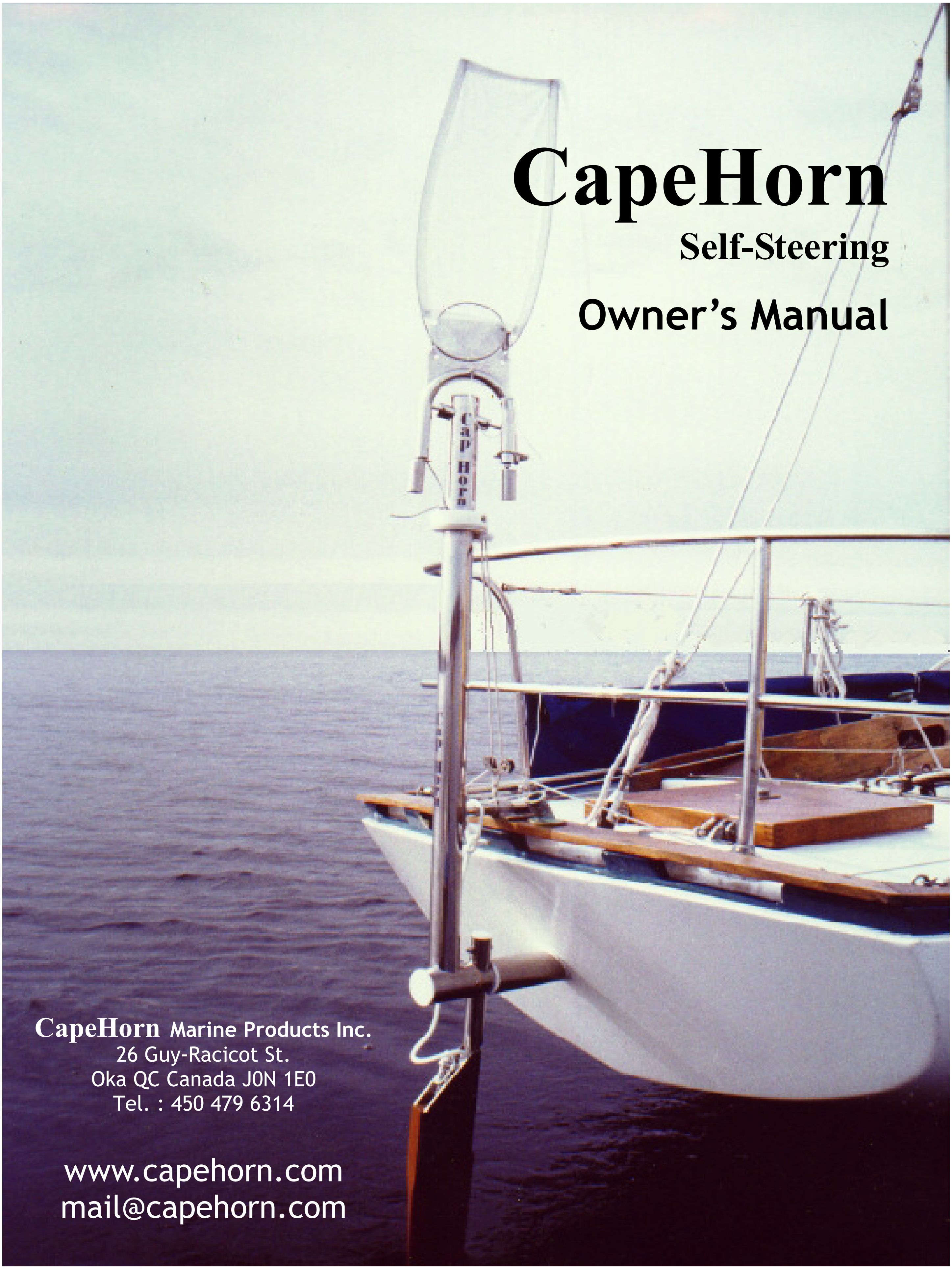

CapeHorn

Self-Steering

Owner's Manual

CapeHorn Marine Products Inc.
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CapeHorn
Self-Steering

Owner's Manual

For operation and installation
of Integrated
and outboard models

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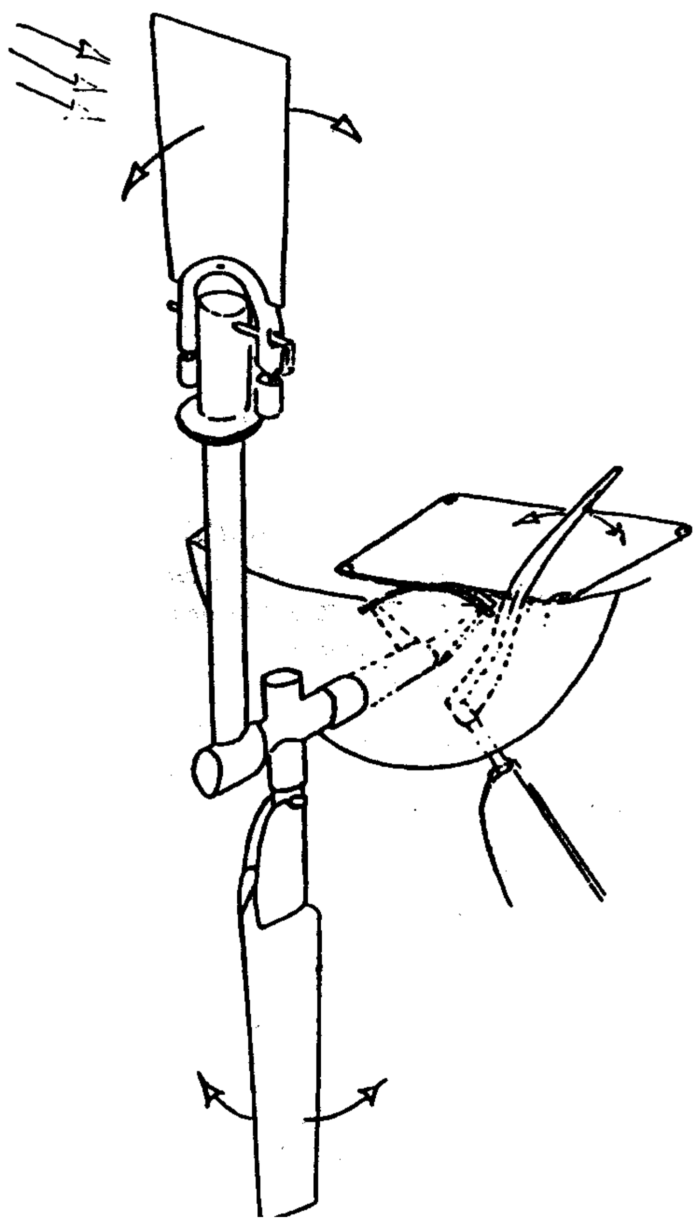
Operation

Operating principle of the Servo-Pendulum Self-Steering



The turret is rotated until the apparent wind hits the windvane on its edge. As long as the boat is on course, the wind pressure on both sides of the vane is equal so that it stays vertical, and the steering oar stays vertical in the water. If the direction of the boat changes in relation to the wind, the vane is tilted by the wind hitting it on one side. This tilt of the vane turns the stock of the steering oar. Because of the forward movement of the boat through the water, this turn of the steering oar (also called "Servo-pendulum") causes it to be pushed with great force sideways, turning the horizontal axle that passes through the transom, rotating the quadrant at its forward end and pulling on the control lines attached to the tiller or to the wheel. As the yacht comes back on course, the tilt of the vane decreases and the steering oar comes back to vertical.

The steering oar (servo-pendulum) can also be controlled by a small electric auto-pilot placed inside the lazarette. The power needed to steer the boat is still provided by the servo-pendulum and the autopilot, providing only the information, uses only a few milli-amperes from the batteries.

Connecting Procedure

1) Set the Course

The turret is rotated until the apparent wind hits the windvane on the edge. (The higher side of the angled rod at the top of the turret points into the wind and the hook is to leeward.)

Tip : The windvane does not always receive the same wind as the masthead. The ribbon on top of the vane indicates the direction of the apparent wind at that point.

2) Cleat the Control Lines

Pull the control lines tight and cleat them on their marks. If you can not cleat both of them at the same time, first cleat the one that causes the boat to bear away (it is doing most of the work) and take up the slack on the other.

3a) Fine Tune the Course Adjustment

Fine tune the course adjustment, so that the boat maintains the precise compass course (or point of sail) required

Tip : When adjusting course, it is difficult for beginners to know which way the turret should be turned. This is easily determined when one asks the question : Do I want the boat to head up into the wind, or bear off? If you want to head up into the wind, the windward side of the vane should be turned towards the bow. Conversely, if you want to bear off, the vane should be turned towards the stern

3b) Limit Yaw

When we have learnt to sail, we were taught to steer with a minimum of rudder angle, in order to maintain boat speed to a maximum. This is also true with self-steering. You want your vane to give just enough rudder angle to stay on course, but not more. The amplitude of the corrections is reduced by limiting the tilt of the windvane. Adjust the tension of the short piece of bungee-cord on the crescent by passing it through the nylon loop on top of the course adjustment disk.

This adjustment is especially critical when sailing downwind in unstable air, when you see the boat oscillate on both sides of the desired course.

4) Trim the control lines

If a boat is not perfectly balanced under sail and requires some weather or lee helm in order to maintain a given point of sail, the length of the control lines can be adjusted to induce a certain rudder angle so that when the boat is on course, the steering oar is approximately vertical in the water and the amplitude of the correction is roughly equal on both sides.

Marking the control lines at the cleat when the steering oar is vertical and rudder amidships makes it easier to connect the vane and visualise how much helm is given.

Or if your jamming cleats are close together, you could tie the lines together in a knot at the position oar vertical and rudder amidships and automatically reach this position by pulling both lines equally tight and cleating them.

