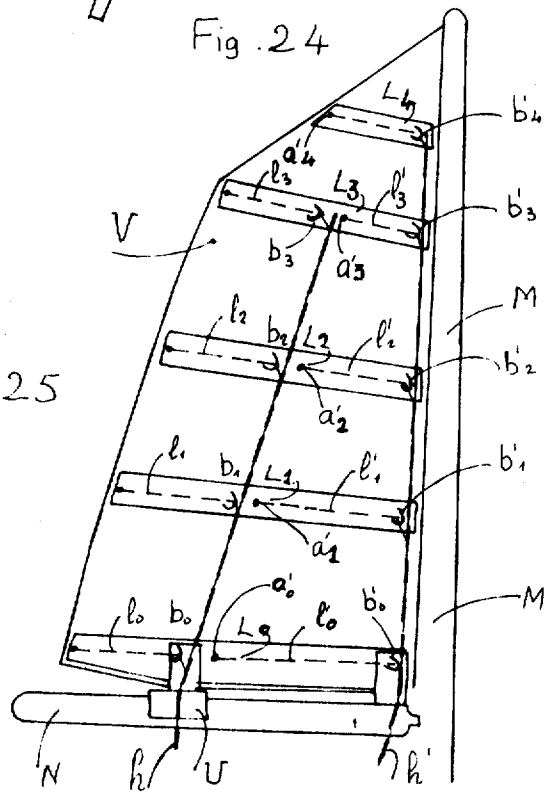

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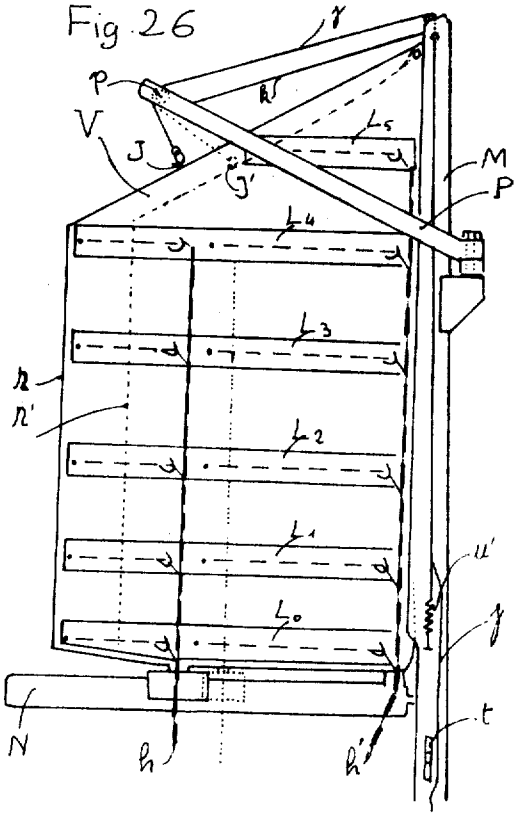

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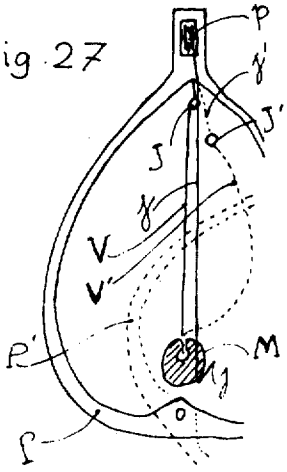

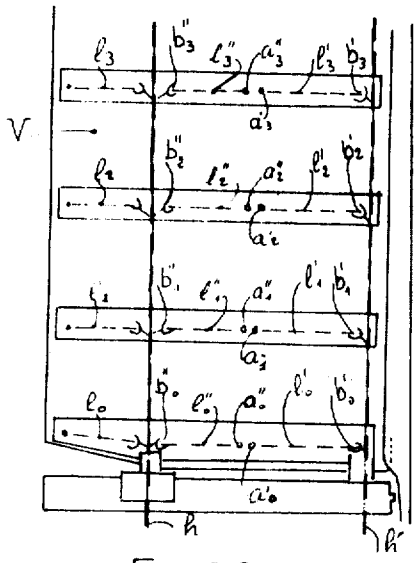

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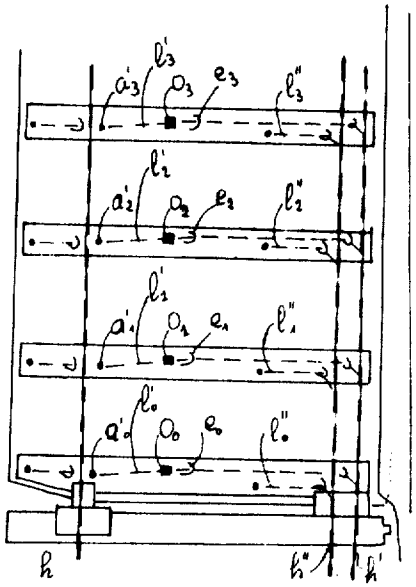

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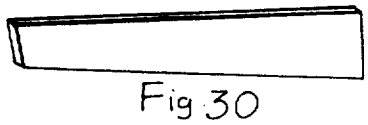

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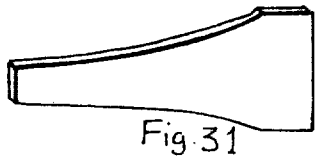

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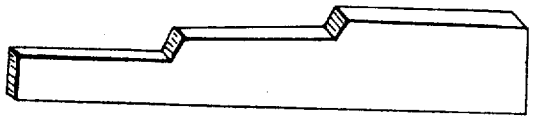

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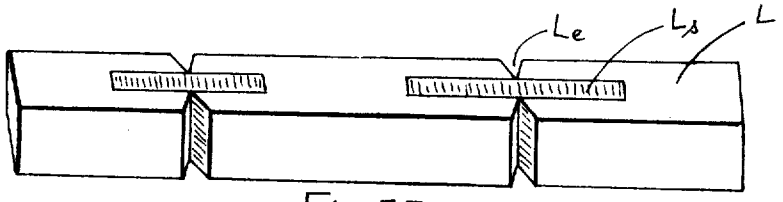

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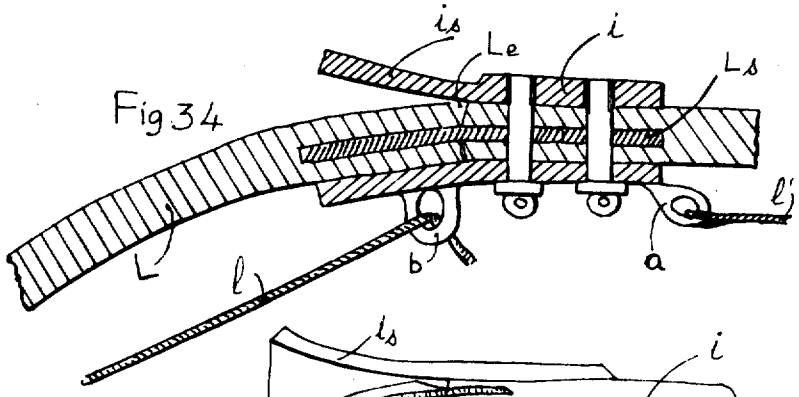

