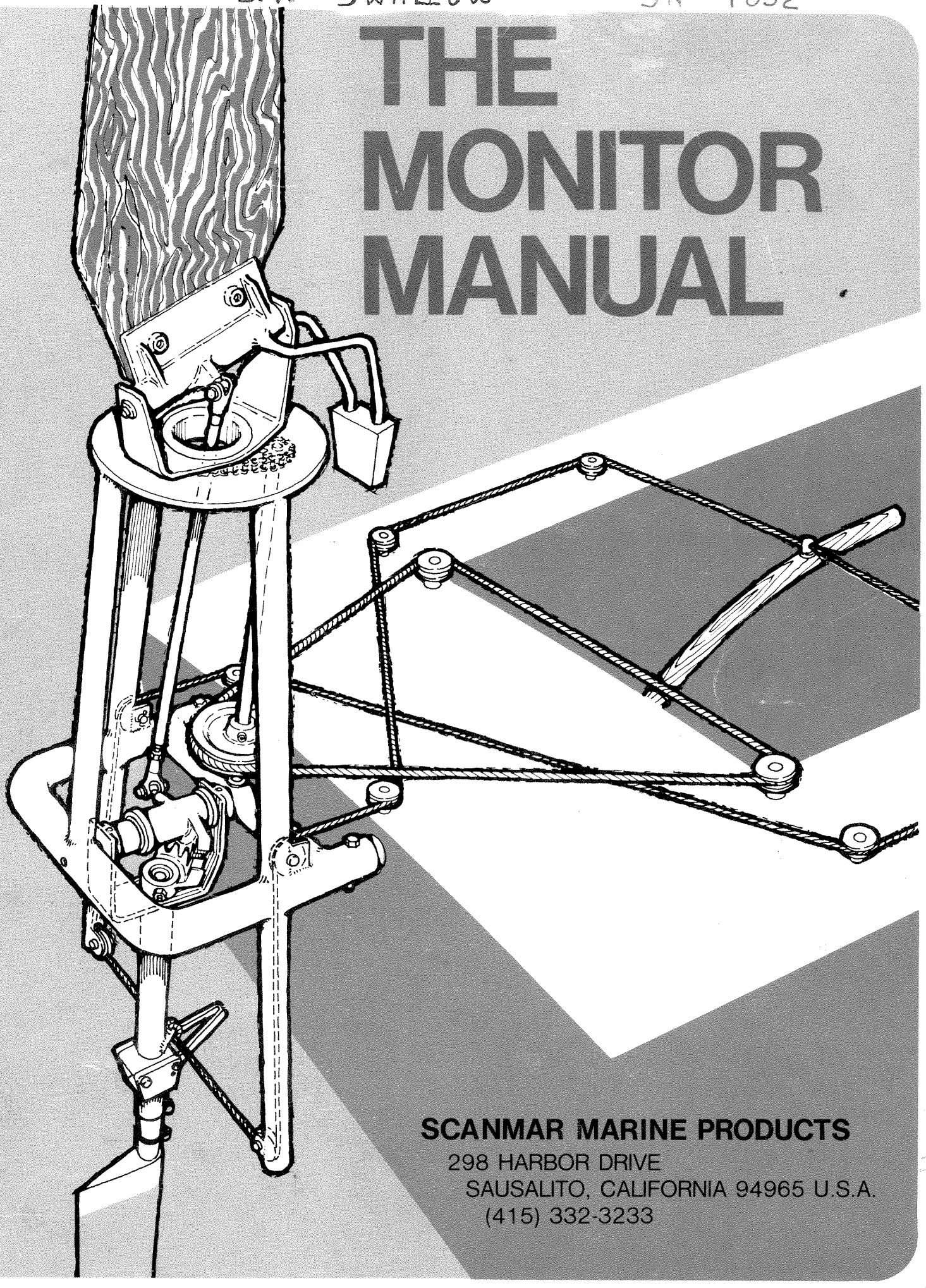
S.V. SWALLOW SN 1032

THE MONITOR MANUAL



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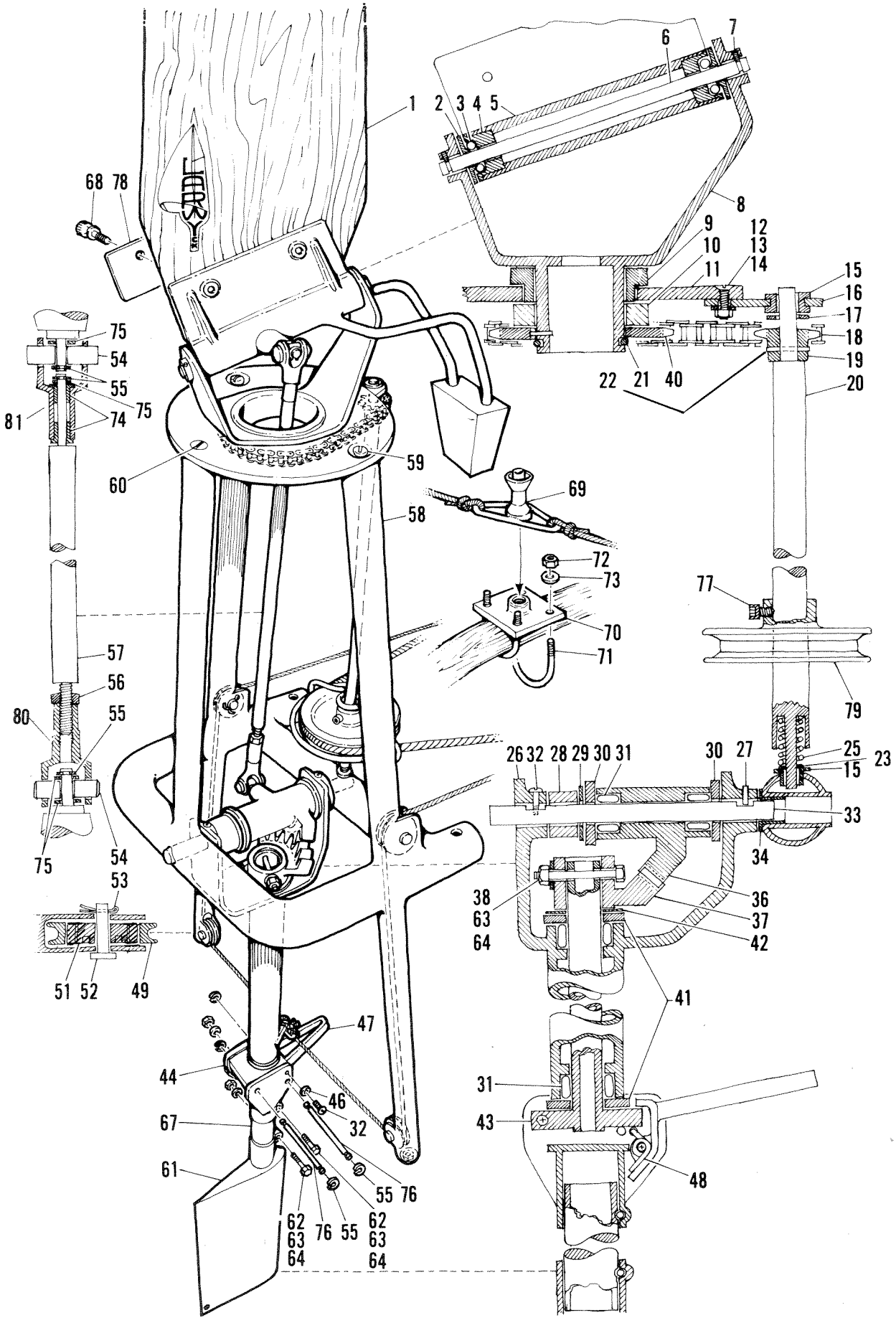
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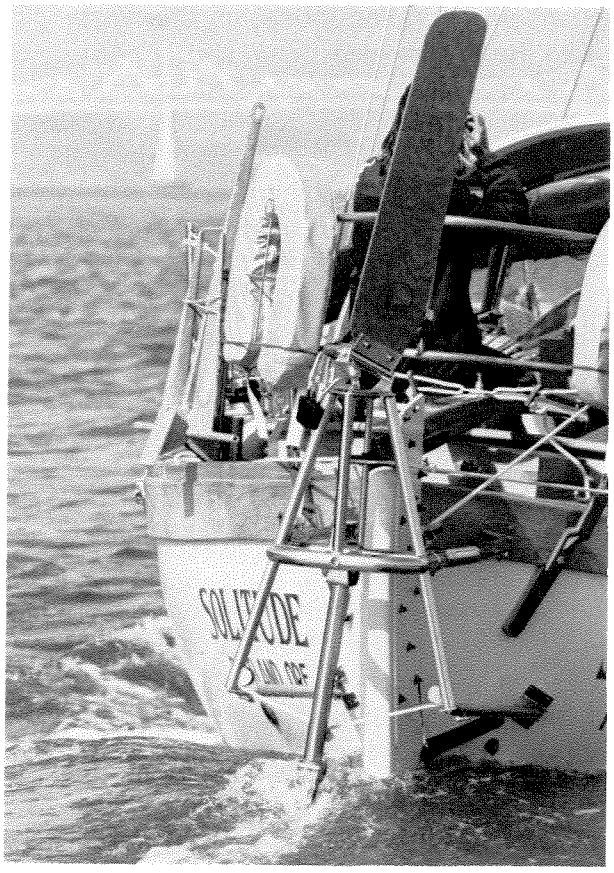
MONITOR PARTS LIST

Part No.	Spares Kit*	Description**
1.		Windvane – spare included
2.		Bearing – cone (2)
3.	36	Ball, delrin (36)
4.		Bearing – cup (2)
5.		Weldment – windvane
6.		Shaft – windvane
7.	2	Set screw #8-32 × ⅛ (2)
8.		Yoke – windvane
9.		Bearing, flanged teflon
10.		Washer, telfon
11.		Base, windvane mounting
12.	2	Screw #10-32 × ½ FH (2)
13.	3	Washer #10 lock (7)
14.	2	Nut #10-32 hex (2)
15.	2	Bearing – nyliner, flanged 5/16 ID (2)
16.		Plate, pilot shaft bearing
17.	3	Washer, 5/16″ SS (2)
18.	1	Chain
19.		Sprocket, 12 tooth
20.		Assy. pilot shaft