If the wind varies in strength. the control lines may need adjustment.

MPORTANT : If the boat needs weather (or lee) helm on a given point of sail, be sure to **invert the trim** of the control lines after you have tacked. Any lack of sail balance that the rudder angle was correcting on the previous tack, is now increased by this rudder angle being inverted. Failure to invert the trim on a new tack, makes the job much more difficult for any self-steerer.

After the gear is connected, it is a good idea to have a look at the windvane quadrant, to ensure the lines are working as they should, and that nothing is fouling them.

Windvanes

Two windvanes are supplied : a smaller one, made of aluminum sheet, for heavy weather, and a larger and lighter one, made of nylon spinnaker cloth and 1/8 in. dia. stainless steel wire, for added sensitivity in light air. It is recommended to change over to the **small vane** after you have taken a first or second **reef**.

The light air vane extends 24 in. (60 cm) above the top of the tower, and the heavy weather vane, 17 in. (43 cm)

The windvane is inserted into a slot cut on the top part of a crescent-shaped tube, and held in place with a thumbscrew.

Windvane Supporting Crescent

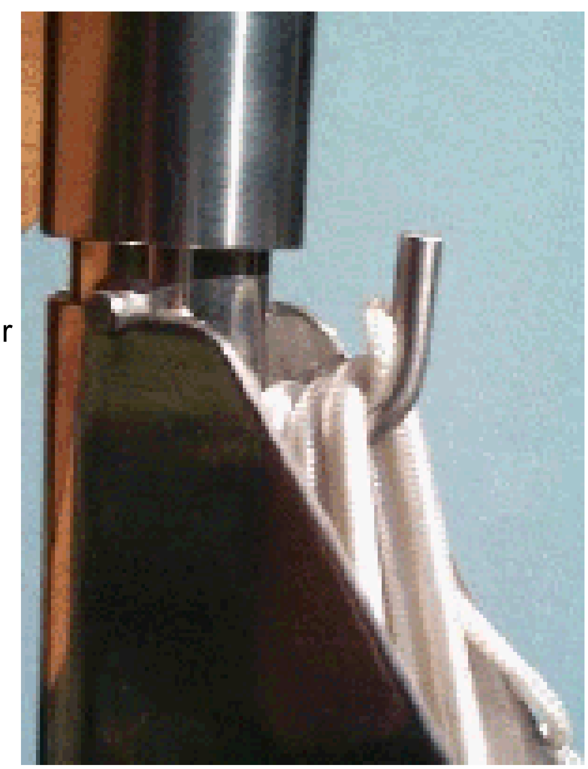
The crescent-shaped piece sits on the angled rod, inserted in a hole on the windward side, and into a slot on the other, with a concentric sliding collar held in position with a split pin. This pin is also inserted into the hook at the lower end of the angled rod, and transmits the tilting movement of the vane to the rest of the mechanism.

The counterweights have been adjusted before delivery and normally, there should not be any need to change this adjustment, unless some weight is added to the light air vane. They are adjusted so that in calm air, the light air vane just comes back close to the vertical after it has been tilted. The heavy weather vane does not need any special adjustment, as there is always plenty of wind when it is in use.

You will notice that this crescent is offset to one side, and the counterweights are sometimes bent to one side : it is because the weight of the crescent is used to counter-balance the weight of the connecting rod inside the windvane tower; the higher the tower, the more the counterweights have to be offset to the side to balance the added weight.

Do not re-adjust counterweights to limit yaw. Use the bungee cord that limits the tilt of the crescent instead.

Steering Oar



The steering oar is linked to its stock with three turns of shock (or bungee) cord between the mounting plate of the oar and the hook on the stock, maintaining the two notches on the plate in contact with the two transverse pins on the stock. This allows the oar to break off if it hits an obstruction, and prevents damage to the stock or to the oar itself.

Tension on the shock cord is adjusted to maintain the oar in place, except when an effort beyond normal is imposed. If it breaks too often, without apparent reason, increase the tension on the shock cord.

The only spare part you really need is a piece of ¼ in. (6 mm) ordinary shock (bungee) cord. Experience has shown that 25 in.(640 mm) for ***Jean-du-Sud*** and 33 in. (840 mm) for ***Spray*** was the correct length to allow 3 turns and the length needed for a fisherman's bend while keeping sufficient tension to keep the steering oar in place. If you notice that the paddle breaks away for no apparent reason, it is most probably because the bungee has stretched and needs to be replaced.

The easier way to connect the steering oar to its stock is first to hook the shock cord to the stock, then swing the steering oar in position over the stock until the two pins are snug into the notches.

Safety line

Should we mention it? It is essential to have a safety line on the steering oar, to avoid seeing it disappear in the wake, the first time it breaks off.

Flipping the steering oar up when underway

The easiest method of flipping the paddle up when under way is to tilt the windvane crescent, which will cause the servo-pendulum to swing to one side, then pull it up out of the water to " park " it along the tower.

Ideal size of the servo-pendulum

Power generated by the servo-pendulum is proportional to its wetted area and to the square of the speed of the boat. From this, we conclude that servo-pendulum area is critical only at low speed. At higher speeds, the pendulum generates considerably more power than needed to steer the boat.

Experience has shown that the wetted area of servo-pendulum needed to steer at 2-3 kts to be somewhere between 8 and 12 % of the yacht's rudder area. Closer to 8 for a high aspect-ratio, partially balanced rudder steering a well balanced boat, and closer to 12 (or more) for a low aspect ratio rudder, on a boat that is not so well balanced, or has a wheel steering system with a lot of internal friction. We normally take the yacht's rudder dimensions and the height of the horizontal axis above the waterline in determining the length of the servo-pendulum for a given boat, but if you find that your pendulum does not generate adequate power to steer your boat at slow speeds, please contact us and we will provide you with a longer one.

A racer concerned with reducing drag to a minimum could order two steering oars : a longer one for light air or slow speed, and a shorter one for higher speeds.

Internal resistance of a cable steering system can be reduced appreciably by loosening the tension on the steering cables. This can be done before a passage when the vane will be steering most of the time. Loosening the cables may induce a little " backlash " in the wheel, but since the vane will be doing most of the steering, this is of little consequence.

Balance under sail

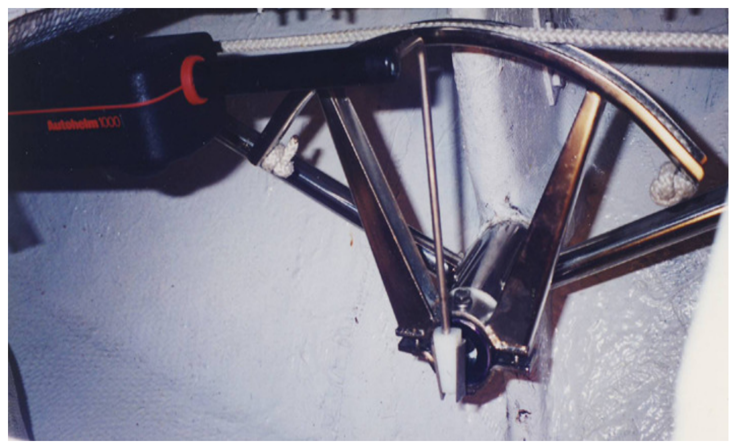
With any kind of self-steerer or autopilot the secret to top performance is sail balance.

Do not expect your gear to steer a straight course if the sails constantly pull the boat to one side, and the self-steerer has to correct this tendency before it can do its job of keeping the yacht on course.

The mast should be tuned to render the **helm as neutral as possible** in medium air. When a boat is steered by hand, it is recommended, for safety reasons, to tune the rig with some weather helm so that if the rudder is left free, the boat heads up into the wind and stops. Now that the boat is destined to make passages under self-steerer, this safety feature is no longer desirable: if the helm is left free, the boat should keep sailing in the same direction (as much as possible).

When under way, watch the course for a while: if the gear always corrects on the same side, it might be that the sails are not set properly. Trim the sheets until the oscillations are about equal on each side.

In selecting sail combinations, consider balance under sail. If the wind is aft of the beam, favor sail area forward. On a broad reach, pole out a jib or a genoa as soon as possible (keeping a second jib to leeward if necessary). This improves sail balance and the boat sails a much truer course.



Reef when needed

As the wind builds up, a yacht acquires weather helm. This is normal and desirable, up to a point. In fact, increasing weather helm is the first symptom of an over-canvassed boat. Often, the wind freshens gradually and as there is no one at the tiller or wheel, this added weather helm goes unnoticed. Whether it is steered by hand or by a self-steerer, a yacht sails better with a moderate heel and the right amount of sail. A self-steering system does not alleviate the necessity of reefing when necessary.

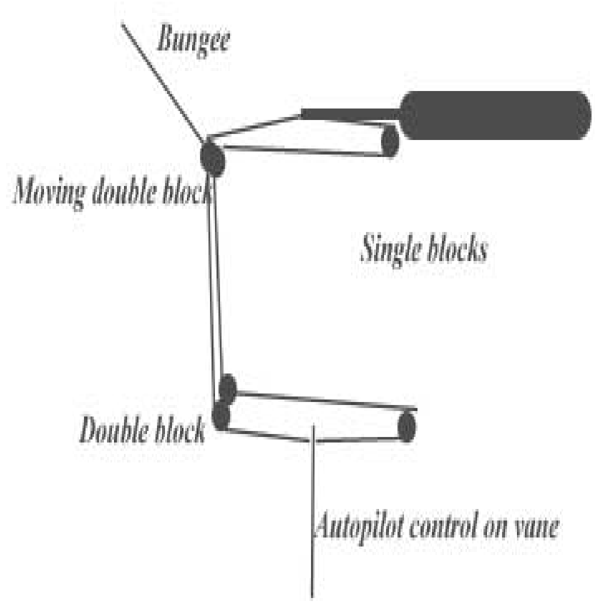
Connection to electric autopilot

It is possible to connect an electric autopilot to the servo-pendulum of the ***Jean-du-Sud*** and ***Spray*** models. Thus, the energy to turn the rudder comes from the water flowing along the hull, instead of coming from the batteries, and the smallest autopilot can control a large yacht. Located just in front of the quadrant, inside the lazarette, the autopilot will be protected from spray and since it has a very light duty to perform, its life will be much longer.