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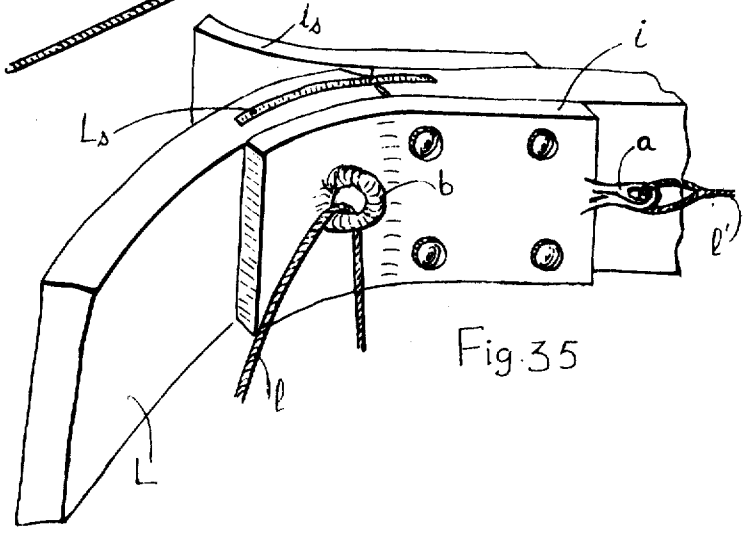

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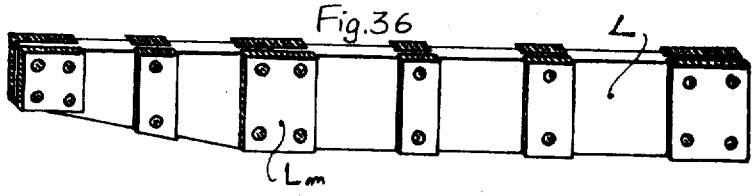

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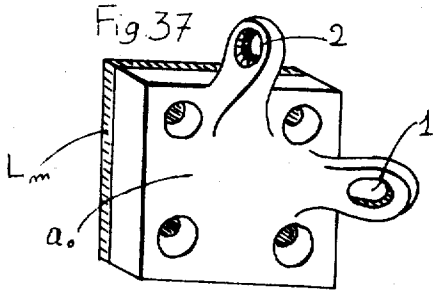

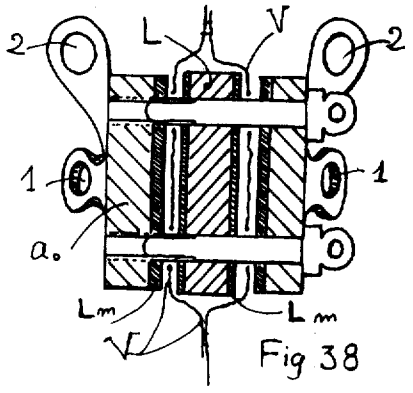

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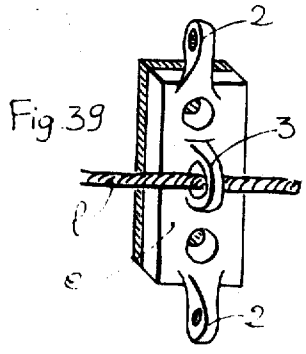

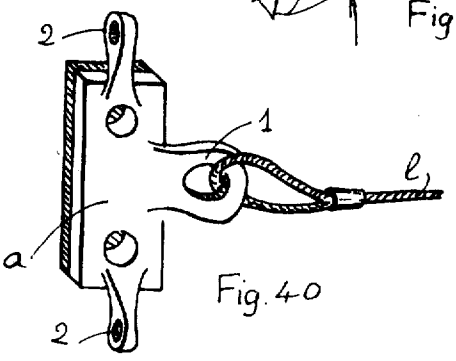

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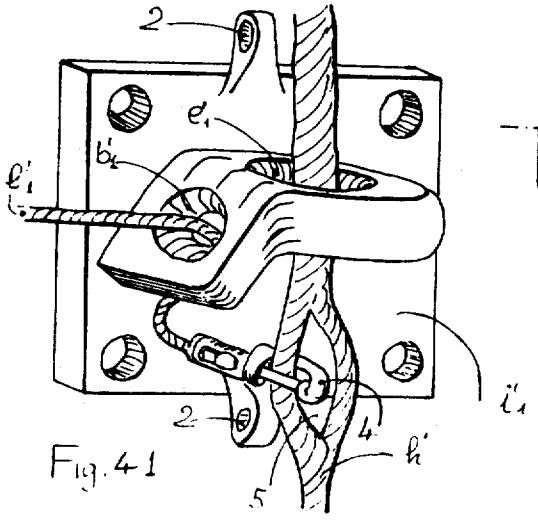

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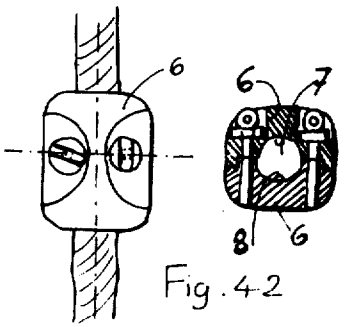
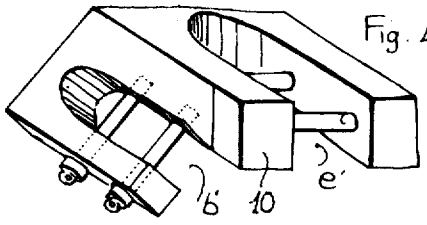


Fig.42

Fig. 43



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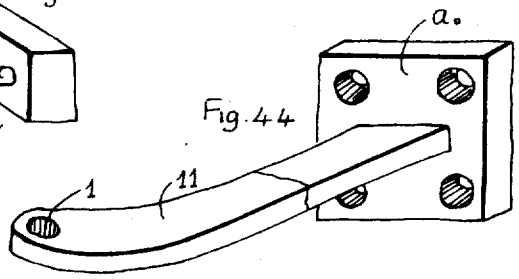

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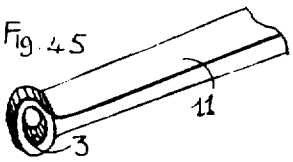

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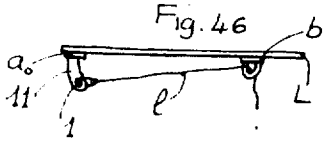

