April 16, 1963 W. PROLSS 3,085,539

SAILING VESSEL WITH SQUARE-RIGGED MASTS

Filed July 29, 1960 7 Sheets-Sheet 1

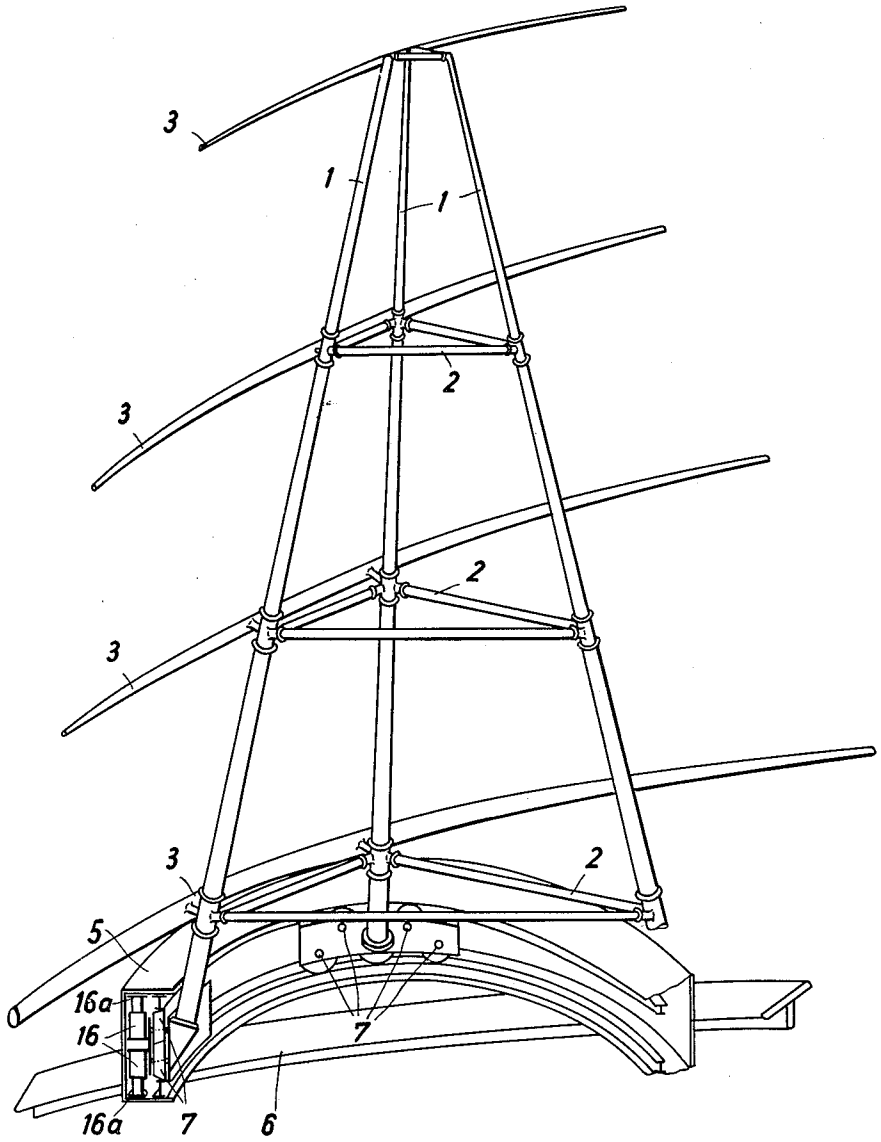


Fig. 1

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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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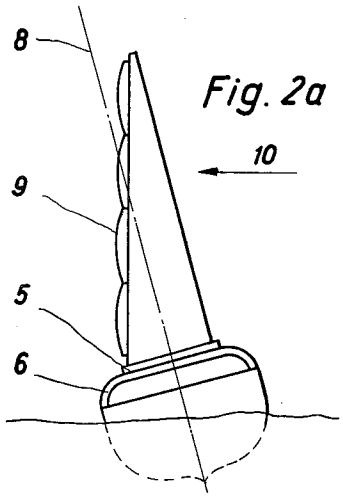