A quick look at the photo suggests that the autopilot is connected to the quadrant. Not true : it is connected to the forward end of the co-axial rod that steers the servo-pendulum . Bottom picture shows the connection to electric autopilot on the Varuna and Joshua

At the end of the autopilot ram, there is a hole made for connecting a vertical pin on the tiller. Turn the ram ¼ turn, drill this hole all the way through with a ¼ in. drill, and insert the L-shaped rod through this hole. Insert the dovetail-shaped plastic connector at the other end of this rod into the corresponding piece, at the end of the horizontal control axle.

The autopilot can be connected with equal effectiveness above or below the horizontal axle, or placed to port or to starboard. If the correction of the autopilot is on the wrong side, flip the changeover switch on the unit. (The 1/4" rod is held by friction inside the dovetail-shaped plastic piece; it can be pulled out and inserted from the other end.)



A tiller autopilot that is designed to be mounted to **port** will also go to port if it is placed **below** the control axle. It can also be placed above and be mounted to starboard.

The amplitude of the correction given by the autopilot is varied by adjusting the length of the rod.

It is possible to mount the autopilot elsewhere and link it to the steering mechanism with light control lines.

Note: rigging steering lines to the control rod also renders remote power steering possible

Stowage

For short periods, the steering oar can be swung 180° to rest along the windvane tower.

For longer periods, the steering oar and windvane (with crescent) are easily removed and stowed below.

Maintenance

After the gear has steered half way around the world, or after two or three seasons, it is prudent to make sure there is some waterproof grease left in the slot in the pendulum stock, to prevent wear of the bent rod passing through it. Remove the cap at top of the tube and insert grease through the hollow top part of the stock, using a stick or a piece of wire.

Do not use grease or WD40 (or equivalent) to lubricate the plastic bushings. The Teflon bushings need no lubrication, however, an occasional squirt of silicone spray on the Teflon bushings of the windvane, connecting rod and steering oar will contribute to maintain top performance in light air.

As with other stainless steel equipment, a regular polish will maintain its bright finish.

Installation

If installation of your Cape Horn is done according to the instructions, we guarantee that it will steer to your satisfaction. Most problems with the Cape Horn are caused by an improper installation.

You will most probably gain time by reading the instructions below : they may prevent many time-consuming mistakes.

Installation of the Cape Horn can be done while the yacht is afloat. It is rendered much easier if the yacht's stern is brought to a stable dock, with the yacht made fast to it so it will move as little as possible

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Installation of Integrated Models

Installation of the models *Jean-du-Sud* and *Spray* is done in 5 steps :

1a) Position the Gear

1b) Trace the centre of the Mounting Tube hole

2) Drill the hole and fasten the Mounting Tube

3)Insert the Horizontal Axle and fasten the quadrant

4)Install the Windvane Tower

5a) Connect the control lines to Yacht's Steering system

5b) Rig Lines for Remote Course Setting

1a) Position the Gear

It is the mounting tube that passes through the transom, and through which pivots the horizontal axis between the servo-pendulum and the quadrant, which determines the position of the gear. Hence, positioning the mounting tube is positioning the entire gear.

The mounting tube should be in a line parallel to the fore-and-aft centreline of the boat (the keel)

However, it can be mounted **off-centre**, in order to avoid cutting or moving the backstay chainplate gusset. Performance of the gear will not be affected if it is offset to one side (provided it is kept parallel to the keel).

It can even be offset enough to allow a transom-mounted rudder to pivot.

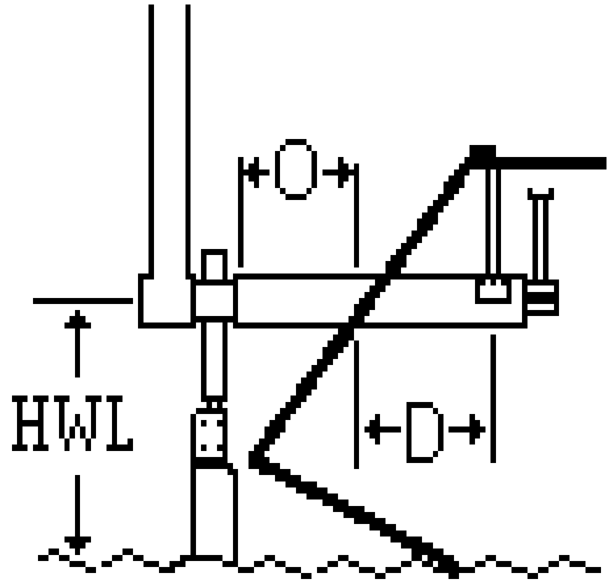
Height Above Water

Drag of the servo-pendulum is kept to a minimum when the metal plate that links the servo-pendulum to its stock is kept out of the water. Therefore, the height of the mounting tube above the waterline (HWL) should be at least
16 in. (40 cm) for the ***Jean-du-Sud***
24 in. (60 cm) for the ***Spray.***
If the gear is higher, we can make the servo-pendulum stock longer, conversely, if it is lower.

Positioning the gear fore and aft

Aft : The aft end of the tube must clear the aftermost part of the transom or stern. It must also clear the trailing edge of the rudder by at least one inch (25 mm) if it extends past the hull.

Forward : A reasonable distance between the transom and the struts supporting the forward end ensures a strong installation. This distance (D) should not be much shorter than the overhang (O) between the transom and the outboard end of the mounting tube .



Provision for 360° Quadrant Movement

At the forward end of the tube, the CapeHorn quadrant needs a circular space (CS) of a diameter equivalent to:

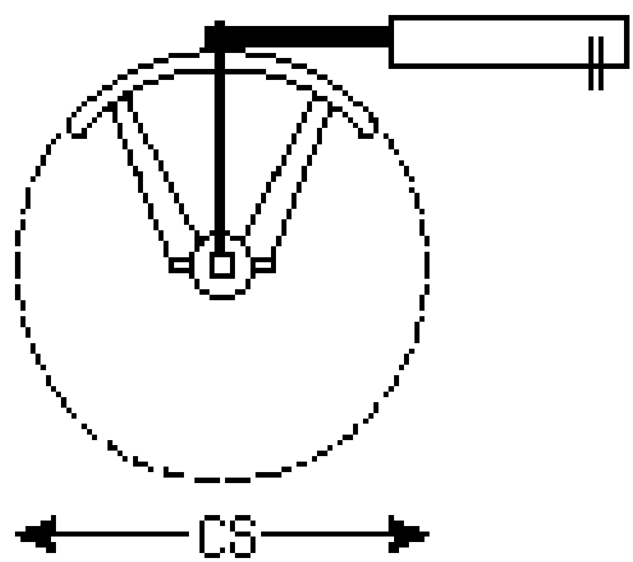
16 1/2" (43 cm) for ***Jean-du-Sud***
22" (56 cm) for ***Spray***.

Quadrant thickness is

1" (25 mm) for ***Jean-du-Sud***
1 1/4" (32 mm) for ***Spray***.

If space (inside the lazarette or in the cockpit) is limited to one half-circle below or above the horizontal axis, the gear will work just as well, but the possibility of swinging the pendulum up for storage alongside the windvane tower will be lost.

The quadrant is delivered with a plastic or wood disk in its center, at the place where the horizontal axle will be ; a 1/4” hole in its center makes it easier to project the position of the hole in the hull by inserting a 1/4” rod (or long drill bit) into it on which you can place a level to ensure the horizontal axle really is.



Provision for connecting an autopilot to the steering oar

The co-axial control rod that steers the servo-pendulum extends in front of the horizontal axis, in front of the quadrant.

An additional 2" (5 cm) of space is required in front of the quadrant, plus the space required for the autopilot itself..

1b) Trace the Centre of the Mounting Tube Hole

Transferring various measures to points on the transom, inside or out, is much easier when the boat's waterline is level, both fore-and-aft and athwartships. In this case, a line can be strung above the rail, made perfectly level and parallel to the keel, and used as a baseline. In most cases, this line will pass over an opening in the lazarette and allow to transfer measures inside it with a plumb line.

Make good use of the level and the square. If the yacht is stable, also use the plumb line (it is easy to improvise one); use it in particular to materialise both ends of the mounting tube and to determine the position of the quadrant..

Use your eyes a lot, and trust them. If it looks off, it most probably is and conversely, if it looks right, it most probably is.

Carefully mark the centre of the hole on the transom or hull, both inside and out.

When this is done, do not grab the drill yet. Repeat each step of the whole measuring operation, <u>to double-check</u>. Remember this is the most critical part of the installation process and has to be done with greatest care.

If you arrive at the same results twice, you can go ahead with a clear conscience and drill the centre guiding hole.

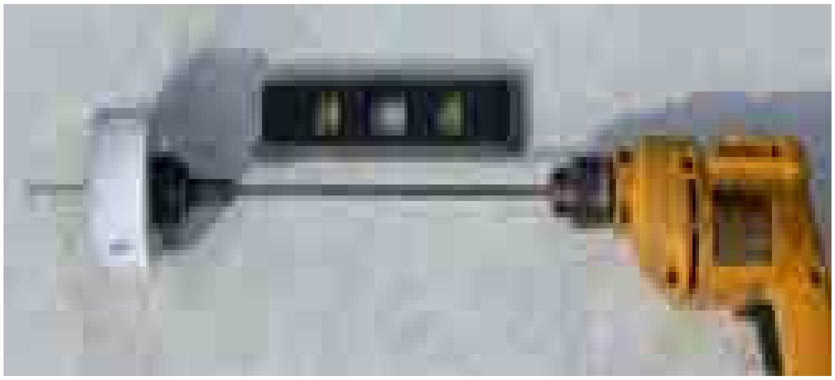
2) Drill the Hole and Fasten the Mounting Tube

Drill the Hole

Drill a hole 1/8 in. (3 mm) or smaller first. If you are satisfied with its position, drill 1/4 in. If not. Drill an other smaller hole in the right position. Drilling a small hole first makes changing its position easier. Do not worry about drilling more than one hole, as this section of the transom will be removed when you drill the large hole.