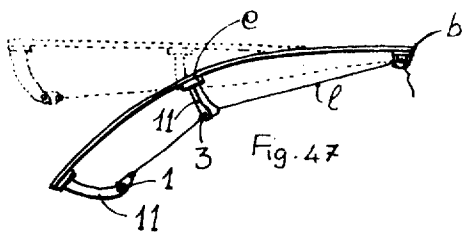

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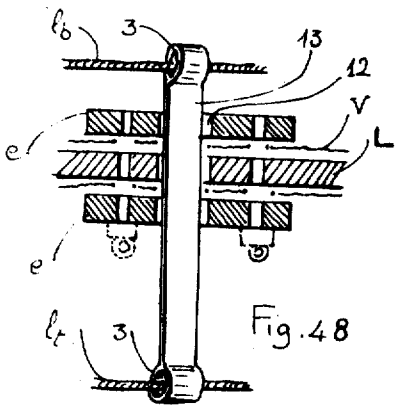

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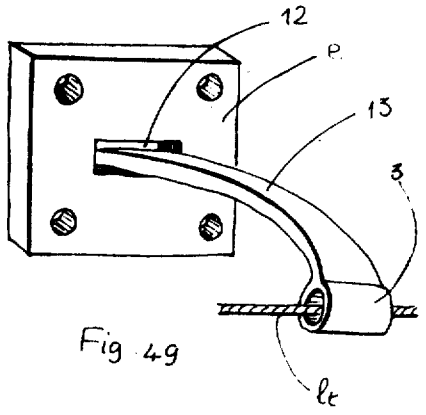

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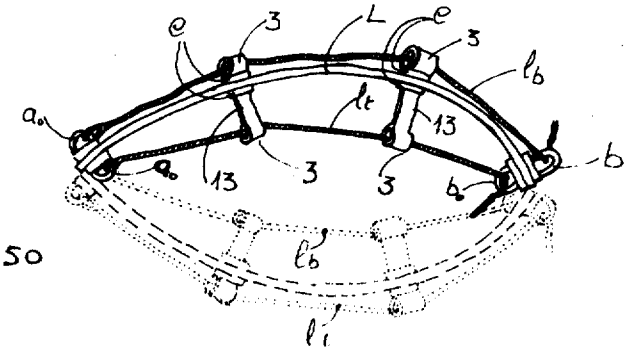

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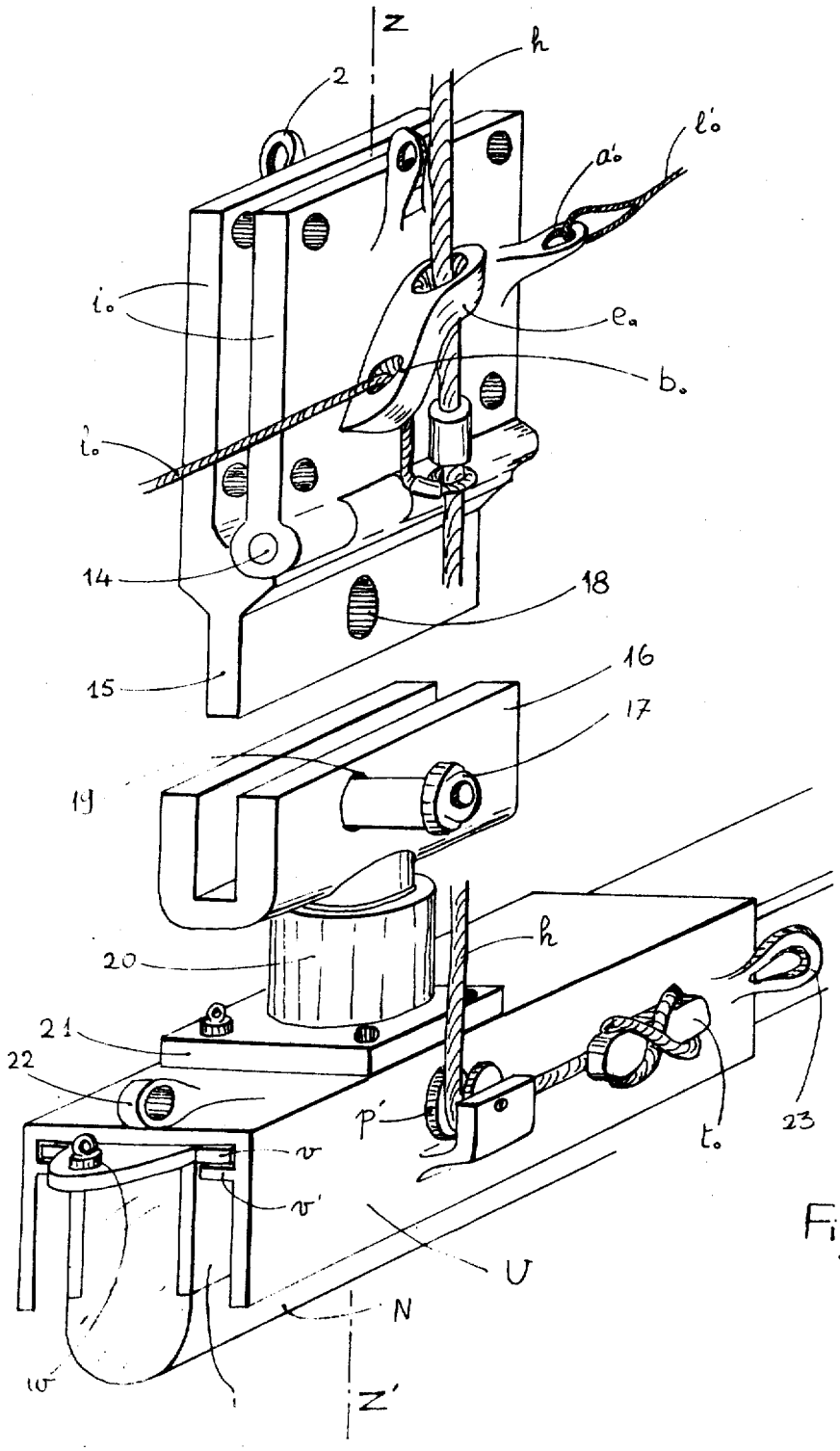

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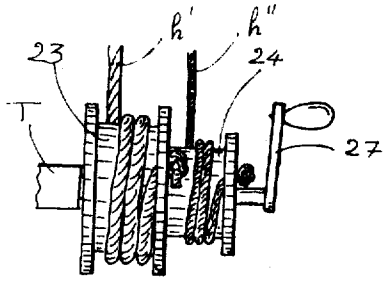

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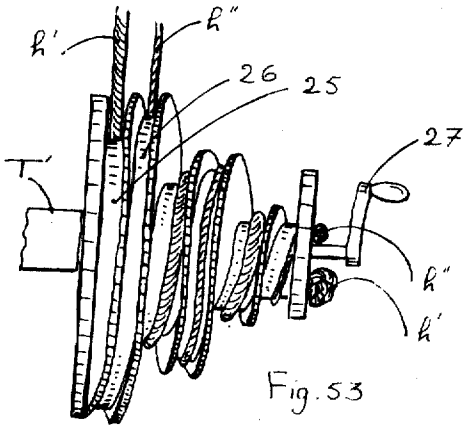