Fig. 2a

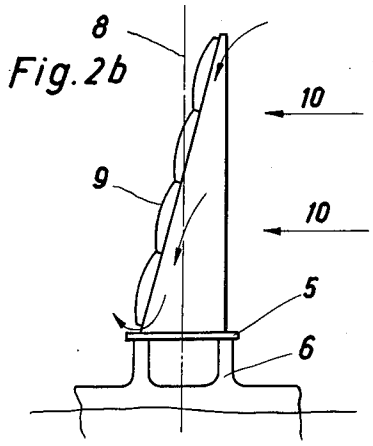


Fig. 2b

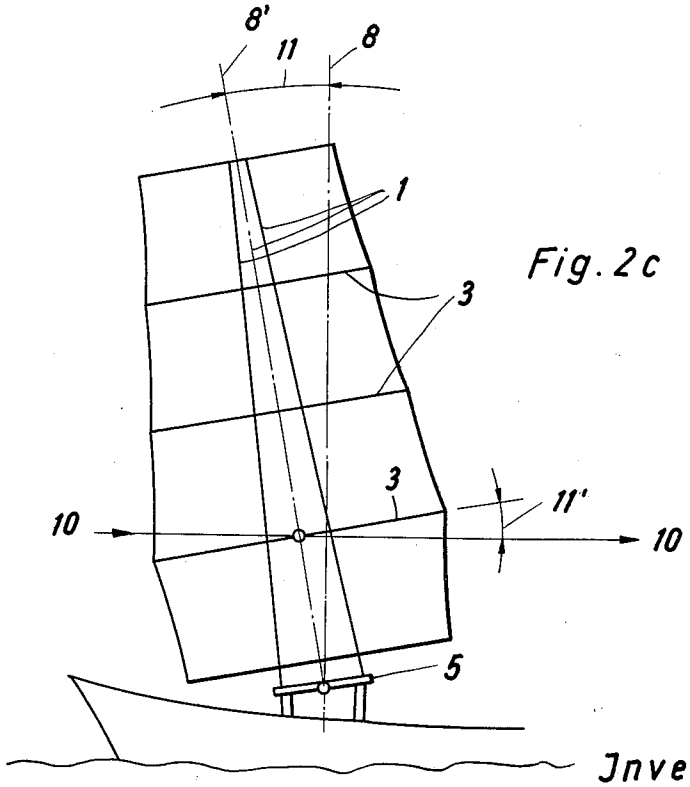


Fig. 2c

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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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Fig. 3

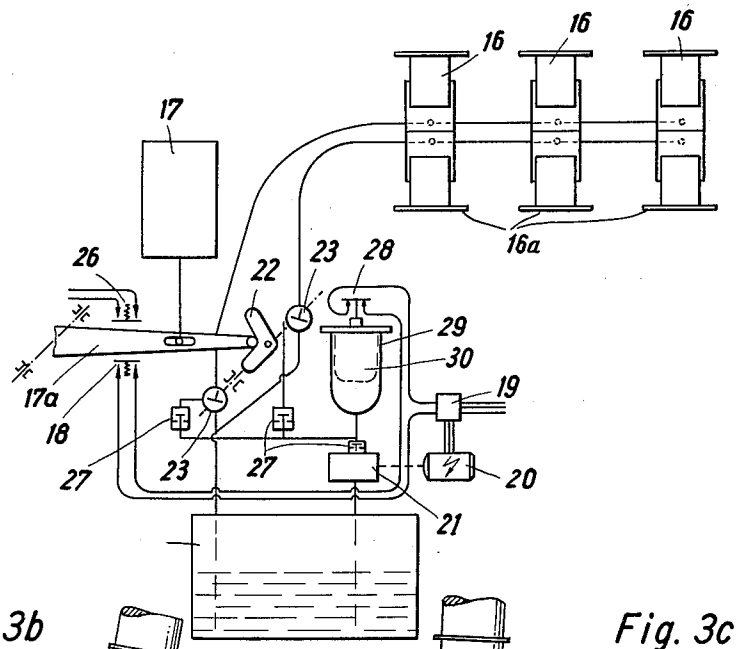


Fig. 3b

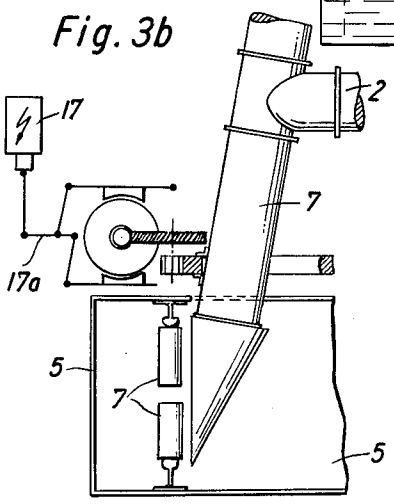
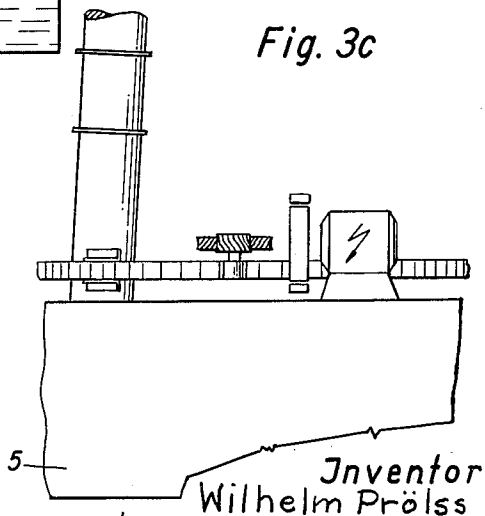