Cutting the Mounting Tube hole through the transom is easier than it appears, with a good quality hole saw :

2 1/2 in. (63 mm) for ***Jean-du-Sud***
3 1/2 in. (89 mm) for ***Spray***



The secret is to maintain the tool very steady, level and parallel to the centre line; this way, you will easily cut through the transom, even if it is at an angle. Or through the curved surface of a canoe stern. If the drill is held very steadily, the hole-saw will not bind. If possible, cut half the thickness from the outside and half from the inside.

Replacing the centre 1/4 in. guiding bit of the hole-saw by a longer one (such as those used for drilling through partitions) makes it much easier to drill level and parallel to the keel.

Fasten the Mounting Tube

The Mounting Tube must be very strongly attached to the transom and hull. Aft, it must absorb the drag of the servo-pendulum through the water, and forward, the torque of the quadrant and pull of the control lines.

Notice that the Mounting Tube is marked fore and aft : the two bushings at each end of the Mounting tube are slightly different (the aft one is larger, due to the fact that at welding, the horizontal axle may have become slightly oval, and the chamfer is a bit deeper, due also to the weld); Hence, the tube must be inserted accordingly.

Fasten the Forward End

The forward end of the mounting tube is held in place with two struts provided - standard length 18 in. (45 cm) for ***Jean-du-Sud*** and 24 in. (60 cm) for ***Spray-***.

These struts are bolted on the tube at angle between 90° and 120° and cut to reach either the underside of the deck above, or pads bonded to the hull below with epoxy.

The center of the strut should not be closer than 2” from the forward end of the tube, to leave room for both bushing and curved back-up plates inside.

Two holes are drilled, dia 5/16 in. (7 mm), 1 ¾ in. apart (centre-to-centre) into the Mounting Tube; the curved back-up plates are placed inside it and the curved U-shaped brackets are bolted on the tube.

The inside curved back-up plate is covered with a double-sided adhesive tape, that will keep it in place until it is bolted. Peel away the protecting paper before inserting.

The struts are cut to the appropriate length, (the tube has one turnbuckle-type end, which allows for 2 inch adjustment of its length) and a ¼ in. hole is drilled through it, ½ in. from the end (make sure this hole is drilled at 90°) for bolting to the flat U-shaped bracket which will be bolted under the deck or to the hull, whichever is more convenient.

If the strut is bolted to a pad bonded to the hull, we recommend to use a 4 in. square (or longer if the same pad is used for the turning block), plywood or hard wood, min. 3/4 in. thick, with edges bevelled 45°. Holes are pre-drilled through it and countersunk bolts are inserted from the bottom before bonding.

The surface of the hull is ground to expose bare fibreglass; all surfaces are coated with epoxy, then bedded in thickened epoxy ; the bevelled edges of the pad are covered with glassfibre tape.

The length of the struts is fine-tuned, using the turnbuckle end, to ensure the tube is parallel to both the waterline and plane of the keel.

If both struts and turning block are mounted on a pad, it is a good idea to mount both on the same pad, as when the line pulls, the strut also pushes and considerably reduces load on the pad (photo).

Fastening the Aft End
Glassfibre or wood hulls

Once the fore-and-aft position of the tube is determined, mark the contour of the transom on the tube with a grease-pencil or a marker, both inside and outside. Then grind with a power grinder or a file, stopping 1/4" short of its outside end, and about one inch past the inside mark.

On the inside of the hull, grind also about one inch around the hole, to remove existing paint and expose bare fibreglass.

(Before applying the epoxy and glassfibre, make sure you have drilled the holes for the struts holding the forward end of the tube)

Apply a coat of epoxy (with hardener) to the ground portion of the tube, and also to the inside and sides of the hole in the hull.

Thicken the epoxy with filler until it does not sag when you take a gob at the end of a stick and hold it for about 10 seconds. Fill the gap between the tube and hull and make a fillet inside. For an even better joint, you may add one or two layers 2 inch wide glass tape.

Epoxy resin provides a better adhesion to cured fibreglass than polyester. If you are using the West System, filler no. 404 is best (you will need less), but 403 and 406 will provide adequate mechanical strength; 405 is for wood. Uncured epoxy can be cleaned with alcohol (methylated spirits), which is less “aggressive” than acetone.

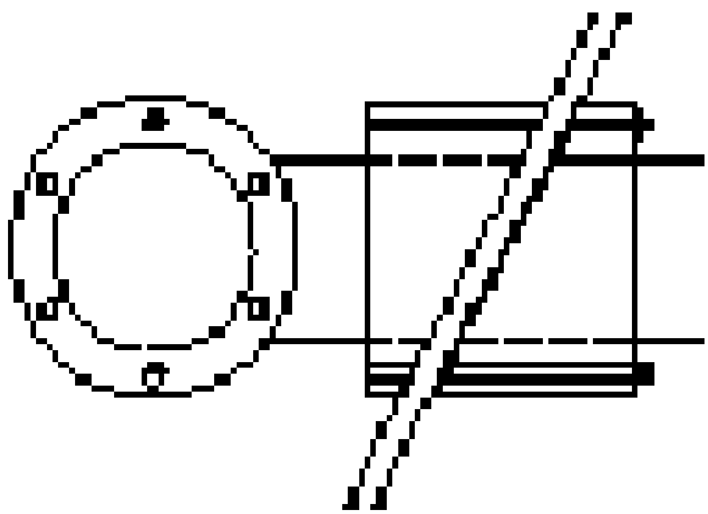
A light bead of sealant will make a nice finish outside.

Metal Hulls

The Mounting Tube can be welded to a steel hull, provided welding is done carefully to minimize tube deformation.

An aluminum Mounting Tube can be supplied for welding to an aluminum hull.

If welding is not practical, an optional Delrin collar adapter can be used to bond the tube to the hull.



The collar is cut to the angle of the transom, and the two halves are inserted over the mounting tube one from the inside, the other from the outside, taking the transom in sandwich, and the two halves are bolted together, using a liberal amount of sealant to fill all voids..

If we are given the angle the transom makes with the horizontal, this collar can be provided pre-cut.

3) Insert the Horizontal Axle and Fasten the Quadrant

Insert the Horizontal Axle

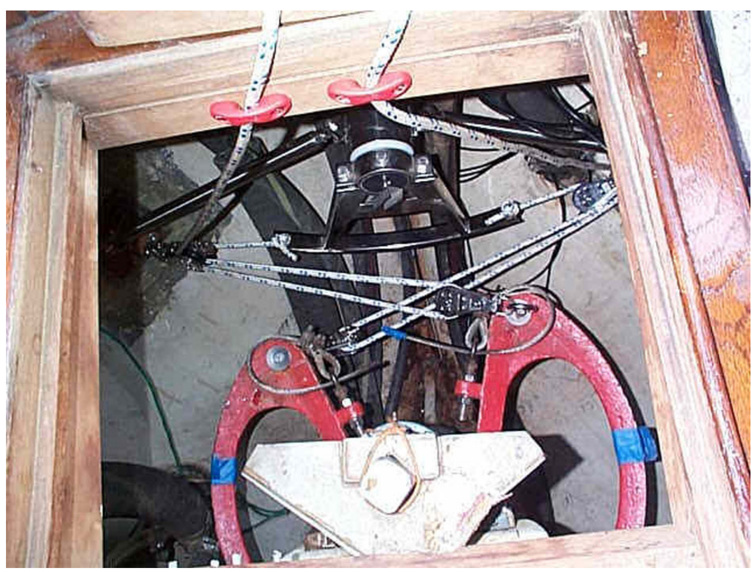
The Horizontal Axle is now inserted into the Mounting Tube. It should **turn reasonably freely**. If it does not, it may be either because the tube has been **inserted backwards**, or because welding has pulled the tube out of shape. In the first instance, if the tube has already been bonded to the hull, all is not lost : just **switch** the two plastic **bushings**. In the first instance, or if switching the two bushings has not solved the problem satisfactorily, smear both ends of the control axle with a felt marker and rotate it inside the mounting tube : the ink will be transferred to the tighter points on the bushings which can then be scraped or sanded away.

Fasten the Quadrant – Quadrant above of below the axle ?

The quadrant can be placed either with the **groove above** the axis **or** with the **groove below**. Whether it is mounted one way or the other is determined by the **most convenient placing of the first pair of turning blocks** and the most direct routing of the control lines to the rudder quadrant, wheel or tiller.

When the control lines are **pulling** the tiller or rudder quadrant **from a position forward of the rudder stock, the lines are connected directly when** the windvane **quadrant is above,** and they have to be crossed if the quadrant is mounted **below** the axle.

Conversely, if they are connected to a **reverse** (auxiliary) **tiller** or to a rudder **quadrant** mounted **behind** the rudder stock, the lines are **crossed** when the windvane quadrant is **above,** and led **direct** when it is **below** (see p.26-28).