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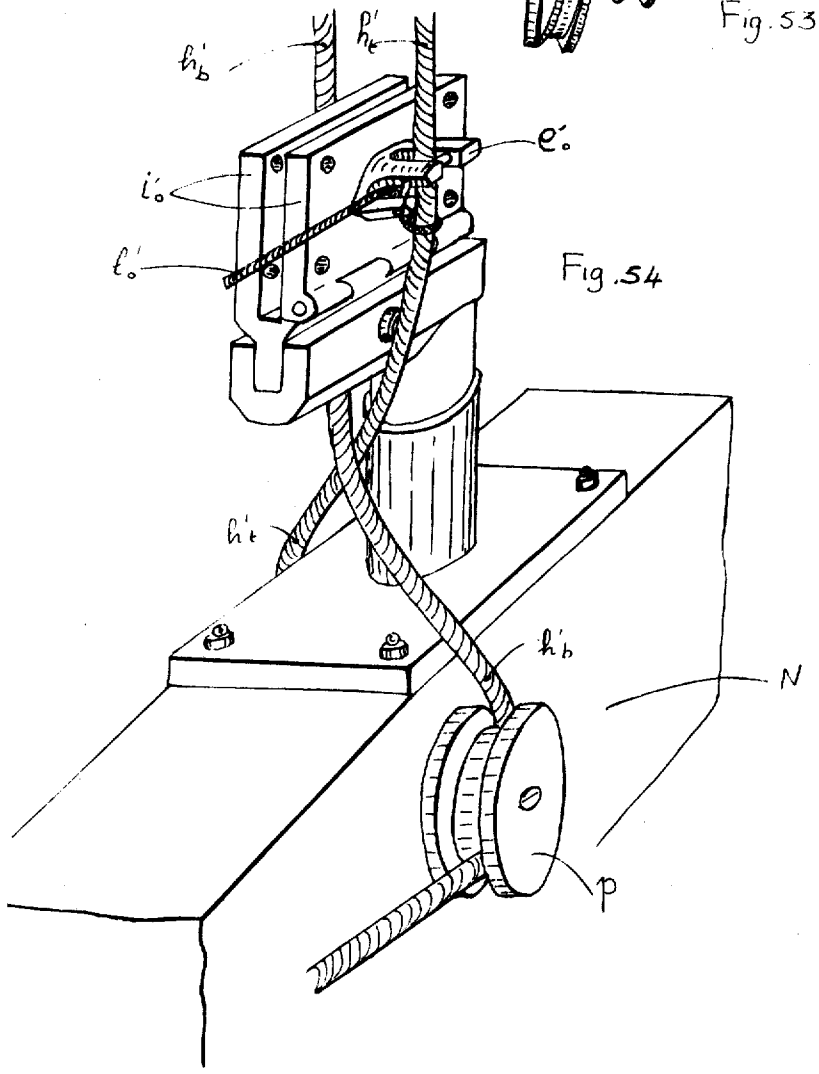

Fig. 54

APPARATUS FOR CHANGING THE CURVATURE OF A SAIL

Theory and experience agree on the importance of the curvature of the sails of a boat in order that they may have the best propulsive efficiency. But the best results, obtained in a laboratory on sails cut out of sailcloth and put into the ideal form, cannot be reproduced on the sails of a boat. In the latter, the belly cannot be formed in accordance with the known ideal. It results from the characteristics of the sailcloth, from the tension on the shrouds, on the halyards and sheets, from the rigidity of the spars, from the direction and force of the wind. In these conditions, the belly is thus a result observed passively rather than obtained actively, above all in points of sailing "on the wind."

The present invention relates to a positive or direct process for the curvature of sails, and to the devices for carrying out the process, and it applies specially to sails provided with flexible battens which have been used hitherto only for increasing the strength and rigidity of sailcloth.

The process according to the invention consists in controlling the curvature of the sailcloth by acting on the curvature of the flexible battens and, more particularly, in exerting traction between two points of the batten, or between points situated on the surface of the sail in such a way as to curve the batten and the surface of the sail with which it is integral, as a string tensioned more or less curves a bow more or less.

By way of example FIG. 1 shows the arrangement of a batten L on a sail V. The curvature of the batten is determined by the tension of a line 1 fixed at A on the batten, running in B thereon, and drawn downwards beyond B.

FIG. 2 is a view of the batten according to FIG. 1 cut along a plane XX' perpendicular to the surface of the flat sail. The outline AB in a dotted line shows the batten without tension by the line. The outline A_1B in continuous lines represents the batten curved under the tension of the line 1. The point A_1 is pulled down to A'_1 on the dotted outline. The shortening of the cord 1, in consequence of the tension between the points A and B, is equal to AA'_1.

Positions of the line with respect to the batten, indicated by way of example in the following FIGS, representing in section, as in FIG. 2, a batten curved under the traction of a line.

FIG. 3, an intermediate running point C of the line 1 is arranged on the batten between the points A and B. This arrangement allows of obtaining a like curvature by traction on a line of less length.

FIG. 4, an intermediate running point E is arranged between the points A and B at the end of a tail *d* itself fixed at D to the surface of the batten. This arrangement allows of obtaining a given curvature for a traction length of line intermediate between the traction lengths of FIG. 2 and FIG. 3.

FIG. 5 represents a batten L with two intermediate running points E_1 and E_2 mounted, as FIG. 4 describes, on two tails d_1 and d_2 fixed to the batten at D_1 and D_2.

FIG. 6 represents a batten L on which a tail d_3 is fixed at D_3 on the batten between the points A and B, the other end of the tail being itself fixed at F, without running, on the line 1. This arrangement allows of continuing the curvature of the batten arc D_3B while the arc AD_3 is not bent any further by continuing traction on the line 1.

FIG. 7 represents a batten L, on the surface of which is arranged, sewn into the sail, a slot *f* in which the line 1 runs. This arrangement allows of appreciably bending the two arcs AD_4 and D_5B situated on either side of the slot, while the portion of the batten supporting the slot is less curved.

FIG. 8 represents a batten curved under the action of two lines 1 and 1' fixed respectively at A and A' and running in two return devices b and b' fixed at the extremity B of the batten. The line 1 runs moreover in an intermediate point C on the batten. It is provided with a stop O arranged between the fixed point of the line A and the intermediate running point C. This stop, butting against the intermediate running point, limits the curvature of the arc AC, while one can still curve the arc CB under the traction of this same line. The second line 1' intervenes to accentuate the curvature of the arc section A'B and to straighten the arc section CA'.