21.	1	Ring – retainer, 3½″ dia.
22.	2	Pin, with #20 (2)
23.		Washer
25.	1	Spring ,1¼″ long
26.		Weldment – strut
27.		Setscrew #10-32 × ⅛
28.		Spacer – pinion
29.	1	Washer, ¾″ ID SS
30.	2	Washer, teflon ¾″ ID (2)
31.	40	Bearing, roller (78)
32.	1	Screw #10-32 × ½ RH
33.		Shaft – watervane support
34.	2	Bearing – nyliner, flanged ¾ ID (2)
36.		Gear – pinion
37.		Gear – ring
38.	2	Screw, 5/16-18 × 2½ hex (3)
39.	2	Screw, 5/16-18 × 1½ hex (16)
40.		Sprocket – chain
41.	2	Washer, teflon 1¼ ID (2)
42.	1	Washer, SS 1¼ ID
43.		Shaft – watervane pivot
44.		Hinge – watervane
47.		Latch, watervane
48.		Spring
49.	2	Ring-sheave (4)
50.		Roller-sheave (76)
51.	2	Core-sheave (2)
52.	2	Pin, clevis ¼″ dia (2)
53.	10	Pin-cotter (6)
54.	2	Bearing, teflon for pushrod (2)
55.	6	Retainer rings ⅜ dia (3)
56.		Nut
57.		Assy. pushrod
58.		Weldment, main frame