Fig. 3c



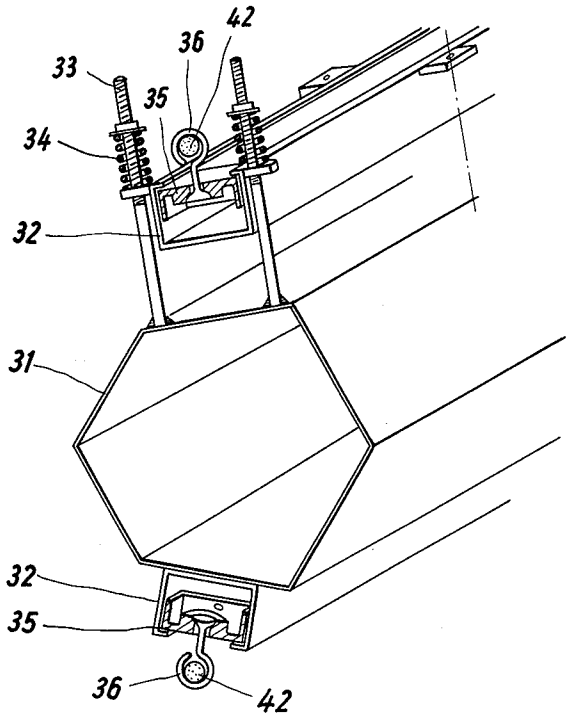
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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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Fig. 4a



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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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Fig. 4 b

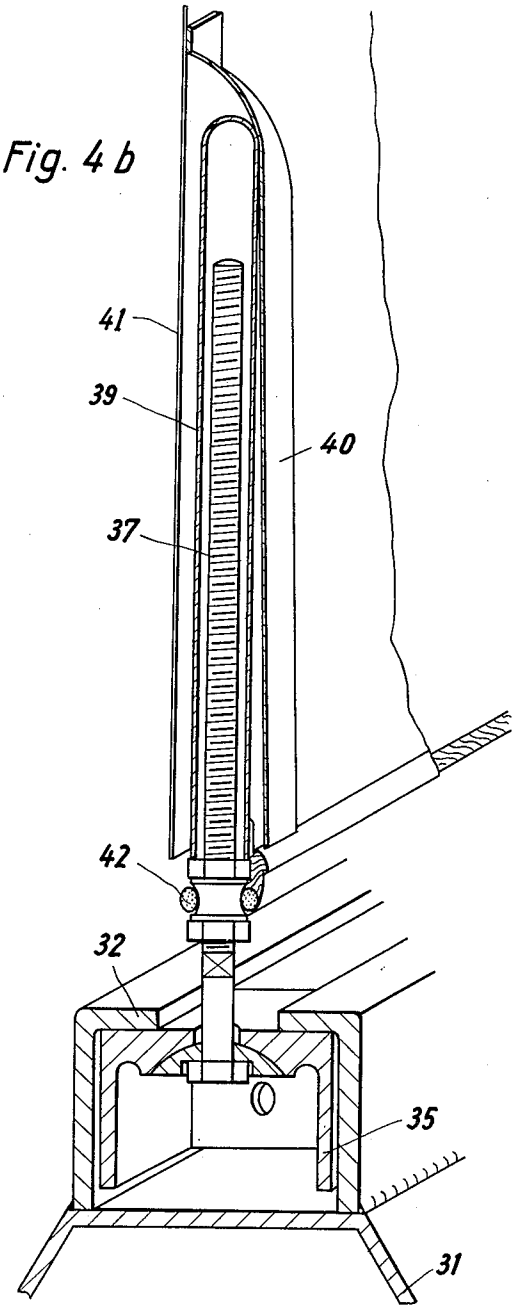
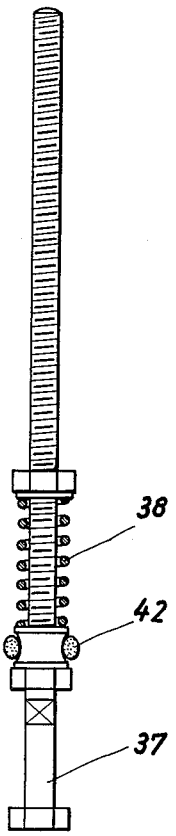