FIG. 9 shows a batten L provided with two intermediate running points C_1 and C_2, curved by a single line 1 on which are mounted two stops O_1 and O_2. These stops limit the curvature of the arc sections AC_1 and C_1C_2 while it is possible to curve still more the arc section C_2B by pulling on the line.

FIG. 10 shows a batten L curved at its two extremities by the independent action of two lines 1_1 and $1'_1$.

FIG. 11 shows the arrangement of battens and of their traction lines in a jib W. The battens L_1, L_2, L_3 of equal length are arranged parallel to the lower edge of the sail. Their extremities, fitted respectively with running points b_1, b_2, b_3, are situated near to the luff-rope G. The tensioning lines 1_1, 1_2, 1_3 are connected, beyond the running point, to a control line *g* which is thus parallel to the luff-rope and at a short distance therefrom. This control line is led aft after passing through a block *p* situated near the tack of the jib, and made fast at a fixed distance on a cleat *t* fixed to the deck. By hauling on a fixed length of this control line *g*, each individual line 1_1, 1_2, 1_3 curves one of the battens. The battens having the same length and the same characteristic, the curves are identical. The outline of the battens thus curved, projected on the plane of FIG. 11 (assuming that the noncurved part of the sail remains parallel to itself), is represented by the dotted lines L_1, L'_2, L'_3, FIG. 11, as well as the outline *r'* of the leech-rope *r* and of the foot.

FIGS. 12 and 13 represent the section of the sail in FIG. 11 in the planes $X_1X'_1$ and $X_2X'_2$ of the sail curved by the pull on the line *g*.

FIG. 14 shows another arrangement of battens and of lines in a jib. The battens are arranged perpendicular to the luff-rope. Each tensioning line is connected to a single control line arranged as in FIG. 11. The outline of the curved batten, obtained as shown in FIG. 11, is superposed on the outline of the uncurved batten, except for the extremities A_1, A_2, A_3 where the lines 1_1, 1_2, 1_3 are fixed which are projected at A'_1, A'_2, A'_3. This arrangement allows of curving the sail without subjecting the battens to a torsion effect.

The sail can also be fitted with battens of unequal length extending over the whole available distance of the sail between the luff-rope on the one hand and the leech-rope or the foot on the other hand.

FIG. 15 shows a mainsail V, rigged on a mast M and a boom N, fitted with battens L_1, L_2, L_3, L_4, the extremities A_1, A_2, A_3, A_4 of which, carrying fixing means a_1, a_2, a_3, a_4 of the ends of the lines 1_1, 1_2, 1_3, 1_4, are situated near the leech *r*. Each line 1_1, 1_2, 1_3, 1_4 passes through a return device b_1, b_2, b_3, b_4 in which it runs. It is then guided downwards and kept close to the surface of the sail by guiding devices *e*, placed for preference on the battens, in such a way that the lines, between the return device and the deck of the vessel, are substantially parallel.

FIG. 16 shows a mainsail fitted with battens as in FIG. 15 but the tensioning lines 1_1, 1_2, 1_3, 1_4 are attached to a control line *h* beyond each running point b_1, b_2, b_3, b_4 so that only the line *h* is controlled from the deck. Traction of a given length on this line brings about shortening of the same length of the tensioning lines between the points A_1 and B_1, A_2 and B_2, A_3 and B_3, A_4 and B_4 of the battens. The dotted lines *r'* on FIG. 15 and FIG. 16 show the position of the leech-rope *r* at a certain curvature of the battens.

FIG. 17 shows a mainsail V fitted with battens L_1, L_2, L_3, L_4 extending from the leech-rope to the luff-rope H near the mast. The battens are tensioned by two series of lines 1_1, 1_2, 1_3, 1_4; $1'_1$, $1'_2$, $1'_3$, $1'_4$. The first series is fixed by means a_1, a_2, a_3, a_4 near the leech-rope *r* running in means b_1, b_2, b_3, b_4 and are attached to the control line *h* directed towards the deck. The second series is fixed by means a'_1, a'_2, a'_3, a'_4 running in means b'_1, b'_2, b'_3, b'_4 and are attached to the control line *h'* directed towards the deck. Under a certain pull on the lines *h* and *h'* each batten curves as FIG. 10 shows. The outline of the bolt rope *r* moves to *r'*. The lower part of the bolt rope, between the batten L_1 and the clew I, is subjected to stretching which would be avoided if the clew slid to I'.

FIG. 18 shows a section of the sail in FIG. 15 in a plane $X_3X'_3$ at a certain tension of the line. The return lines from the battens L_2, L_3, L_4, situated above L_1, are kept close to the sail by guides *e*. The sail at rest is shown by a dotted line.

FIG. 19 shows a section of the sail in FIG. 17 in the plane $X_4X'_4{}'_1$ is tensioned. The sail at rest is shown by a dotted line. FIG. 20 shows a section of the sail in FIG. 17 in the plane $X_5X'_5$, the two lines 1_4 and $1'_4$ being tensioned. The sail at rest is shown by a dotted line.

FIG. 21 shows a means of shifting the clew I according to the curvature of the sail when the batten nearest to the boom is at a certain distance therefrom, thus avoiding the stretching indicated in FIG. 17. A line 1_o fixed to the clew passes through a block *p* fixed to the boom near the mast. Through this block also passes the control line *h* for the curvature of the batten. The two lines 1_o and *h* are joined to one another after their passage through the block, so that traction of a given length on the line *h* is applied equally to the other line 1_o. The clew I and the point of fixing a_1 of the line 1_1 on the first batten L_1 are thus shifted by the same amount by a single pull on the line *h*. The sail wrinkles at the foot bent to the boom. The belly of the sail should have enough fullness to allow of the curvature of the batten l_1. The clew I is hauled aft by a line *s* passing over a sheave *q* fixed in the axis of the boom beyond the clew; the line *s* is fixed to one end of an elastic means *u* consisting, for example, of a metallic spring or a rubber cable, the other end of which is fixed to the boom. The spring *u* is already under tension when the clew is at I. When the clew is hauled to I' by the line 1_o, a pull of the same length is transmitted to the spring *u* by the line *s*. Their corresponding position at I' is shown by the dotted lines *s'* and *u'*.