Part No.	Spares Kit*	Description**
59.	2	Screw, 5/16-18 × ½ RH Allen (2)
60.	2	Screw, 5/16-18 × ½ FH Allen
61.		Watervane/servo-paddle
62.	2	Bolt, 5/16-18 × 2 hex (2)
63.	6	Washer, 5/16 lock (3)
64.	6	Nut, 5/16-18 hex (3)
66.		Sheet control (2)
67.		Tube, safety – spare included
68.	2	Thumbscrew (2)
69.		Tie-tiller
70.		Plate-tiller sheet attach
71.		Rod-latch hanger (2)
72.		Nut #10-32 hex (4)
73.		Washer, #10 lock
74.	2	Bearing, delrin upper push rod (2)
75.	4	Washer (5)
76.	1	Shaft – hinge latch, ⅜ dia SS (2)
77.		Screw, 5/16-18 × ½ RH
78.	1	Clamp – windvane
79.		Pulley – windvane control
80.		Weldment – clevis, threaded
81.		Weldment – clevis
82.		Tube assy. lower mounting (2)
83.		Extension tube, lower mounting (2)
84.		Angle-tube mouting (4)
85.		Tube, spacer (6)



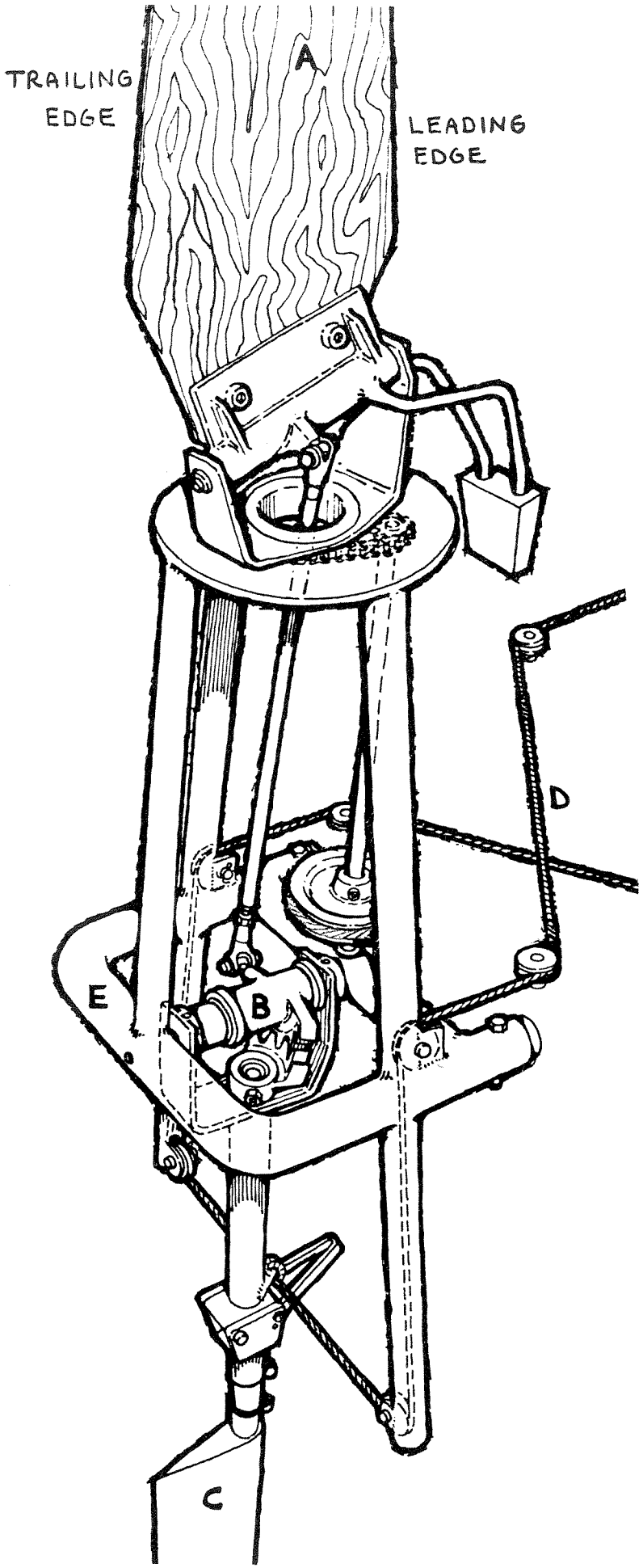
*Parts included in standard spare parts kit recommended for extended passages.

**Bracketed numbers indicate quantity in assembly.

CONTENTS

1. WELCOME ABOARD

Welcome among the MONITOR sailors. We hope you will be as satisfied as most of us are. The MONITOR is built to give you years of excellent performance and to take the kind of punishment the sea sometimes delivers.



Many yachtsmen are still very unfamiliar with windvane self-steering gears. They view vane gears as oddities, used by single-handed race heroes and circumnavigators. The truth is that a good vane gear, such as the MONITOR, is a wonderfully useful piece of equipment, even on short passages of no more than an hour or so. Once the freedom of sailing with the MONITOR has been experienced, this will be fully appreciated.

In order to enjoy the experience of self-steering, the vane gear must, of course, work. Unfortunately, windvane self-steering is not a pushbutton phenomenon. Knowing how to sail and how to balance your boat on different points of sail is necessary to get the most from the gear. Even experienced ocean racing sailors have confessed that vane sailing has taught them some things they did not know about balancing and trimming a boat.

This is no excuse for inferior performance. The MONITOR is at least as powerful and forgiving as any other vane gear. It is certainly the gear that is built with absolutely no corners cut and the greatest consideration for performance and durability.

However, the extent of this manual is explained by the fact that windvane self-steering requires a bit of learning before you become a perfect operator. Proper installation and proper operation are essential, and we hope that the number of pages will not keep you from reading them.