Fig. 4 c



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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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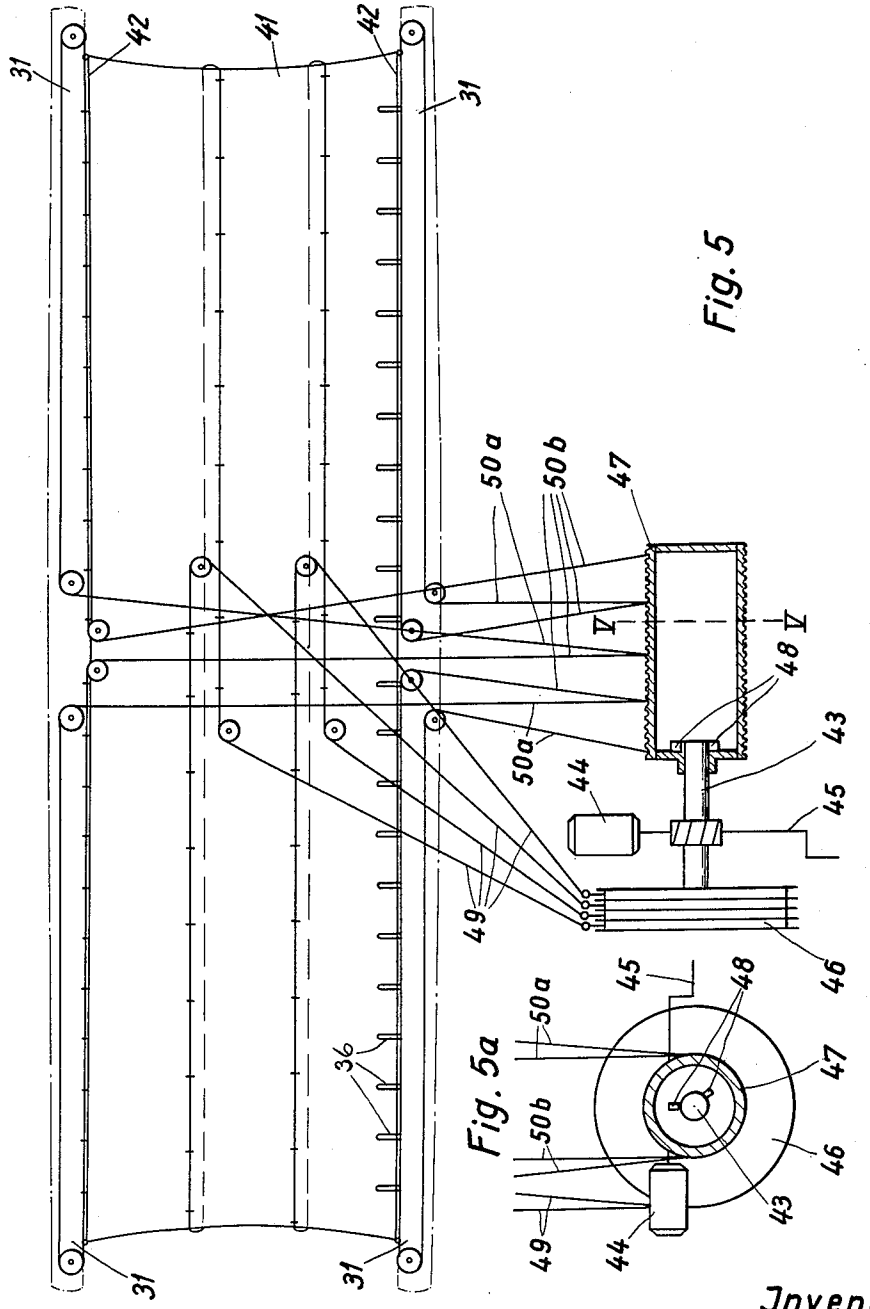


Fig. 5

Fig. 5a

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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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Fig. 6a