FIG. 22 shows a more developed device for shifting the clew of a mainsail according to the curvature of the batten L_o situated near to the boom. The batten L_o is mounted in a known way in a pocket worked in the sail. This is not in direct contact with the boom. Two metallic devices i_o, i'_o are screwed to the combination of sail and batten. The device i'_o fixed to the end of the batten nearest to the mast pivots in the boom about a fixed axis $Z_1Z'_1$ perpendicular thereto. The device i_o, which corresponds to the clew, fixed on the batten at a certain distance from the leech-rope, pivots in the boom about an axis ZZ', perpendicular to the boom, fixed on a runner U capable of sliding on the boom in the longitudinal sense. This runner, in the form of an inverted U, is maintained in its sliding movement by two rails *v* fixed on opposite sides of the boom and terminated by a stop *w*. The runner is fitted with a jamming cleat t_o intended to fix the length of a control line *h* of the battens; with an outhaul line *s* leading aft from the clew, passing over a block *q* joined to a spring *u* fixed on the boom, with a traction line leading forward n_o itself attached to the control line *h'* situated near the mast. The boom is fitted with: a block *p* allowing of the horizontal return of the lines *h'* and n_o and with a jamming cleat t'_o for these lines, with a cleat *t* intended for the tautening line s_1 connected to the two return lines from the clew. The batten L_o is curved by the action of two lines: one line 1_o fixed by the part a_o near the leech-rope, running in the return eye b_o carried by the part i_o and attached to the line *h*; and a line $1'_o$ fixed at a'_o carried by the part i_o running in b'_o and attached to the line *h'*. The upper batten L_1 is equipped in a similar way (as well as those following): the part i_1 fixed on the batten L_1, square with the runner, carries the eye b_1, the fixing ring a'_1 and the guide e_1 of the line *h*. The part $i'_1{}'$ at the end L_1 near the mast, carries the eye b'_1 and the guide e'_1 of the line *h'*. The curvature of the after part of the sail, in overhang above the boom starting from the runner U, is obtained by hauling down on the line *h* for the desired amount and fixing the line *h* in the cleat t_o. This operation has no appreciable effect on the forward part of the sail. There is thus no need to modify the position of the runner U. The curvature of the forward part of the sail is obtained by hauling on the line *h'* downwards and backwards passing through the block *p*. The line *h'* draws with it the lines $1'_o$, $1'_1$, etc. and curves the part of the corresponding battens. It also draws with it the line n_o which, drawing on the runner U, moves it forward by the same length as the line *h* has been drawn. By this traction, transmitted by the line *s* to the spring *u*, the matter is elongated by the same length; the action of *u* is completed, when the handling of *h'* is finished, by making fast the line s_1, well tautened, on the cleat *t*. To give to this part of the sail a less pronounced curvature, the line *h'* is released from the cleat t'_o and the desired length is paid out. The return of the line *h'* upwards is ensured by the elasticity of the battens and by the action of the spring *u*. This arrangement allows of regulating the curvature of the two zones, forward and after, of a mainsail, in an independent way.

FIG. 23 shows a plan view of the boom N according to FIG. 22 fitted with rails *v*, with a runner U, with lines *s* and n_o, sheaves *p* and *q*, cleats t_o and t'_o. The batten L_o and the sail (not shown on the batten) are held in the two devices i_o and i'_o, the batten being parallel to the boom.

FIG. 24 shows a plan view of the arrangement according to FIG. 23 when the batten is curved by the action of the lines (not shown). The devices i_o and i'_o have pivoted to take part in the curvature of the batten. The runner U has slid forward on the guide rails *v*, due to the pull of the lines n_o drawn forward by the line *h'* (not shown). The springs *u* appear between the sheaves *q* and the runner U which masks them in FIG. 23.

FIG. 25 shows the totality of a mainsail V, fitted with a device according to FIG. 22. The battens L_o —L_4 are of unequal length. The eyes b_o —b_3 of the lines 1_o —1_3 are at the same distance from the leech-rope. The control line *h* is practically parallel to this bolt rope. The fixing means a'_o —a'_4 are at the same distance from the line *h* and close thereto. The control line *h'* is parallel to the mast. The after part of the sail is curved by the lines 1_o —1_3 of the same length. The forward part is curved by lines of unequal length $1'_o$ —$1'_4$.

FIG. 26 shows an arrangement of the mainsail V, fitted with a device according to FIG. 22 in which the two parts of the sail are curved by means of batten sections of equal lengths in the same part. The leech-rope is parallel to the mast for a great height. The battens L_o —L_4 are of equal length. To prevent the sail, the horizontal part of which is important, from sagging and from causing the battens to bend, a gaff P is fitted, fixed on a pivot on the forward side of the mast. This gaff is in two branches which surround the sail and allow it room to curve according to the action of the battens. The gaff is maintained in position by a halyard *k* passing through the masthead and handled in a known way. Another halyard *j*, starting from an eye J, fixed on the mainsail aligned with the line *h*, passes over a sheave *p* fixed at the end of the gaff, is carried from the masthead to the foot of the mast where it can be made fast on a cleat *t*, or kept in approximate position by means of an elastic connecting *u'*, branching from it at one end and fixed to the mast at the other end. The functioning of the arrangement is as follows: when the sails are curved in the manner already described, the bolt rope *r* comes to *r'*, the fixing eye J for the halyard *j* on the sail comes to J', nearer to the mast, the halyard *j* must then extend to allow of this movement. This extension is permitted by the elastic link brought into operation by casting off the end of *j* made fast on the cleat *t*. When the operation of curving the sail is finished and the point J has come to J', the slack allowed in the halyard *j* by the elastic link *u'* is taken up by making taut the end of *j* made fast again on the cleat *t*. This arrangement limits the spiralling of the sail from below upwards under the effect of the wind; the upper part of the sail maintains a still appreciable angle of incidence to the wind.

FIG. 27 shows a partial view in plan of the two-branched gaff mentioned in FIG. 26. The mast M is inside the perimeter of the two branches. V is the sail in the plane position; V' as a dotted line, the sail in a position of curvature. P' as a dotted line is the position which the gaff can take up with respect to the mast when sailing with the wind free.

FIG. 28 and FIG. 29 show two other arrangements of the tensioning lines in the lower and middle part of a sail such as in FIG. 26. In FIG. 28, the line *h* controls the tension of the lines

$1_o - 1_4$ arranged on the after part of the sail and the lines $1''_o - 1''_3$ arranged in the after region of the forward part of the sail V, fixed on the batten at $a''_0 - a''_3$, and passing through the eyes $b''_o - b''_3$. The line h' controls the tension of the lines arranged in the forward region of the sail fixed to the batten at $a'_o - a'_3$ and passing through the eyes $b'_o - b'_3$. In FIG. **29**, the line h controls the curvature of the after part of the sail. The curvature of the forward part is controlled by the lines h' and h''. The line h' is connected to tensioning lines fixed at $a'_0 - a'_3$ in the vicinity of the line h, fitted with a stop $O_0 - O_3$ placed between the point of fixation and a running eye $e''_o - e''_3$. The line h' is connected to tensioning lines fixed at $a_0 - a'_3$ in the vicinity of the line h, fitted with a stop $o_0 - o_3$ placed between the running eyes $e_0 - e_3$ and the mast. The curvature of the sail under the action of h' and h'' is shown in FIG. **8**.

FIG. **30** shows a batten of constant thickness with straight sides, of a width increasing uniformly from one end to the other.

FIG. **31** shows a batten with partially curved sides.