All the **power** transmitted to the yacht's rudder is **concentrated** on the link between the quadrant and the horizontal axle; this is why **the quadrant must be bolted very tightly on the axle.**

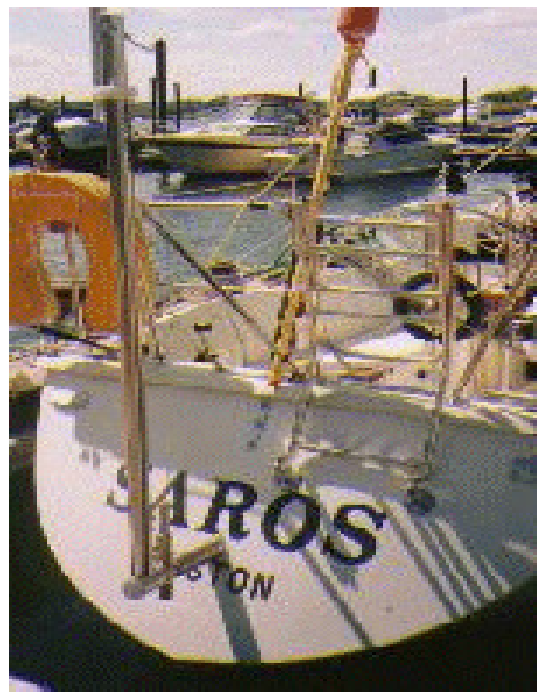
Tighten first the two bolts on the centre of the axle itself, then the two bolts and nuts on either side of the collar. After the first few hundred miles of self-steering (or first bout of heavy weather), re-tighten if needed.

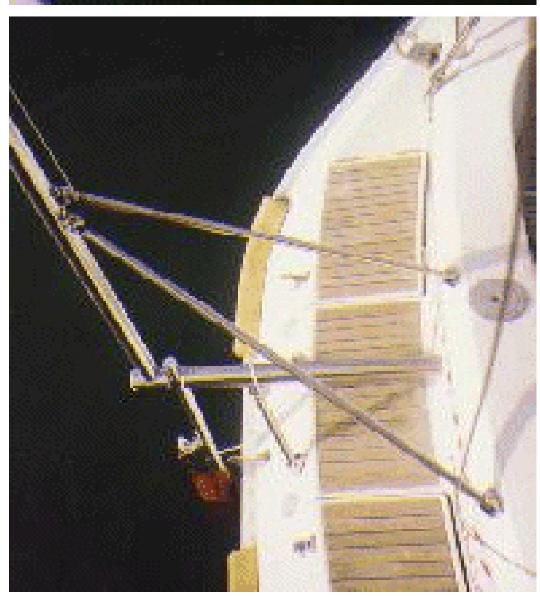
4 : Install the Windvane Tower

The windvane tower is kept vertical by two diagonal braces made of SS tube 7/8 in. OD supplied with their appropriate fittings for fastening to the tube at one end. and to the deck at the other. These braces can be **placed wherever convenient** to provide adequate support. On the tower, they are connected with 2 U-shaped curved plates that are bolted to an inside back-up plate. They should not be higher than 2 ½ in. below the course adjusting disk, to allow space for the back-up plate inside the tube.

On the tower, drill two holes dia. 5/16 in. (7 mm), on 1 ¾ in. (44 mm) centres at the correct height.

In marking these holes, make sure the **short horizontal tube** at the base of the tower **lines up perfectly fore-and-aft**, in the same plane as the mounting tube, otherwise the moving ring to which it is bolted may bind and keep the axis from turning freely. If in spite of your precaution, the ring binds after it has been connected to the base of the tower, it can be brought back in line by enlarging the four holes on one side, to allow the tower to pivot until it is brought back in line. Since the U-shaped bracket covers the holes, nothing will show.





Bringing the threaded back-up plate in position inside the tube requires a little ingenuity :

At the end of a piece of light line long enough to reach the bottom of the tower, tie a small nail around its centre, then feed it through the top hole until it drops to the bottom of the tube. Pass the nail through the top hole of the back-up plate and pull it up with the string. When it comes in position, insert the bottom screw, then remove the nail and string, and insert the top screw. The back-up plates are fitted with double-sided adhesive tape, to keep them in position. Peel off the protecting paper before installation.

Provided some angulation between them is kept, **the braces do not need to be placed symmetrically**. One of them can be placed almost fore-and-aft, and the other to one side, **to allow passage** through the stern on one side.

Connecting the windvane tower to the horizontal axle

The short tube welded horizontally at the base of the windvane tower is fastened to the control axle with four screws through its edge, into a ring near its end. Two punch marks identify the top of the ring and makes alignment of holes easier.

Connecting the Control Mechanism

The **handle** that controls the steering oar **should be to the left** (to port).

At the bottom of the pushrod that moves up and down inside the tower (and transmits the tilt of the vane to the steering oar), is screwed a connecting rod made with a piece of threaded rod welded to a short piece of tube with HUMW lining inside. Notice that the threaded rod is offset to one side. Connect it to the handle so that the **short tube** is **offset to port** (left, looking forward); this keeps the pushrod **away from the wall** of the tube.

The cap that covers the end of the horizontal tube is thicker on one side. The thicker part should be to starboard, in order to keep the crank to port.

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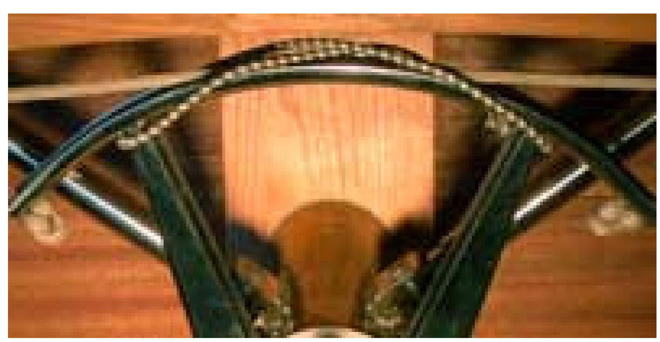
5) Rig Control Lines



Type and Size of Lines

We recommend rigging **rather light** control lines, in order to use them as a **fuse**. A control line is easily replaced and in the case of a sudden overload, it is better to break a control line than some other component of the system.

We recommend control lines made of polyester if they are relatively short, or Spectra if they are rather long, as this material stretches less, of a dia. ¼ in. (6 - 7 mm) for ***Jean-du-Sud*** , or 5/16 in. (8 mm) for ***Spray***. Alternately, in order to reduce stretch, a larger diameter line can be used, but in this case, it is prudent to provide a “ weak link ” somewhere in the system, for example by fastening a block with a lashing that will break before something else gives way.

Blocks for Control Lines

There is no need to use roller or ball-bearing blocks, (friction here is not an issue and those blocks are meant to work for short periods then rest) and since they are continually working, they may overheat. Ordinary plain bearing blocks are perfectly OK and are cheaper. Minimum sheave diameter should be 34 or 40 mm for ***JdS***, and 40-45 mm for ***Spray***.

The control lines are fed through a hole at either end of the groove on the edge of the quadrant and prevented from pulling through with a figure-eight knot.

They are led through turning blocks on either side. <u>The turning blocks must be **solidly secured**, **to very strong points**, as they absorb the total steering effort and more.</u> The first pair of blocks must be positioned so that each line **works precisely in the axis** of the quadrant groove. The distance between the quadrant and the turning blocks is immaterial so the blocks can be placed close to the quadrant or away to the sides. The sheaves of all the blocks must be allowed to line up freely with the lines (if not, the lines would chafe through very rapidly).

The lines are kept inside the groove with a piece of shock cord inserted over the groove in the shape of a figure 8, crossing over the groove.

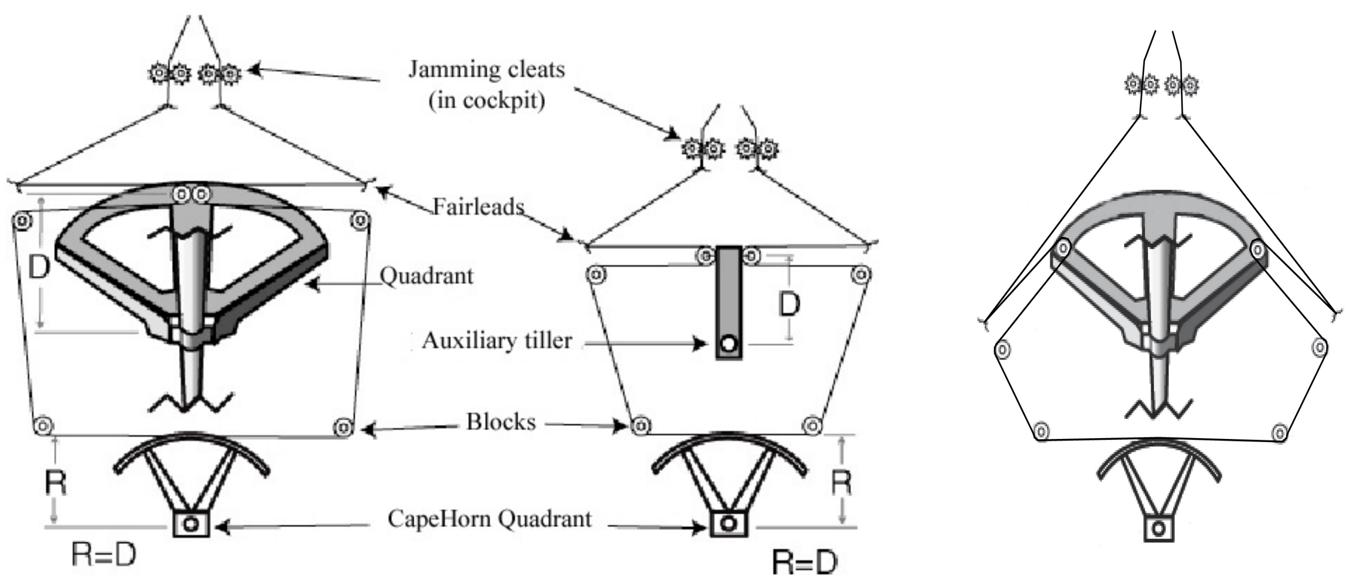
Direct Connection to Yacht's Steering System

The control lines can be connected directly to the yacht's steering system. They are led through turning blocks fastened to the quadrant (or to a short auxiliary tiller such as the tiller of a hydraulic system), **pulling from a direction 90°** from the attachment point of the blocks on the quadrant (or tiller) and the rudder axis After passing through the blocks on the quadrant (or tiller), the control lines are led back to a fairlead placed close to the last turning block. From there, they are led to jamming cleats placed within reach of the wheel.