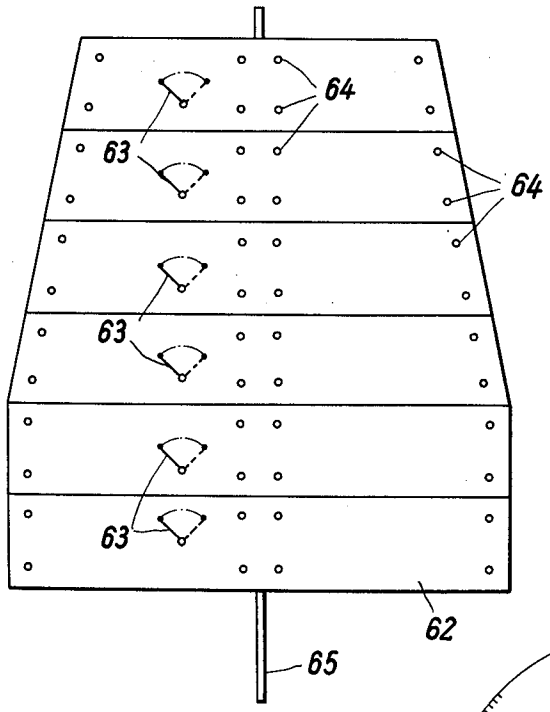


Fig. 6b

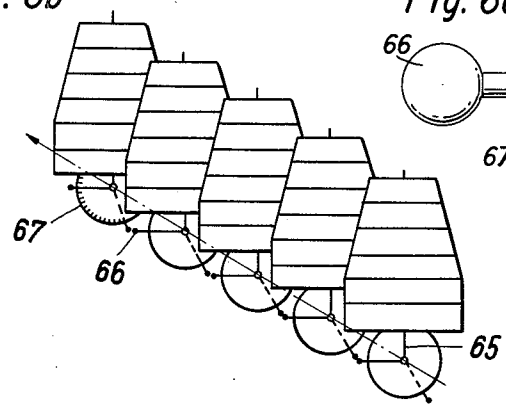
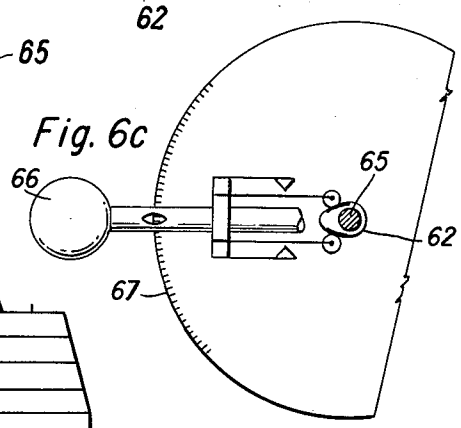


Fig. 6c



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SAILING VESSEL WITH SQUARE-RIGGED MASTS

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Filed July 29, 1960, Ser. No. 46,253
19 Claims. (Cl. 114—89)

Sailing vessels of the type of construction known and customary heretofore have the following disadvantages: they require a large crew to handle the sails; the work of the crew is dangerous especially in cold and rough weather; and manoeuvrability is inadequate; in addition, there are poor aerodynamic conditions (poor propulsion effect of the sail and high drag for the complete rigging), especially in the case of sailing close to the wind, so that as a result of all these disadvantages voyage times were inadmissibly long. Previous attempts to improve at least the handling of the sails, for example in the form of an inward furling or electric winches incorporated in the yards, were unsuccessful since no change was made to the basic principle of said control by means of a large number of free-moving spars and ropes, and/or the shape of the yards and sails were not aerodynamically correct so that the said improvements could not take effect. Nor has it been possible to dispense with stays in the case of previously known square-rigged lattic masts rotatable about their vertical axis. Finally, owing to the large number of ropes and other control means, there is no longer sufficient room for hatches and the operation thereof. The remote control system for operating the sails, as known in square-rigged sailing vessel, has also not become established in practice. The final result is that sailing vessels—especially large sailing cargo vessels—have become unprofitable and accordingly have practically died out, although wind power is still available at adequate strength and regularity over considerable long ocean distances.

Attempts to improve the sailing ship must therefore be concerned firstly with eliminating the complicated control of the sails customary today and improvement of the aero-dynamic conditions. The present invention relates to a sailing ship with square-rigged masts, which are rotatable about their vertical axes and on which the yards are rigidly disposed. The invention consists in the combination of the following partly known features:

(*a*) That the masts are of at least three-strut strut construction.

(*b*) That the two mast struts serving to fasten the yards are so inclined that the axis of rotation of the mast passes substantially through the centre of gravity of the parts belonging to the mast and that for the normal heel of the ship the surface of the sail is still substantially vertical.

(*c*) That the yards fastened on the mast struts are curved in a plane extending substantially normally to the mast axis.

(*d*) That the sails are furlable and horizontally guided between the yards.

(*e*) That the movement of the masts, yards and sails is remote-controlled from one or more points situated at any desired location and independently of one another.

As a result of the multi-strut masts, all the shrouds, stays and other supporting devices can be dispsensed with,

and this gives considerably lower drag when sailing close to the wind and improves the size and accessibility of the hatches. The yards are rigidly fastened on these multi-strut masts in such manner that no ropes or chains are now required to hold them in their correct position; this rigid fastening also makes it possible to curve the yards themselves in a substantially horizontal plane in such manner that they promote and in part render possible for the first time at all an aerodynamically favourable curvature of the sail surface. The entire mast is joined to the hull by a device after the style of a pivot mounting, and this facilitates and mechanically renders possible the rotary movement of the mast for bracing the yards; this does away with a large number of additional ropes, tackle, and so on.

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

FIG. 1 shows, partly in cross-section, a mast assembly according to the invention;

FIGS. 2*a*, 2*b* show the positions of the mast relative to the sailing vessel when the wind is abeam and abaft respectively;

FIG. 2*c* is a diagrammatical representation of the manner in which the mast may be forwardly inclined;

FIGS. 3, 3*b* and 3*c* are diagrammatic views showing the means for operating the pivot mount drive;

FIG. 4*a* is a cross-section of a rigid, resiliently adjustable jackstay;

FIG. 4*b* shows, partly in cross-section, a rigid tightener;

FIG. 4*c* is a view corresponding to FIG. 4*b* of a rigid tightener;

FIG. 5 is a diagrammatical representation of a winch arrangement for setting or furling the sails;

FIG. 5*a* is a section along line V—V of FIG. 5;

FIGS. 6*a* and 6*c* are diagrammatic showings of switch means for operating the winches, and

FIG. 6*b* is a similar view showing manual means for operating said winches.