FIG. **32** shows a batten increasing in thickness from one end to the other, one side of which is in the form of a stepped line.

FIG. **33** shows a part of a batten L, the interior of which is provided with flexible material L_s capable of performing the function of a hinge between the more rigid parts which it joins. The lateral parts of the batten have notches L_e up to the hinge in such a way as to facilitate the bending on the hinge. The notches can be faced with an expanded plastic material, very flexible and spongy, which prevents the sail from being nipped during bending of the batten. This arrangement of the batten allows of obtaining, without strain on the line, a prearranged minimum curvature of the sail.

FIG. **34** shows in section in a plane like FIG. **2**, a batten like FIG. **33** and its fixation metalwork on the sail (not shown). The metalwork comprises two symmetrical plates i, fixed to the batten by screws, and extended by two widened flanges i_s able to support the curved batten under the tension of the line **1** passing in the eye b carried by i which likewise carries the fixing ring a of another line **1'**.

FIG. **35** is a perspective view of the arrangement in FIG. **34**.

FIG. **36** shows a lateral face of a batten L, provided with reinforcements L_m made of flexible material. These reinforcements are let in to the batten and are slightly proud of its surface. They are arranged at the location of the parts such as i, FIG. **35**, in such a way that the sail, compressed between the batten and the part i, is not damaged by contact with a hard material.

FIG. **37** shows a metal part such as a_o in FIG. **22** to be fixed on the batten, provided with a layer of flexible material L_m on the face in contact with the sail. This metal piece carries two rings **1** and **2**. **1** is intended for fixing a tensioning line (not shown). **2** is intended for taking a reef in the sail by a method described later on.

FIG. **38** shows a section, in a plane perpendicular to the surface of the batten, of the totality of the metalwork of FIG. **37**, mounted on a batten L fitted with flexible reinforcements L_m as in FIG. **36**. The batten L is accommodated in the pocket of a sail V. The whole is represented not clamped together in order to avoid confusing the lines representing the flexible material and the sail.

FIG. **39** represents an intermediate running means e of the batten L, previously mentioned in FIG. **3** and FIG. **29**, carrying a running eye **3** and two reefing eyes **2**.

FIG. **40** represents a means of fixation a of the end of a line **1** on a batten. **1** is the fixing eye, **2** are the reefing eyes.

FIG. **41** represents in perspective a metal part such as i'_1 of FIG. **22**. The control line h' passes into a guide eye e'_1. The line $1'_1$ passes into a guide eye b'_1. The line $1'_1$ carries at its end a snaphook **4** fastened to an eye **5** worked in the line h' below the eye e'_1. The metal part also carries two eyes **2** intended for reefing the sail. The metal pieces in FIG. **39**, FIG. **40**, FIG. **41** are fixed on the batten as described in FIG. **38**.

FIG. **42** shows an external view and a section along XX', of a stop O such as mentioned in FIG. **8**, FIG. **9** and FIG. **29**. Two half shells **6**, each carrying a half slot **7** of the line to be clamped, fit face to face and are clamped by two screws. The slot for the line is provided with projections **8** which complete the clamping action on the line to prevent any slipping.

FIG. **43** shows another embodiment of the totality of the two guides b'_1, e'_1 as described in FIG. **41**. The closed rings are replaced by shackles b' and e', united by a common limb **10**, welded at their base to the metal part i'_1 (not shown) and which can each be closed by one or two threaded shackle pins. One can thus guide two control lines h and two neighboring tensioning lines as in the case in FIG. **29**.

FIG. **44** represents a fixation fitting a_o at the end of a line in which the fixing ring **1** is offset to a certain distance from the surface of the metalwork by an arm **11**. This device allows of curving the batten more easily for small curvatures.

FIG. **45** represents an arm **11** carrying a running ring **3** instead of the ring **1** of FIG. **44**.

FIG. **46** represents the end of a batten L fitted with a metal part a_o as in FIG. **44**, with a running ring **3** as in FIG. **39** and with a line **1** passing through the return means b.

FIG. **47** represents a batten L fitted with an end fitting a_o as shown in FIG. **44**, with an intermediate running fitting e as represented in FIG. **45** and a return means b. The batten curved under the tension of the line **1** is represented by continuous lines. The uncurved batten is shown in dotted lines.

FIG. **48** represents, in section on a horizontal plane, the totality of the two metal parts e, screwed to a batten L, and a sail V. The totality of these parts carries a rectangular opening **12** crossing them from side to side and allowing the passage of a strip carrying an eye **3** at each end. These serve as guides to two lines 1_b and 1_t. The strip is capable of sliding along its length in the opening **12**. Its movement is limited by the eyes, larger than the opening **12**, which butt on the metalwork e.

FIG. **49** shows a perspective view of a metal part e, such as FIG. **48**, and of a strip **13** carrying an eye **3**.

FIG. **50** shows in continuous lines a batten L, flexed under the action of a line 1_t, fixed on the batten at a_o, passing through two eyes **3** carried by two strips **13** such as described in FIG. **48** and FIG. **49**, and returned after passage through the eye b. The line 1_b, not under tension, is kept at a short distance from the convex surface of the sail by those of the eyes which perform the function of stops against the metal parts e situated on this side. The dotted outline shows the same batten curved inversely by the tensioned line 1_b, while the line 1_t not under tension is kept near the sail by the eyes **3** situated on the convex side. To pass from one curvature to the other the strips **13** have slid the whole of the length allowed by the presence of the eyes forming the office of stop. This arrangement allows of having line guides projecting substantially only in the concave part of the sail, which is not the case with the device with the rigid arm described in FIG. **45** and FIG. **47**. The flat strip form is favourable because it limits the risks of twisting and entanglement. Any method of embodiment of the strip and of the eyes allowing their displacement as described in FIG. **50** comes within the scope of the process.

FIG. **51** represents, in exploded view, the detail of the arrangement of the metal fittings i_o on a runner U such as already mentioned in FIG. **22**. One of the metal parts i_o is mounted on a hinge **14** which allows of the easy placing, before compression between the two metal fittings, of the sail-batten assembly (not shown). Under this hinge a tongue **15** engages in a groove **16**. The assembly of these two parts is locked together by a threaded pin **17** passing through the hole **18** in the tongue **15** and the holes **19** of the groove. The groove is capable of pivoting about the axis ZZ' in a sleeve **20** fixed on the back of the runner U by a plate **21** screwed to the boom N. The runner, in the form of an inverted U, carries on the internal faces of the arms of the U, two slides v' forming projections over the whole of its length. They provide accommodation for the rails v already mentioned fixed to the boom N and which serve for guiding the runner. The sliding of the runner is limited in length by a screw w performing the function of a rear stop. Another screw (not shown) has the same function in

a forward direction. The runner also carries the eye **22**, intended to fix the return line aft, the eye **23**, intended to receive the tensioning line n_o (not shown) forward, a sheave p' and the cleat t_o.