2. A DESCRIPTION OF THE MONITOR

2.1 Servo-pendulum Principle

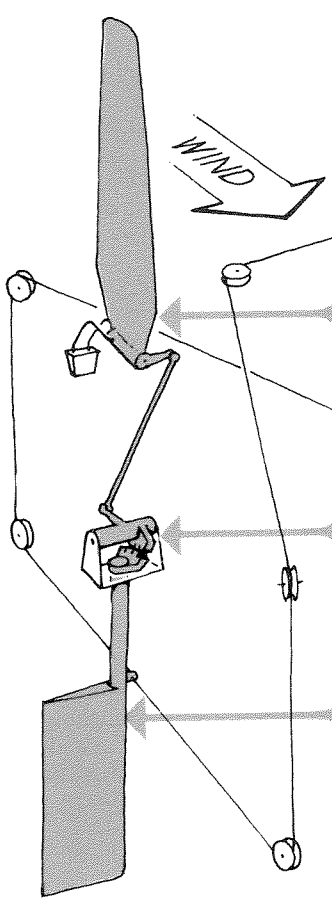
The MONITOR, as you probably are aware, is a servo-pendulum type vane gear. This vane design was first developed by Colonel "Blondie" Hasler for the early single-handed trans-Atlantic races.

The signal from a windvane is always comparatively weak and usually not in itself powerful enough to correct the course of the boat. The intermediate mechanism of the servo-pendulum provides an enormous amplification of the force of the windvane's signal, using the boat's own speed through the water as a power source.

A servo-pendulum vane gear consists of (A) a WINDVANE, which registers whether the boat is on or off a desired heading. Through a (B) PUSHROD and GEAR LINKAGE the signals from the windvane control the angle of the blade of an oar or paddle, the so called (C) SERVO-PENDULUM, which is suspended from the stern of the yacht. When the boat wanders off course, the windvane gives a signal, which rotates the blade of the servo-pendulum, causing the blade to get hit on its side by the water rushing past. The water forces the oar to swing to the side and a considerable leverage is created through the pendulum shaft.

The oar is connected through (D) LINES and BLOCKS to the tiller or wheel of the boat and the resulting movement of the boat's rudder brings the yacht back on course again.

The windvane, pendulum and control lines are held together in a (E) VANE FRAME which is installed on the stern of the yacht.

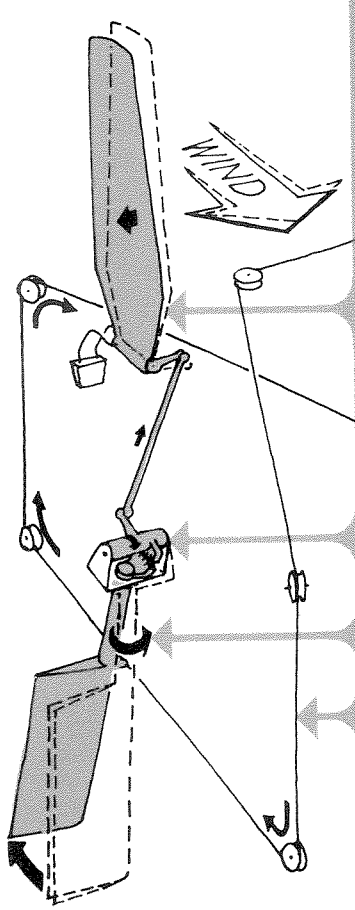


WITH THE BOAT TRIM AND ON COURSE, AND THE WIND VANE INTO THE WIND, THE VANE STANDS UPRIGHT. . .

. . . AND THE LINKAGE AND GEARS ARE CENTERED.

IN THIS ATTITUDE, THE PENDULUM WATER-VANE IS ALIGNED WITH THE HULL. . .

. . . AND THE TILLER OR WHEEL AND RUDDER ARE IN THE ON-COURSE POSITION.



AS THE BOAT YAWS TO PORT, THE APPARENT WIND, AS SENSED BY THE WINDVANE, CHANGES, PUSHING THE VANE AFT.

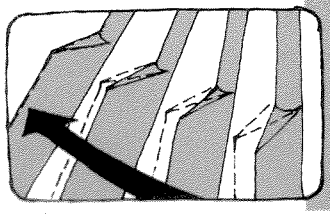
THE MOVEMENT OF THE VANE ROTATES THE MASTER GEAR SLIGHTLY. . .

WHICH ROTATES THE PENDULUM WATER VANE IN THE DIRECTION THE RUDDER MUST TURN. WATER PRESSURE AGAINST THE PENDULUM SWINGS THE VANE TO PORT

. . . PULLING THE PORT CONTROL SHEET. . .

WHICH PULLS THE TILLER TO PORT CAUSING THE BOAT TO MOVE TO STARBOARD AND BACK ON COURSE.

AS THE WATER VANE SWINGS OUT OF ITS NEUTRAL POSITION TO MAKE THE CORRECTION, THE MESH OF THE GEARS ROTATES IT BACK TOWARD ALIGNMENT WITH THE HULL. THE FORCE OF THE WATER ON THE VANE REDUCES PROGRESSIVELY AND THE COURSE CORRECTION IS THUS SMOOTH AND WITH NO APPARENT OVER-CORRECTION.