In FIGURE 1, reference **1** is a three-strut mast, reference **2** denotes normally horizontal bracing member herein referred to as stiffening platforms which can, for example, be connected to the mast struts by means of flanges so that the mast can also be assembled from relatively small component parts—this may be important to lift in the event of damage—reference **3** denotes curved yards fitted rigidly on the mast struts and on the platforms, reference **5** is a pivot mount, which is rigidly connected to the hull by cross-members **6** and similar stiffening parts, and reference **7** denotes sets of rollers, by means of which the mast struts can move inside the pivot mounting.

The struts **1** of the mast are so disposed and inclined that the weights of the individual parts of the rigging have their common centre of gravity approximately on the pivot axis of the mast, so that the rotation of the masts results in no change of heel of the ship through gravity forces. The inclined position of the mast struts further has the effect that in the case of wind abeam and with the normal heel of the ship the sail surfaces are substantially vertical and hence give their maximum efficiency; in the case of wind abaft, on the other hand, the then inclined sail surface permits a better discharge of the wind. FIGURES 2*a* and 2*b* clearly show the effects

described, reference 8 denoting the vertical axis of the ship or mast, reference 9 the position of the sail surfaces and 10 the horizontal projection of the wind direction.

In addition, the pivot axis of the mast may be inclined forwardly, as shown diagrammatically in FIGURE 2*c*, reference 8 denoting the vertical to the surface of the water, reference 8' the pivot axis of the mast and 11 the angle between these two imaginary lines. By this arrangement, the yards are situated horizontally when they are squared (transversely to the longitudinal axis of the ship) while in the case of close-hauling (turning in the direction of travel) they are directed aft and upward at the angle 11'; the angle 11' increases with the degree of close-hauling and largely compensates for the inclination of the yards in the aft and downward directions, which would otherwise be caused when sailing close to the wind through the heel of the ship to lee. As a result of this compensation the longitudinal direction of the yards always corresponds as far as possible to the direction of flow 10 of the air, which is substantially horizontal; the laminar flow of the air is thus disturbed to a lesser degree, and this means an increase in efficiency and hence of the propulsion effect.

The fact that the yards are braced by turning the entire mast is known. An example of realization is illustrated in FIGS. 3*b* and 3*c*. The mast struts 1 which are connected to one another by stiffening platforms 2 may be rotated within the pivot mount 5 by means of the roller sets 7. There are used for example well known driving means as a motor, which drives through a worm gas sprocket and a teeth annulus which may be secured to the mast struts. It is possible to provide in well known manner a brake acting on the shaft between motor and worm gear, which may be lifted by an electrical magnet 17 by means of lifting levers 17. It is possible additionally to equip the pivot mounts of the masts with locking members—for example screw spindles or hydraulic cylinders—by the operation of which the rollers are relieved and the mast struts are operatively connected rigidly to the pivot mount 5, so that the rollers and rails are not continually subjected to the varying pressures resulting from the movements of the ship. As an example, two hydraulic cylinders with pistons 16 and two pressure plates 16*a* are shown in FIGURE 1. The operation of these pressure means may be rendered dependent on, for example, the electrical operation of the pivot mount drive (as known per se and not shown here), so that the operative connection is automatically broken before the pivot movement is put into operation and is restored after the completion of said pivot movement. This will be explained with reference to FIGURE 3: the pivot mount drive is equipped with a brake lift electromagnet 17, as is customary, for example, with crane drives; the movement furnished by this magnet may be used to control the complete installation. If, for example, the magnet 17 is put into operation, it not only lifts the pivot mount drive brake (not shown) by way of the lever 17*a* but also first breaks the current supply to the motor 20 of the hydraulic pump 21 by way of the operating contact 18 and the contactor 19, and by means of the angle lever 22 and the two control elements 23 mounted on a common shaft with said angle lever 22 connects the hydraulic cylinders 16 of the pressure elements to a return and supply tank 25 before putting the pivot mount driving motor into operation by way of the second operating contact 26 and a contactor (not shown). If the magnet 17 is conversely de-energised, then it first puts the pivot mount driving motor out of operation by way of the contact 26, and then connects the hydraulic cylinders 16 to the pump 21 by means of the curved lever 22 and the control elements 23, and finally puts the pump motor 20 into operation by way of the operating contact 18 and the contactor 19; pressure fluid can now flow through the non-return valves 27 into the cylinders 16 until the maximum pressure is reached and a pressure-operated rest contact 28 puts the pump motor out of operation and operates the brake; an air pressure vessel 29 with a separating bag 30 ensures that the pressure is maintained in the system for a relatively long time. In the event of faults in the electrical installation, the brake lift lever 17*a* can be lifted by a hand lever (not shown) and the hydraulic system can be pressurised by a hand pump (also not shown). Otherwise, all the individual parts of the installation are known and commercially conventional, so that they need not be described in detail here.