If the blocks are fastened to the rudder quadrant, it is better to fasten them to its underside, to prevent fouling the steering cables with the control lines when they are loose.

The vane is connected by putting the lines in tension and cleating them; it is adjusted for weather or lee helm (if any is needed to maintain a given point of sail) by varying the length of the lines. Releasing the lines from the jamming cleats instantly disconnects the vane and allows to take over manually.

Whenever possible, it is better to place the **jamming cleats close together**. This allows to tie the two control lines in a knot and pull them tight together : this way, the **rudder** is **automatically connected amidships** when the quadrant-pendulum are vertical and if any rudder angle is needed to maintain a point of sail, it easy do visualize it by pulling one line shorter. If the jamming cleats can not be placed close together, **marking** the control lines at the point where they should be cleated has the same effect.

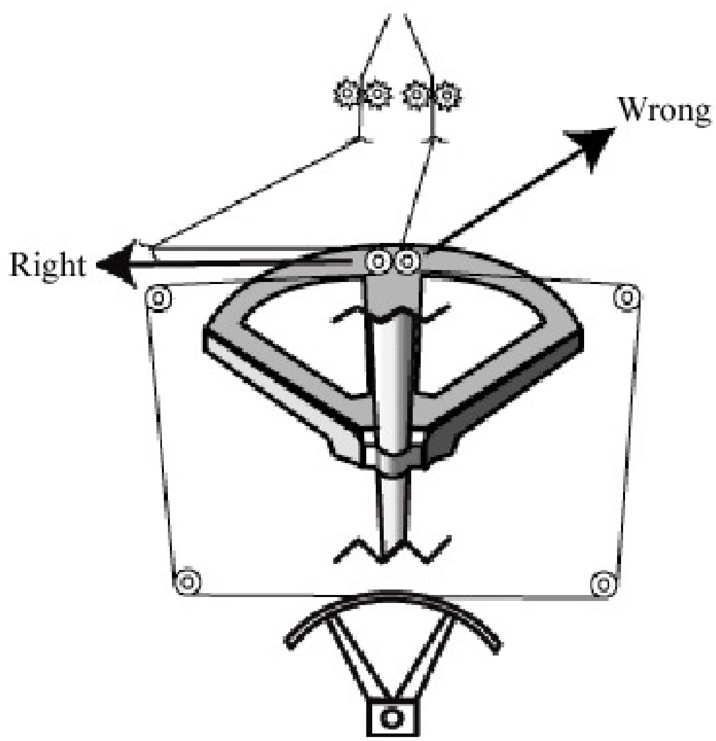


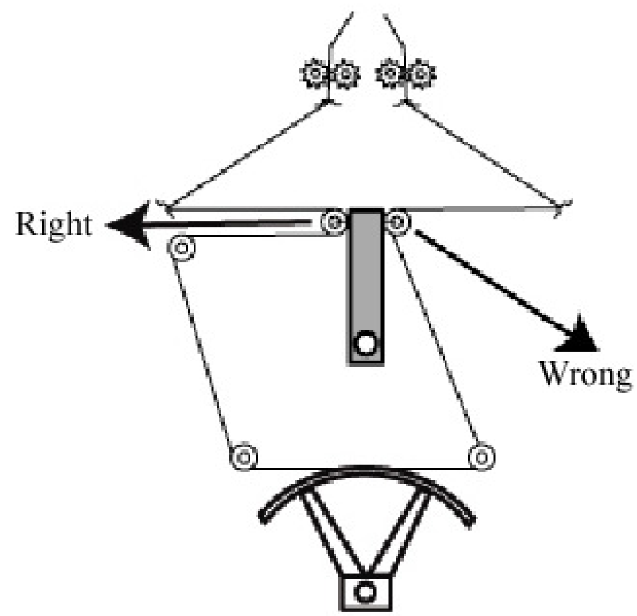
Note : when the vane is in operation, only the segment of control lines between the two quadrants (or CapeHorn quadrant and aux. tiller) moves and therefore, needs to be led through blocks. The segment between the rudder quadrant (or tiller) and the jamming cleats does not move, it is only kept in tension and can be led through fairleads instead of blocks.

Position of the Turning Blocks on quadrant or tiller

The ideal ratio between the tilt angle of the pendulum + quadrant, and the rudder angle is 2 : 1 (for 10° of pendulum + quadrant tilt, 5 ° rudder angle). Since the turning block on the rudder quadrant (or tiller) divides the travel by half (and doubles the force), the **distance between** this **block and** the **rudder axis** should be **equal to** the **windvane quadrant radius** : 8 in. (20 cm) for ***Jean-du-Sud*** and 10.1/2 in (27 mm) for ***Spray***.

Most wheel failures requiring use of an emergency tiller are caused by breakage of a steering cable. If the above method of connection is used, the vane will still steer, should a cable break.





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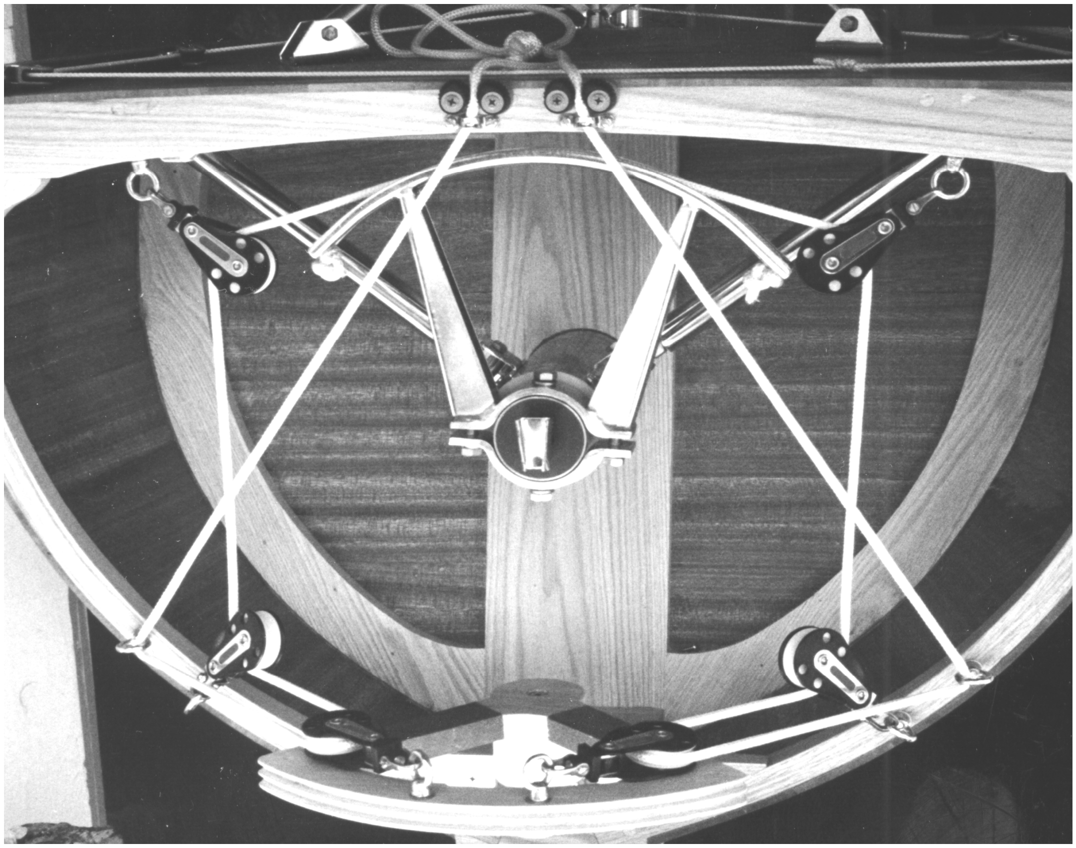
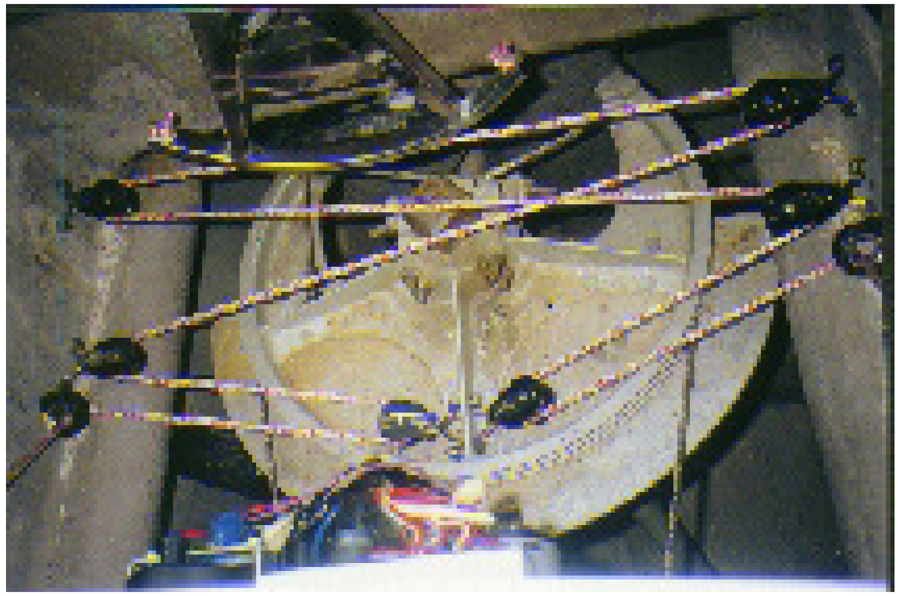
EXAMPLES OF DIRECT CONNECTION

CH quadrant mounted in the "UP" position, lines connected to the rudder quadrant forward of the rudder stock. Jamming cleats placed close together (**Cape Horn** display model)



CH quadrant below axle, control lines led to blocks fastened on a short auxiliary tiller clamped on rudder stock (Pan Oceanic 43).