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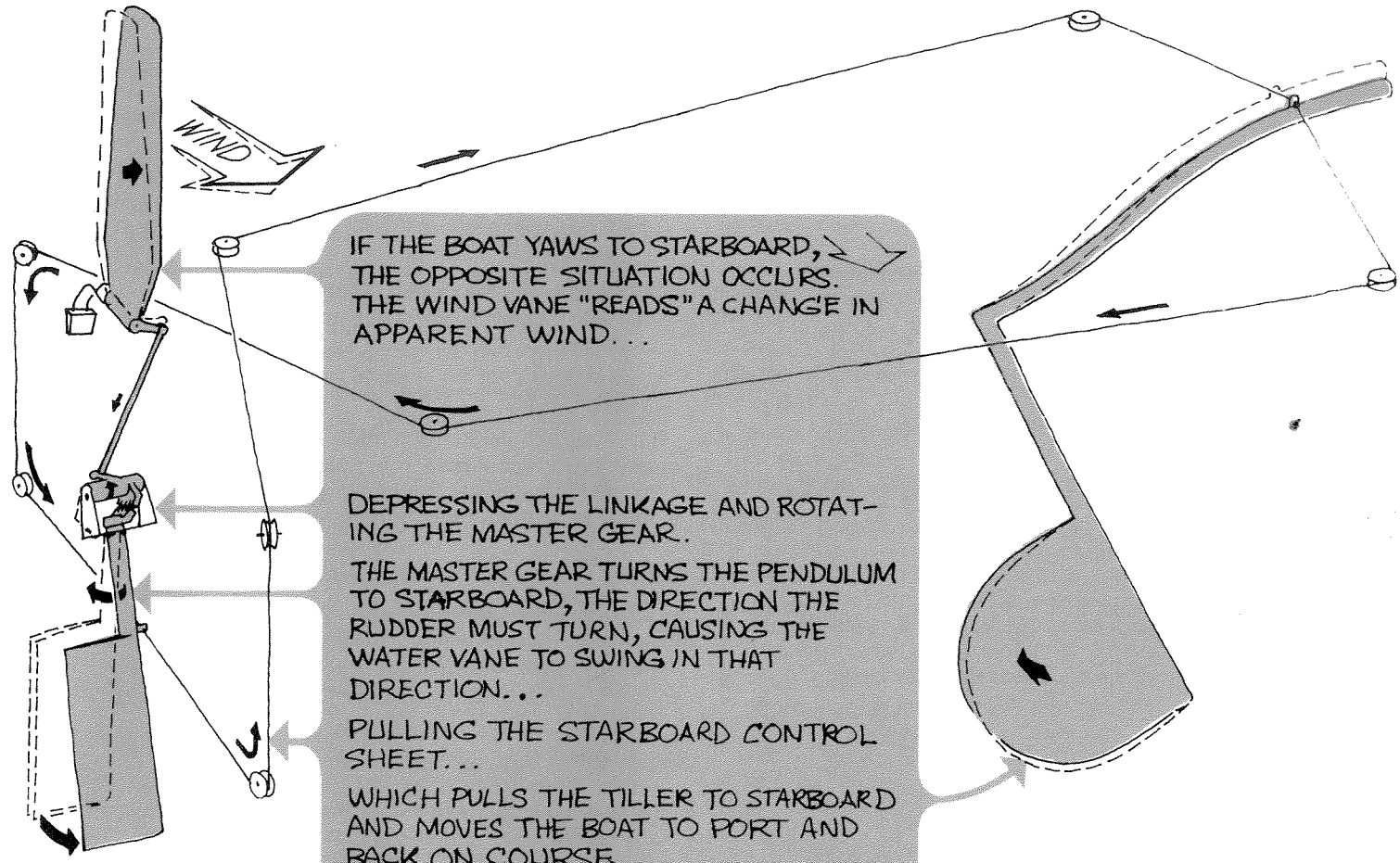


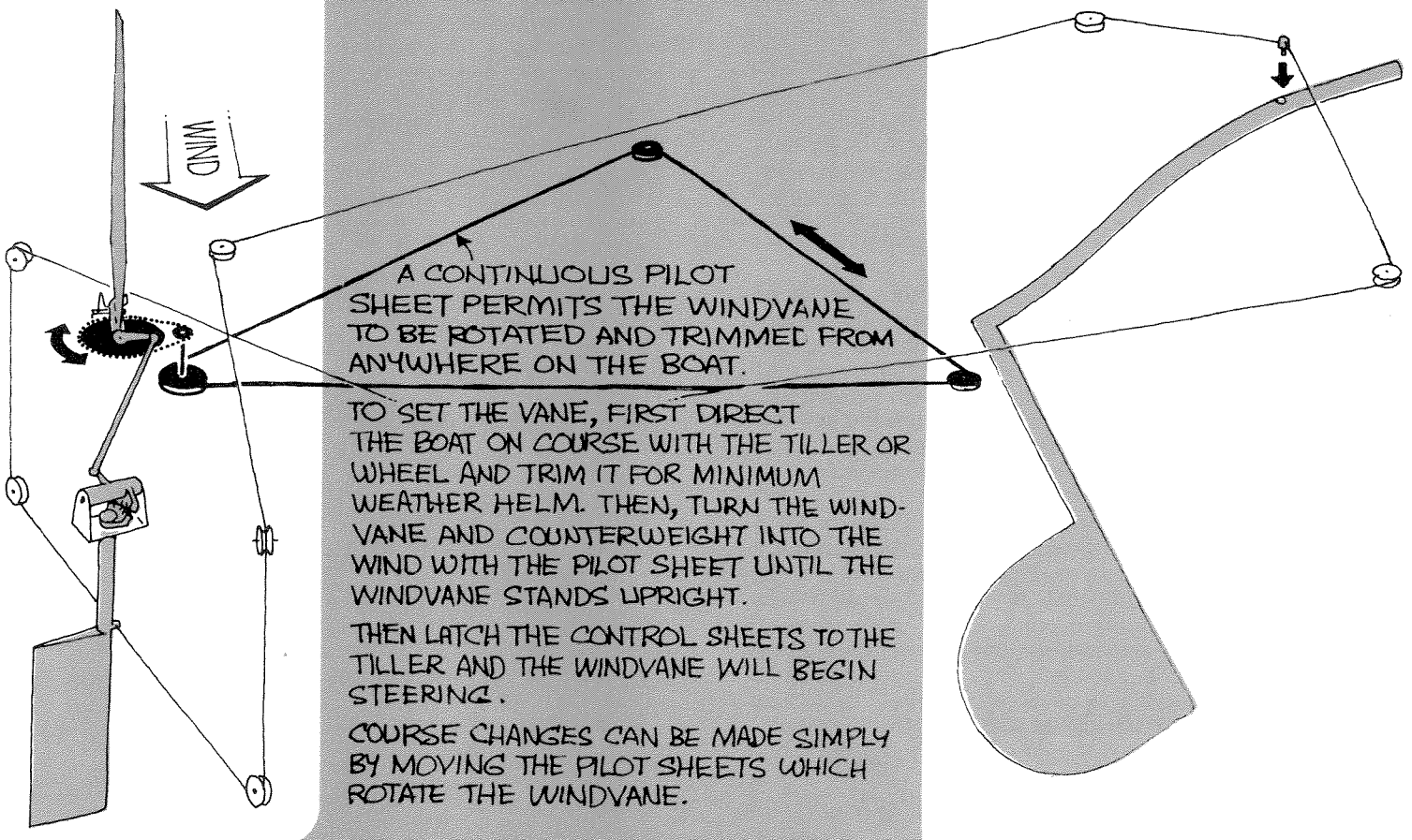
IF THE BOAT YAWS TO STARBOARD, THE OPPOSITE SITUATION OCCURS. THE WIND VANE "READS" A CHANGE IN APPARENT WIND...