The setting and furling of sails can be effected purely mechanically by the per se known inward furling, in which the sail is guided between two yards after the style of a curtain; this inward furling becomes simple, reliable and aerodynamically satisfactory, however, only if the yards—as described hereinbefore—are rigidly fastened in the correct form and position on two mast struts according to the invention. The top and bottom of the sail can now be guided in jackstays, which advantageously have the form of a rigid rail; tightening of the sail is effected either by adjusting the jackstays or one of the same quite rigidly or, according to the invention, with the interposition of springs, or by tightening the sail itself according to the invention by means of rigid or resilient tighteners. FIGURE 4*a* shows in section a rigid and a resiliently adjustable jackstay, while FIGURE 4*b* shows a rigid tightener and FIGURE 4*c* a resilient tightener; in these figures, reference 31 denotes the yard, 32 the jackstay, 33 adjustment screws for the jackstay, 34 adjustment springs for the jackstay, 35 guide shoes in the jackstay rail, 36 retaining eyelets for the bolt rope, 37 adjustment screws for the sail, 38 springs for the sail adjustment screws, 39 protective sleeves for the said screws, 40 pockets for the same on the sail, 41 the sail and 42 the top and bottom bolt rope. Setting of the sail is effected in known manner by means of sheets, and furling is effected by means of horizontally guided clew-lines and buntlines, while according to the invention for the mechanisation of this process use is made of a combined winch which can, for example, simultaneously unreel and reel four sheets, four clew-lines and four buntlines of a sail. In the exemplified embodiment the buntline drum is mounted rigidly on the manually or mechanically driven winch shaft, while the sheet and clew-line are mounted to be about one turn loose, with the result that at the beginning of a winding operation the buntlines always become rigid or loose in the correct sense; moreover, the buntlines are reeled concentrically, so that guidance is simplified and the sail is hauled tightly together at the end of the furling operation. FIGURES 5 and 5*a* show the combined winch diagrammatically, reference 43 being the winch shaft, 44 the driving motor, 45 the hand crank, 46 the quadruple buntline drum, 47 the continuous sheet and clew-line drum, 48 the two drivers for the latter drum, 49 the four buntline ends and 50*a* and 50*b* the four sheets and the four clew-lines respectively. The individual winches themselves are disposed preferably on the stiffening platforms 2 of FIGURE 1 close to the yards.

For the total efficiency of the sail drive it is important to be able to react to changes of wind direction and strength without delay by controlling the effective sail area and angle of attack; for the safety of the ship and for its manoeuverability in narrow waters it is essential that all changes should be capable of immediate performance and, if necessary, simultaneously at all the masts. With a sail drive of the construction described both requirements can be satisfied by the fact that all the movements of the masts and sails can be remote-controlled in manner known per se from one or more points, this being possible both with electric and, for example, hydraulic mast and sail winch drive. All the control and

indicating elements are advantageously combined at one operating station where, for example as shown in FIGURES 6*a* and 6*b*, the sail surfaces of each mast are denoted by a symbol in the form of a vertical panel **62** sub-divided according to the number and form of the sails; on these symbols there are provided in a conspicuous arrangement small control switches **63** to operate the sail winches or their contactors and also pilot lights **64** to indicate the sail end positions which can in turn be controlled in manner known per se from hoist construction, by means of limit switches at the winches or sails; the individual symbol panels **62** are adapted to pivot about their vertical axes **65** and assume a position corresponding to the actual position of the mast by means of Bowden cables or other known transmission means, while hand levers **66** are provided, which are adapted to turn about the same vertical axes **65** and by means of which the required mast position can be preselected by way of a quadrant scale **67**, with the result that by means of follow-up contacts (not shown since known) or corresponding hydraulic control cocks the masts can be set to the required position by means of their turning elements. FIG. 6*c* illustrates an example wherein **65** represents the rotation axis (*a*) for symbol **62**, corresponding to the actual position of the mast by means of Bowden cables or other known transmission means, (*b*) for hand lever **66** which serves for pre-selecting of the required mast position according to the quadrant scale **67**. The camshaft rotates with **62**. To the hand lever **66** are attached follow-up contact springs. Turning of the hand lever will close and open the follow-up contacts. The mast will thereby be caused to rotate until the camshaft (and simultaneously **62**) has reached its original position with respect to lever **66** in which the contacts have their zero position. By means of this control station it is possible, for example, for the officer of the watch of the ship himself to carry out all the sail manoeuvres so exactly and rapidly that—assisted solely by the helmsman—he can manoeuvre in difficult water and—as a result of the sail drive construction described hereinbefore—if necessary can even sail astern and turn astern. In a sailing ship of the construction described the crew required is greatly reduced, while dangerous working aloft is normally no longer necessary, and the holds and hatches can be served more satisfactorily, the speed of travel is higher and manoeuvrability is decisely improved, and these features together render economic operation possible even today.