CH quadrant mounted down, lines connected forward of the rudder stock have to be crossed. (Bénéteau Oceanis 39).



CH quadrant mounted down. Lines connected direct to blocks fastened to circular quadrant, pulling from aft of the rudder stock. (Christina 40).

CH quadrant mounted down. Lines led to blocks fastened to pads bonded to the hull. Lines look like they are crossed, but actually, they are not : they pull directly from the other side of the steering quadrant. (Union 36).

CH quadrant below axle, lines led to blocks on plate bolted to back of steering disk (CS36)

(Seen from above) Axle offset to locate **CH** quadrant in front of rudder stock ; control lines led to block on tiller (which has **been** extended) to which hydraulic ram is connected. (CT 37)

Jamming Cleats

The jamming cleats should be located within easy reach of the wheel. Whenever possible, they should, placed side by side, which allows tying the two lines in a knot when the rudder is amidships and quadrant and pendulum are vertical, and to find this position automatically by pulling the two lines together. (If the cleats can not be located together, the lines should be marked to locate the position rudder amidships and pendulum-quadrant vertical.)

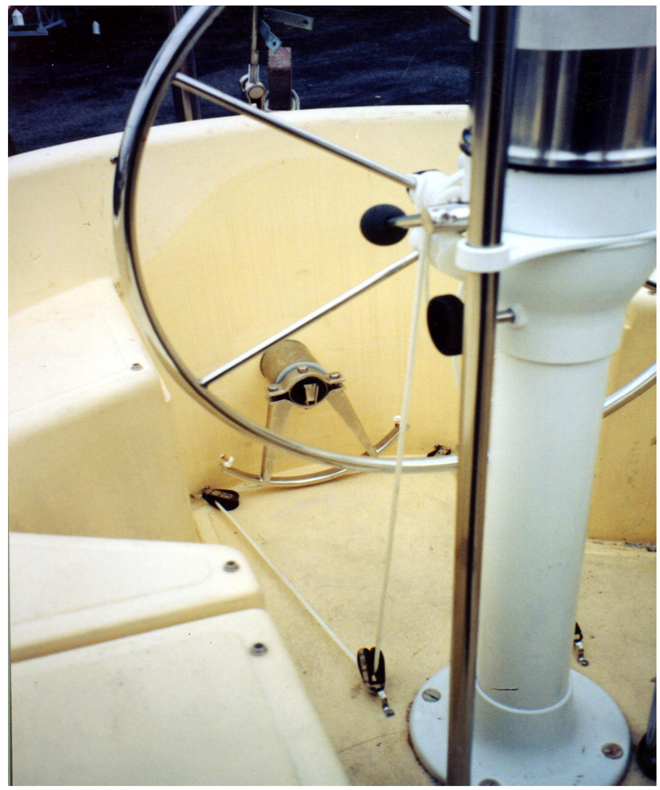
If the jamming cleats are located above the holes (instead of below), the lines can be pulled and cleated in one single movement.

Connection to Wheel or Tiller

The control lines are led out through holes drilled in the sides or back of the cockpit bulkhead, then (trough other blocks if needed), to the wheel or tiller.

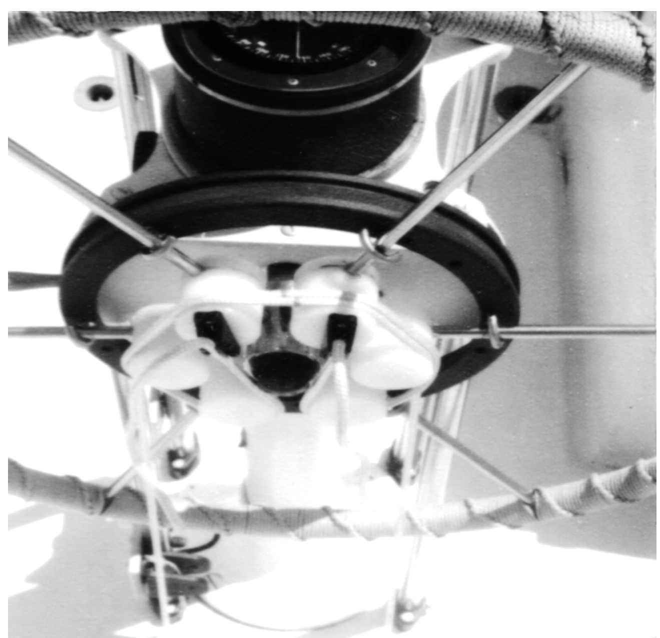
The turning blocks must be placed in such a manner that the control line is guided exactly in the centre of the hole, and that it does not touch its side; otherwise, it will chafe through very rapidly. In the case of a line chafing on one side, enlarge the hole with a round file or a Dremel tool.

Connection to Wheel



The control lines turn the steering wheel by going around **grooved Delrin cylinders** placed on the wheel spokes, then to a cleat. These cylinders can be placed closer or farther from the hub, so the ideal ratio of rudder angle for a given quadrant tilt can be arrived at. This ideal ratio is 2 to one : for 10° of pendulum-quadrant tilt, 5° of rudder angle.

If the quadrant is mounted **above** the axle, the lines must be **crossed** before they reach the wheel; if it is mounted **below**, they can be led **directly**.



An autopilot drum already fitted to the wheel poses no problem : the cylinders are placed inside this drum and when it is to one side of the wheel, they can be place on the other side.

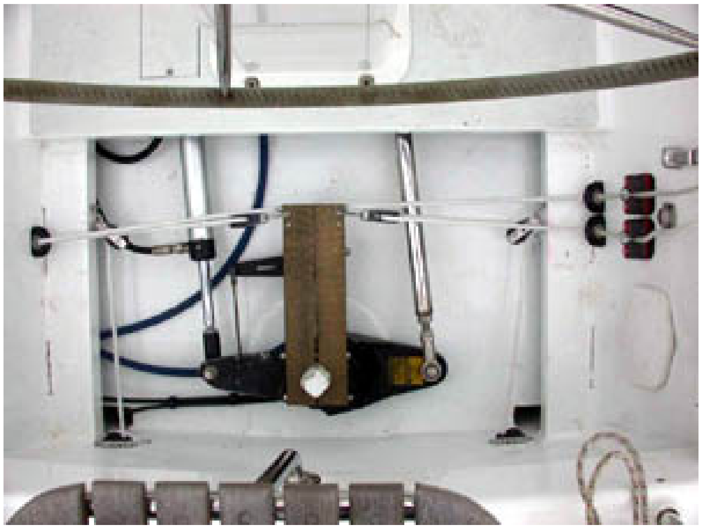
Connection to Tiller

The control lines are led through fairleads placed on either side of the tiller, and then forward to a pair of jamming cleats. These fairleads should be placed at a distance from the rudder axis, close to **twice the quadrant radius** (or, in the case of the ***Varuna***, twice the length of the control arm) :16 in. (40 cm) for ***Jean-du-Sud***, and 21 in. (24 cm) for ***Spray***.

Tying the control lines together at the position rudder amidships and pendulum vertical makes it easier to tighten the lines and cleat them in a single movement.

Connection to auxiliary tiller

If control lines are led to an auxiliary or emergency tiller, this tiller can be kept shorter by leading the lines through blocks fastened to the tiller at a distance (from the rudder axis) equal to the quadrant radius or control arm length. The block on the tiller divides the travel by two and doubles the force, so you get the ideal 2:1 ratio between pendulum tilt and rudder angle.



Rig Lines for Remote Course Setting

Friction of a 5/32 or 3/16 in. (4 - 5 mm) endless line inside a groove at the base of the course adjustment disk rotates the revolving turret at the top of the windvane tower and allows to set a precise course from a remote position.

Two rollers guide this line down to blocks at deck level. Leading this endless line through blocks **around the cockpit** (along the coaming) allows to **set** the **course from any position** in the cockpit, even from below by reaching through the companionway.

If the turret becomes too stiff and the line slips in the groove, put a rubber band in the bottom of the groove to increase friction.

Important :

The turret is built to revolve reasonably freely at the top of the tower, so if this endless line is not used, **rig at least a line to the pushpit or backstay, that creates additional friction** and maintains the course adjustment.

Assembling the *Varuna* or *Joshua*

To reduce the volume of the parcel for shipping, the mounting arms, the horizontal axis and the tower are shipped unassembled. The assembling procedure is as follows :

1: Insert the horizontal pivoting axis (the T-shaped piece) through the horizontal tube at the base of the tower. As you push it through the tube, connect the crank at the forward end of the tower in the manner described and illustrated on page 24. After the vertical rod is connected to the crank, fasten both parts together with a bolt in the bottom hole (do not tighten too hard at first, allow a little motion). Make sure you use the shortest bolt and make sure the hole with 2 punch marks is at the top position.

2: Place the frame on the base of the tower and fasten the 3 remaining holes (one on top and 2 each side) using the 3 remaining bolts that are longer than the first one, since the frame adds some thickness. Do not tighten one bolt before all 3 are engaged. Allowing a tiny motion will help. Do not tighten these bolts too hard before the last step is done.

3: Engage the first of the last 2 bolts (these bolts are the longest) in one hole on the tower. Even if the little bracket does not lay against the tower, the bolt should be long enough to get engaged in the threads (not using the lock washer or using a longer bolt you have in stock can help for this operation). When the first bolt is engaged, engage the second. When the 2 bolts have been engaged, with their lock washer, tighten them both. This will bring the little bracket to lay against the tower. Do the final tightening on all the bolts holding the frame to the base of the tower.