The pulling of several lines, simultaneously and by the same length, is described with respect to FIG. **21** et seq. To operate several lines simultaneously which must be shortened by different amounts, one can use winch or capstan drums such as described hereafter: FIG. **52** shows a winch T fitted with two cylindrical coaxial drums **23** and **24** of different diameters operated by a handle **27**. The two lines h' and h'', each fixed in a known way on one of the drums, are wound up simultaneously. Their speed of winding is proportional to the diameter of the drums. It may be necessary to vary the ratio of the speeds of winding in the course of operation. This is particularly the case for a complex of several control lines operating the runner FIG. **22** and the curvature of the sail at different distances from the mast: at each degree of curvature of the sail, the length ratio of the lines to be tautened varies in order that the sail may keep a coherent shape. One can then use a winch which, in addition to a cylindrical drum of circular section, such as for example **23** in FIG. **52**, carries two helicoidal windings, the radius of curvature of which is not constant, for the whole length of the winding.

FIG. **53** shows a winch drum carrying two distinct windings **25** and **26** in which are accommodated two lines h' and h''. For a constant speed of rotation of the handle, the speed of tautening or paying out the lines h' and h'' varies. The number of windings is adjusted to the number of lines to be handled. If the length to be tautened is not too great, the windings can be reduced to cams of short profile extending over a sector of the circumference.

FIG. **54** shows a pivoting fitting such a i'_o of FIG. **22**. The general arrangement is the same as in FIG. **51**, but a new arrangement is adopted: since they are arranged on the preceding FIGS. the pulling of the lines h counteracts the pivoting of the fitting with respect to the boom. The lines h' in FIG. **54** are crossed under the pivoting fitting in such a way that the pulling of a line acts so as to pivot the fitting in the desired sense. The lines h'_t and h'_b are then operated on the lee side of the boom unless they are then taken to the windward side by passing under the boom.

The battens described in various aspects in FIG. **30** to FIG. **36** are formed in a homogeneous way or of lamina material cut to the desired dimensions, glued together in the manner of the leaves of a spring. The whole can be coated by a flexible or elastic material, the exterior lines of which have a geometrical form suitable for accommodation in the pocket of the sail. The adherent laminae can differ by the nature of the material, the thickness, the height or the length. They can be perforated or ribbed, reinforced at right angles to the metal fittings which clamp them in the pocket. If their form requires it, they are laced into the pocket and not slipped in the usual way. They can have in the sail all the positions contributing to give to it the desired curvature and homogeneity of shape.

The lines for curvature and the control lines can be nonextensible over their whole length or elastic in certain parts.

A particularly advantageous reefing device can be used due to the presence of battens of equal length extending over the whole foot of the mainsail as in FIG. **25** or FIG. **26**. The metal fittings such as FIG. **37**, FIG. **39**, FIG. **40**, FIG. **41** are arranged in line with one another on the battens corresponding to the reefs to be taken in respectively. If the fittings are spaced out too far, intercalary fittings are added which carry only the reefing eyes. To take down a reef, one slacks away the halyard by the desired amount. The two adjacent battens then come together. The upper eyes **2** of the lower batten come to the level of the lower eyes **2** of the upper batten. These rings are joined together by a reef point, snap hooks, or any other known means. The tensioning lines **1** of the battens concerned in this reef are attached to the control lines at the appropriate level after the coming together of the battens, so that the curvature of the sails by these battens can still be controlled by the lines h which are readjusted in length on the cleats carried by the boom and the runner.

By extension of the process, the curvature of the sails can be obtained by pulling on the lines fixed to the convex surface of the battened sail and returned to fixed points on a spar; in particular to fixed points on the topmast crosstrees or on cross trees arranged in parallel to the topmast crosstrees at different heights along the mast.

I claim:

1. A device for positively controlling the curvature of a sail comprising: flexible battens fixed on said sail, at least two control lines provided for each batten and arranged on either side of said sail, two sets of fittings positioned on either side of each batten, means for firmly attaching one end of each line to the respective fitting of the first set of fittings, means for running the free ends of each line through the respective fittings of the second set of fittings, and means for exerting a pull on the free ends of said lines to effect curvature of said battens.

2. A device for positively controlling the curvature of a sail according to claim **1**, wherein each control line has its one end firmly attached to the batten and is passed through at least one running means fixed on the batten.

3. A device according to claim **1**, wherein connecting members fixed on the batten are provided between said fitting means and the batten whereby the means for attachment and for the running means of the lines are spaced from the sail.

4. A device according to claim **3**, wherein said connecting members are rigid.

5. A device according to claim **3**, wherein said connecting means are flexible.

6. A device according to claim **3**, wherein the battens arranged on both sides of the sail have registering openings and the said connecting members are arranged to slide through said openings and are provided at their both ends with fittings for attachment and for the running fittings for the control lines.

7. A device according to claim **1**, wherein the control lines are provided with stops fixed on them between an attachment point and a running point to form an abutment on the running means of the respective fitting.

8. A device according to claim **1**, wherein each control line is extended downwardly to the deck and provided with individual driving means.

9. A device according to claim **1**, comprising common control lines extended downwardly to the deck, having their upper ends connected to the individual control lines of each batten respectively beyond a running means thereof and having their lower ends attached to common driving means.

10. A device according to claim **9**, wherein the battens provided on the jib have a fitting with running means arranged on the end of the batten adjacent the luff-rope of the jib and the common control lines attached to the individual control line beyond said running means and extending downwardly to the deck are arranged substantially parallel to said luff-rope and adjacent thereto, whereas the driving means to which said common control lines are attached are fixed on the deck and located on the port side of the middle line of the boat for the lines arranged on the starboard side of the sail and vice-versa.

11. A device according to claim **9**, wherein the battens provided on the mainsail have a fitting with running means arranged on the end of each batten adjacent the luff-rope and adjacent the mast and vertically above the clew.

12. A device according to claim **11**, wherein the after part of the mainsail is overhanging beyond the clew.

13. A device according to claim **11**, wherein the clew is slidingly arranged along the boom, a runner being slidingly arranged on the boom and the clew having a pivot fixed to said runner, means being provided to control the forward sliding of said runner by one of the common control lines connected to the individual control lines of the battens, whereas the rearward sliding of said runner is controlled by spring means arranged on the boom.

14. A device according to claim 13, wherein the battens of the mainsail are each provided either side of the sail with two control lines, one of which controls the curvature of the forward part of the sail and is attached at one end of the middle point of the batten and has a running means located at the forward end of the batten adjacent the luff-rope, said individual control lines being connected to common control lines activated by driving means fixed to the boom, whereas the other individual control line is provided to control the curvature of the after part of the sail and is attached to the rear end of the batten and has running means located in the middle part of the batten, whereas the common driving lines, to which said other individual control lines are attached beyond their running means, are activated by driving means passing through the runner sliding on the boom.