DEPRESSING THE LINKAGE AND ROTATING THE MASTER GEAR.

THE MASTER GEAR TURNS THE PENDULUM TO STARBOARD, THE DIRECTION THE RUDDER MUST TURN, CAUSING THE WATER VANE TO SWING IN THAT DIRECTION...

PULLING THE STARBOARD CONTROL SHEET...

WHICH PULLS THE TILLER TO STARBOARD AND MOVES THE BOAT TO PORT AND BACK ON COURSE.



A CONTINUOUS PILOT SHEET PERMITS THE WINDVANE TO BE ROTATED AND TRIMMED FROM ANYWHERE ON THE BOAT.

TO SET THE VANE, FIRST DIRECT THE BOAT ON COURSE WITH THE TILLER OR WHEEL AND TRIM IT FOR MINIMUM WEATHER HELM. THEN, TURN THE WINDVANE AND COUNTERWEIGHT INTO THE WIND WITH THE PILOT SHEET UNTIL THE WINDVANE STANDS UPRIGHT.

THEN LATCH THE CONTROL SHEETS TO THE TILLER AND THE WINDVANE WILL BEGIN STEERING.

COURSE CHANGES CAN BE MADE SIMPLY BY MOVING THE PILOT SHEETS WHICH ROTATE THE WINDVANE.

MONITOR WORKS

2.2 The Windvane

The windvane (1)* of the MONITOR is made of ¼" marine plywood. This material may not be completely ideal from the standpoints of aerodynamic shape and weight, but this is by far outweighed by durability and ease of replacement.

The windvane pivots around an inclined horizontal axis, rather than around a vertical axis, like the flag-type vanes seen on some other gears. The horizontally pivoting vane is a lot more efficient under all circumstances. By tilting the axis slightly away from straight horizontal, the effect is achieved that the windvane gradually feathers into the wind as it flips to the side, providing a feedback system, which prevents overcorrecting.

The horizontally pivoting vane should be adjusted with its leading edge facing into the wind, when the boat is on the desired heading. The leading edge is the one on the side of the lead counterweight, over the high side of the tilted horizontal axis. When this edge is turned into the wind, the equal wind pressure on either side of the vane blade will keep the vane upright. If the boat wanders off course, the wind hits one side of the windvane only, making it pivot.

It is very important to remember which edge is the leading edge and which is the trailing one. It is possible to bring the vane upright by turning the back edge into the wind also, but this will produce completely reversed reactions in the vane gear, taking the boat further off course instead of bringing it back to the desired heading.

The vane is adjusted and kept in position by a control line, which turns the vane through a pulley (79), and a chain (18) and sprocket drive (40 and 19).

As stated, the vane has very little power, even under the best of conditions. To get maximum performance the MONITOR windvane pivots on specially made ball bearings consisting of delrin balls in stainless races.

The windvane is most sensitive and powerful when mounted straight vertical. However, by turning the windvane around in the clamping fitting that holds it, you can make the vane lower and less sensitive. This may be desirable in very hard weather, or if it will give clearance under a mizzen boom when short tacking upwind, or possibly to prevent oversteering when running. The leading edge is still the one closest to the lead counterweight.

The counterweight under the windvane balances the vane. Ideally it should just barely be able to keep the vane upright when there is no wind. The windvane must not be top heavy, and without the counterweight it would not work at all in light airs.

2.3 Pushrod and Gear Linkage

The pivoting of the windvane is transferred through a pushrod (57) and a bronze master gearset (36-37) into a rotation of the underwater pendulum blade. This linkage in the MONITOR is strong, direct and relieved of friction through teflon bearings (54) in the pushrod and delrin roller bearings (31) in the gearset and pendulum shaft. The strength and freedom of slop and friction in the windvane-to-pendulum linkage is an important key to the superior performance of the MONITOR.

Through the ratio of the bronze gearset a second feedback is provided as the gear will gradually neutralize the rotation of the pendulum blade when this blade swings to the side. Again the feedback serves to dampen any oversteering tendencies.

When the windvane is in the upright on-course position, the pendulum blade should be lined up exactly fore and aft. This adjustment is initially made at the MONITOR factory. If, for some reason, it has to be repeated it is performed by releasing the locknut (56) at the lower end of the pushrod and adjusting the length of the rod.

2.4 The Servo-pendulum

The MONITOR servo-pendulum is hinged in the frame on a solid ¾" stainless steel shaft (33). The upper half consists of an outside strut (26) with roller bearings (31) at each end for friction free rotation of the pendulum shaft (43) inside it.

Below the strut the pendulum shaft ends in a ½" thick hinge block which is part of the latch mechanism (47) that allows the bottom part of the servo-pendulum to be lifted out of the water.

The MONITOR latch is self-energizing. It engages harder under increased pressure. At the same time it is easier than other types of arrangements to operate quickly and safely, even in hard weather at sea.

The lower half of the pendulum starts with the latch arrangement, below which is mounted a safety tube (67). This tube is weaker than the rest of the pendulum and will break or buckle upon severe impact that would otherwise cause more extensive damage to the gear.

Below the safety tube is the watervane (61) or servo paddle itself. This paddle is the powerhouse of a servo-pendulum gear. In the MONITOR it is both stronger in construction and better designed that in other vane gears of the same type.