Installation to the transom

If the freeboard is less than about 28 in. for ***Varuna*** or 32 in. for ***Joshua***, the mounting arms can be bolted to the deck or caprail. If it is greater, they are bolted to the transom.

If the mounting arms have not been previously cut to the appropriate length, cut them so that the body of the unit or the steering oar clear the rudder by about one inch.

The arms should be fastened to the transom at a height that keeps most of the wood part of the servo-pendulum below the (dynamic) waterline, while keeping the metal plate at the top of the steering oar out of the water in normal sailing conditions.

Control Lines

Shackle a turning block to the half-ring on each side of the mounting arms and pass the control lines through. From there, the control lines are led to the tiller or wheel in the manner described in on pages 26-32.

How to connect an autopilot on the *Varuna* and *Joshua*

The little vertical arm (a) is engaged in the dovetail shaped receptacle located on the large cap at the base of the tower. (Make sure the inside part of this cap is correctly connected to the end of the ¼ rod to transmit the motion to the oar).

A bungee cord attached to one side of the mounting frame pulls the vertical arm in one direction. A light line passing through a block on the other side of the frame pulls the arm in the other direction ; passing through as many blocks as needed, this line is attached to the end of the autopilot ram

When the autopilot rod pulls, the bungee line stretches.

When the autopilot pushes, the bungee pulls the arm in the other direction.

When the autopilot is not used, simply disconnect by removing the vertical arm from its receptacle. It can be left hanging or tied to one side until the autopilot is used again.

Don't forget to remove the vane when using the autopilot.

Extended *Varuna* or *Joshua* on step stern

If the step is high enough to keep the U-shaped metal plate at the top of the paddle out of the water, the horizontal axle can be located directly on the step. If not, its forward end end is bolted to the transom with U-shaped bracket provided, and its aft end supported with a pair of struts.

Note : On this boat, control lines are led through blocks shackled to an auxiliary tiller pointing aft, in place of emergency tiller

Installation of the *Toucana*

Insert the horizontal axle into the horizontal tube at the foot of the tower and bolt to the revolving ring.

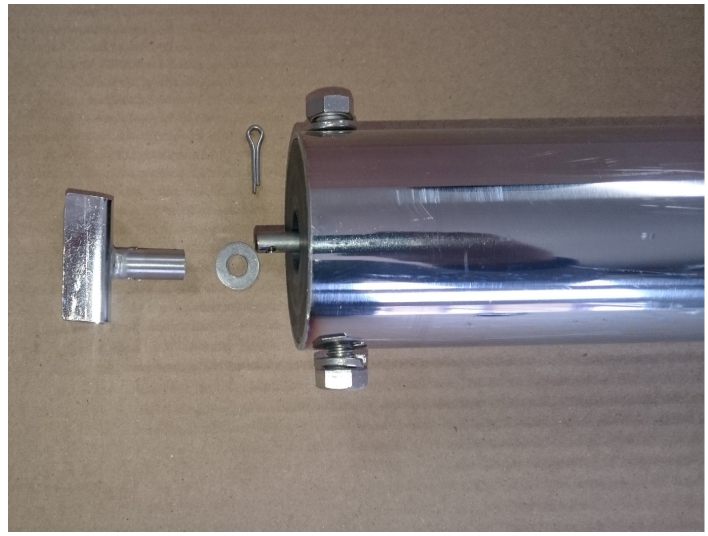
Installation of the Toucana is only a matter of fastening the struts to the boomkin. Fasten also the diagonal struts to either the boomkin or the hull.

If there is enough room, behind the trailing edge of the rudder, the windvane tower can be located inside the V of the boomkin.

An Omega-shaped strap or a U-bolt can be used to fasten the tower to the boomkin. Additional diagonal struts can be added to the boomkin for more support.

Control lines are led to tiller as described on page 30.

Taking the horizontal axle apart



1 : At the forward end of the horizontal axle, remove the cotter pin that fastens the autopilot wedge-shaped connection to the co-axial ¼ in. control rod.

2 : Pull the two screws fastening the 1 ½ in. bushing that supports the aft end of the rod. Mark the precise position of the bushing (see below) Pull the rod with the bushing aft.

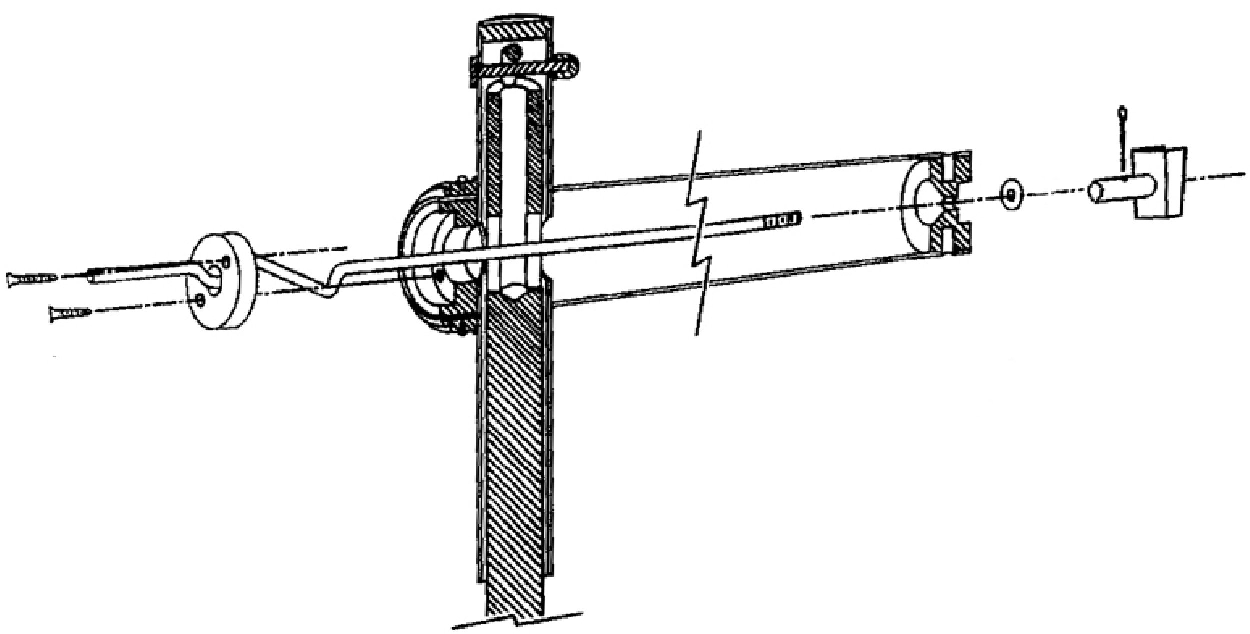
3 : Remove the ¼ in. fore-and-aft bolt at the top of the servo-pendulum stock. Pull the stock down.

When re-assembling, the precise position of the co-axial control rod , both fore-and-aft and lateral, is critical to ensure that there is no friction between the control rod and the stock of the servo-pendulum.

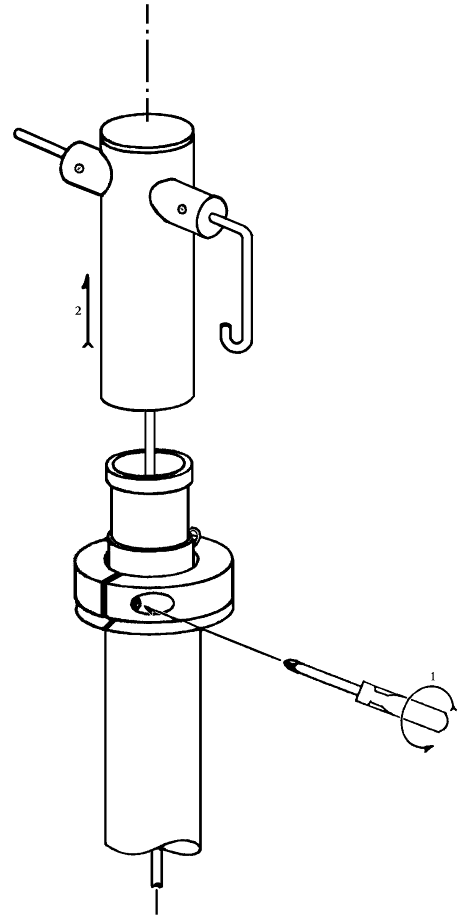
Fore-and-aft : There should be about 1 mm of play fore-and-aft.

Lateral : The hole guiding the control rod in the 1 ½ in. bushing is offset 0.020 of an inch to correct any mis-alignment between the axis of the horizontal and vertical tubes.

If, after re-assembling, you find a hard spot when rotating the crank in the left semi-circle, rotate this bushing, to move the control rod laterally until it moves freely and there is no hard spot and replace the screws in the new position.



Taking the windvane tower apart



The turret is held in position by friction of the course-adjusting disk around the perimeter of the turret. Loosening the ¼ in. bolt in the edge of the disk allows to pull up the turret and connecting rod.

When re-assembling, make sure the turret is pushed down all the way, as the precise length of the connecting rod in relation to the total length of the tower is critical to maintain the servo-pendulum in the vertical position when the vane is also vertical.

If it is not, and the crank at the aft end of the horizontal axle is not bent out of shape, the length of the connecting rod is re-adjusted by loosening the lock nut at its base and rotating it from the top.

Photos

**If you make photos of your installation,
of the way control lines are led
to the boat's steering gear
and E-Mail them to us,
we will be able to detect an eventual mistake
and recommend a correction
that will improve the performance of your gear
or make it easier to operate.**

**Those photos could also inform
the owner of a similar boat who wants it
steered by a CapeHorn.**

mail@capehorn.com

Guarantee

We build the **CapeHorn** with the greatest care,
and when we ship a unit,
we have the assurance that it could steer us around the world.

We naturally expect that comparable care
will be given to installation.

**We guarantee its performance
for one circumnavigation,
28 000 miles or three years
against any damage caused by wind or sea.**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