I claim:

1. A sailing ship including at least one square rigged mast adapted to turn about its vertical axis, each mast having three struts constituting a tripod, a plurality of rearwardly curved yards rigidly disposed upon said mast and secured to two of said struts, said yards being substantially perpendicular to said axis, said two struts being inclined to said axis so that said axis passes through the center of gravity of said yards and rigging, at least one sail adapted to be carried by said mast, the surface of said sail being substantially vertical during normal heel of said ship, means attached to said sail and adjacent yards for horizontally guiding and furling said sails between said adjacent yards, means on said ship and connected to said sails, mast and yards whereby the movement of said sails may be controlled independently from each other.

2. A sailing ship as claimed in claim 1 which the pivot axis of each mast is inclined from the vertical and forwardly of the ship.

3. A sailing ship as claimed in claim 2 including means attached to the hull of the ship whereby the turning of each multi-strut mast may be effected, said means being a pivot mounting and serving as a base for the mast and comprising a fixed ring secured to the hull of the ship, a rotatable ring within said fixed ring and having sets of rollers running in the fixed ring, said mast having its lower end secured to said rotatable ring.

4. A sailing ship as claimed in claim 3 including drive means whereby the mast may be rotated, means whereby the drive may be rendered inoperative after completion of a requisite extent of rotation, the means for rendering inoperative the drive means including pressure elements at the base of said mast and adapted to be displaced in synchronism with the control of the drive means to press upon said mast and lock said mast in adjusted position.

5. A sailing ship as claimed in claim 4 including jackstays adjustably and resiliently secured to the yards, said jackstays serving to guide the inwardly furled sails.

6. A sailing ship as claimed in claim 4 including jackstays attached to said yards, said sails mounted within and between adjacent jackstays, and means whereby the sails may be adjustably secured thereto, said means being in the form of a tightener attached to a jackstay and mounted on a yard.

7. A sailing ship as claimed in claim 5 including horizontal stiffeners secured between said struts, cable winches mounted on said stiffeners and operatively connected to said sails, whereby the sails may be set or furled.

8. A sailing ship as claimed in claim 6 including combined cable winches whereby the sails may be set or furled said winches being operatively connected with said sails.

9. A sailing ship as claimed in claim 1 including means whereby the turning of each multi-strut mast may be effected, said means comprising a fixed ring secured to the hull of the ship, a rotatable ring within said fixed ring and having sets of rollers running in the fixed ring, said mast anchored in said rotatable ring.

10. A sailing ship as claimed in claim 9 including drive means whereby the mast may be rotated, means whereby the drive may be rendered inoperative after completion of a requisite extent of rotation, the means for rendering inoperative the drive means including pressure elements at the base of said mast and adapted to be displaced in synchronism with the control of the drive means to press upon said mast and lock said mast in adjusted position.

11. A sailing ship as claimed in claim 10 including jackstays adjustably and resiliently secured to the yards, said jackstays serving to guide the inwardly furled sails.

12. A sailing ship as claimed in claim 10 including jackstays attached to said yards, said sails mounted within and between adjacent jackstays, and means whereby the sails may be adjustably secured thereto, said means being in the form of a tightener attached to a jackstay and mounted on a yard.

13. A sailing ship as claimed in claim 11 including horizontal stiffeners secured between said struts, cable winches mounted on said stiffeners and operatively connected to said sails, whereby the sails may be set or furled.

14. A sailing ship as claimed in claim 11 including combined cable winches whereby the sails may be set or furled.

15. A sailing ship as claimed in claim 1 including drive means whereby the mast may be rotated, means whereby the drive may be rendered inoperative after completion of a requisite extent of rotation, the means for rendering inoperative the drive means including pressure elements at the base of said mast and adapted to be displaced in synchronism with the control of the drive means to press upon said mast and lock said mast in adjusted position.

16. A sailing ship as claimed in claim 15 including jackstays adjustably and resiliently secured to the yards, said jackstays serving to guide the inwardly furled sails.

17. A sailing ship as claimed in claim 15 including jackstays attached to said yards, said sails mounted within and between adjacent jackstays, and means whereby the sails may be adjustably secured thereto, said means being in the form of a tightener attached to a jackstay and mounted on a yard.

18. A sailing ship as claimed in claim 16 including horizontal stiffeners secured between said struts, cable winches mounted on said stiffeners and operatively con-

nected to said sails, whereby the sails may be set or furled.

19. A sailing ship as claimed in claim 17 including combined cable winches whereby the sails may be set or furled said winches being operatively connected with said sails.

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