The MONITOR paddle has been given a NACA high lift profile and its leading edge has been moved forward of the center of rotation to semi-balance the blade. This allows the windvane to rotate the paddle with a minimum of force, improving especially the light air performance of the gear.

The paddle has a stainless steel skin, spot welded to a stainless inside shaft. Its hollow part has been filled with polyurethane foam and the ends capped with epoxy compound. The end result is an extremely strong and rigid servo paddle.

2.5 Lines and Blocks

Four roller bearing blocks and 35' of ⅜" dacron yacht braid rope are delivered with the MONITOR vane gear. This is usually all that is required to link the pendulum to the boat's rudder, especially in tiller installations. As will be discussed later, paying some extra attention to the installation of the pendulum sheet lines can often make it much more pleasant to live with the vane gear.

*Numbers refer to the diagram and parts list on the front two pages.

2.6 The Vane Frame and Hull Attachments

The MONITOR vane frame (58) forms a very strong integrated unit. The pendulum lines are led through the outside "legs" of the frame. This method offers simplicity and great strength, and with this arrangement the lines cannot be lost as they can from a quadrant, when the almost inevitable occasional slack develops in one or the other line during a course correction.

The frame is attached to the hull by means of two larger upper tubes, which slide into sockets on the frame, and two lower tubes attaching to the bottom of the frame legs. The tubes are fitted with angle brackets at their ends for through bolting to the hull.

The MONITOR four-point attachment is universally adaptable to all kinds of stern configurations. It is the easiest and strongest attachment of any vane gear of this kind.

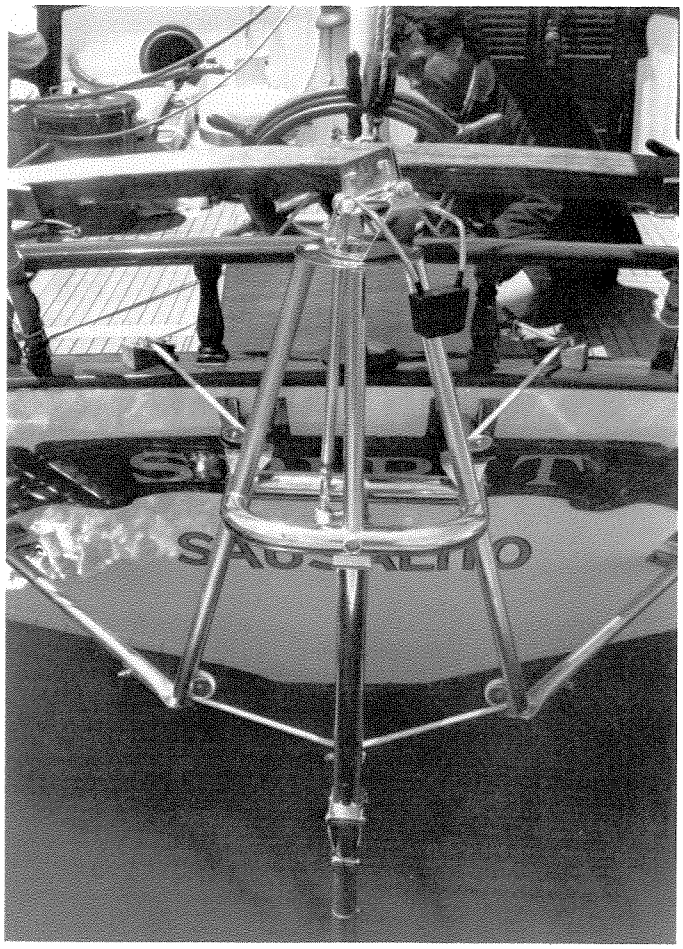
3. INSTALLING THE MONITOR

3.1 Attaching the Frame

3.1.1 Important alignments

Generally the MONITOR is attached to the stern with two upper and two lower mounting tubes, which are bolted to the boat by means of universal angle brackets.

The gear has to be aligned on the center line of the yacht as well as vertically and horizontally. These alignments are critical and great care should be taken that the vane gear is not visibly off center or tilting forward or aft or to one side.



3.1.2 Installing afloat or hauled

Contrary to what may be expected, it is generally much easier to install the vane gear with the boat afloat, especially with the stern backed into a floating mooring dock. Just take great care not to drop vane, parts or tools into the water.

3.2 Determining the Proper Height of Installation

3.2.1 Standard height

Most often the vane gear is located height-wise so that about one inch of the top of the paddle is out of the water when the boat is stationary. This puts the main frame, into which the heavier upper mounting tubes are inserted, at approximately 36 inches above the water. Depending on the freeboard of the yacht, the upper mounting tubes will either be mounted on deck or on the stern.

3.2.2 Longer or shorter pendulum shaft

Boats with very low or very high freeboard at the stern may require a shorter or longer pendulum that standard. The length of the MONITOR pendulum shaft is varied by shortening or lengthening the safety tube (67). The standard rule of leaving about one inch of the paddle blade out of the water still applies, although the frame itself will now be mounted lower or higher than the standard 36" above the water.

3.2.3 Importance of the boat's wake

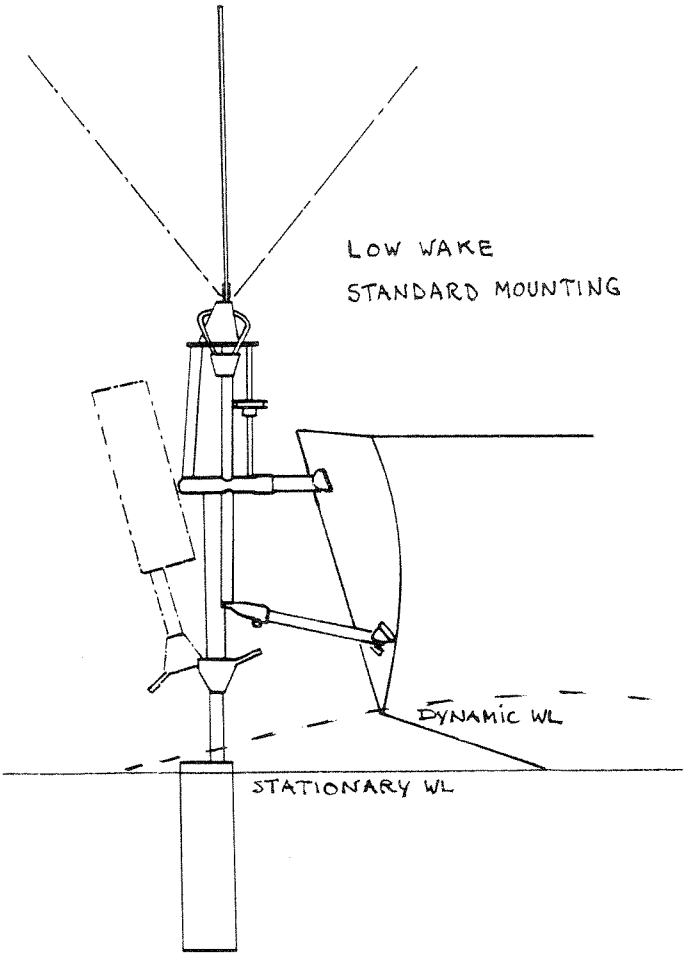
The level indicated above is a rule of thumb, which is subject to much variation. The proper location of the vane gear, up or down, should be determined by the dynamic waterline which is created when the boat is moving at different speeds on different points of sail. Proper location becomes more crucial in larger and faster yachts, where the potential loads are much greater, than for a smaller or slower yacht. On a heavy displacement thirty-footer, a few inches up or down really do not matter. On a boat capable of 10 knots and better, it is necessary to be much more careful in determining the proper level of the installation.

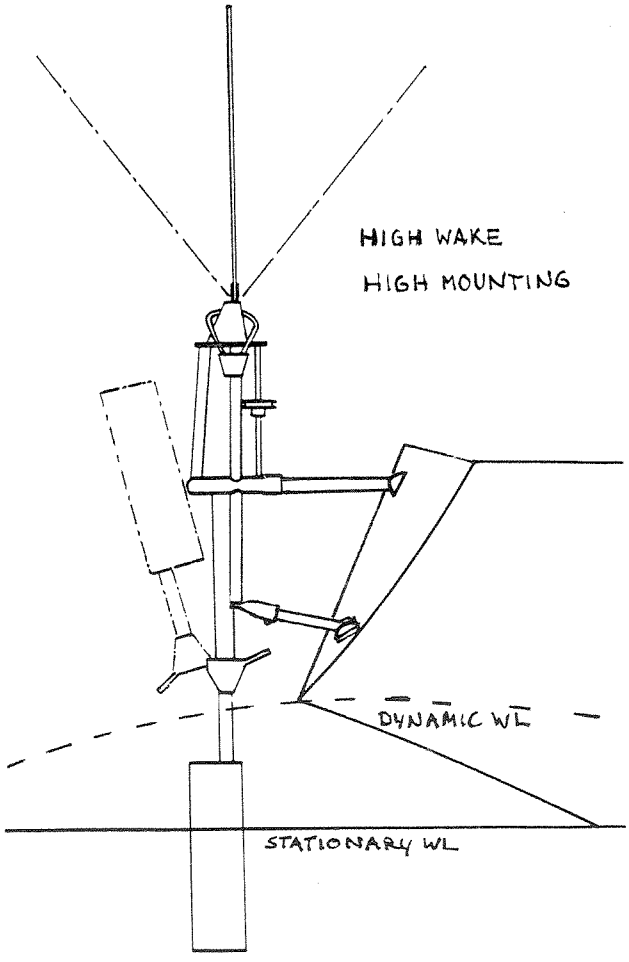
Each boat is different and its characteristics should be best known by its owner. Because of this no fixed tables will be given. Instead we will give the guidelines to be used in determining proper mounting height.

The paddle at the end of the servo-pendulum is the power-source of the vane gear. As long as a part of the paddle blade is immersed in the wake behind the boat, the vane gear will operate as designed.

If the paddle lifts out of the water occasionally,—as it will do on a yacht with long overhangs in choppy seas,—this will not interfere seriously with the efficiency of the gear. However, if the paddle stays out of the water for long periods, the performance of the vane will be affected. This could happen if the vane has been mounted too high on a boat which sails hard to weather without building up a large stern wake. A combination of the heeling of the boat and a movement of the pendulum to the lifted, windward side could bring the paddle out of the water for a long period and make the gear inoperative.

On the other hand, nothing is gained by mounting the vane gear so low that not only the paddle blade but also the pendulum shaft is covered by the wake. The strains on welds and mountings mutiply, without any improvement in the functioning of the gear.





FROM THIS FOLLOWS THAT THE SELF-STEERING SHOULD BE MOUNTED SO THAT THE PENDULUM PADDLE IS ALWAYS IMMERSED TO SOME DEGREE BUT THE PENDULUM SHAFT AS LITTLE AND AS SELDOM AS POSSIBLE.

Some boats have very different waterlines at the stern when they are still and when they are moving fast. Yachts with high reverse transoms generally have water all the way up under the transom when sailing downwind at cruising speed and the wake can be 18 to 24″ higher than when the boat is still or moving slowly. Double-ended hulls tend to squat, especially downwind, and if the stern is fine with little buoyancy, the wake can sometimes climb close to the toerail. In these cases the vane gear must be mounted as high as possible, while still keeping the paddle immersed to some degree at slower speeds and on different points of sail. Again, this is especially important if the boat is large and fast or uses an extra long pendulum shaft, which also increases the loads on the gear.

To sum up: Owners of smaller, slower yachts can follow the basic guideline of mounting the MONITOR leaving about an inch of the paddle out of the water when the boat is still. On large, fast yachts, especially when a longer than standard pendulum shaft is used and when the water level at the stern varies greatly, care should be taken in determining the installation level. The gear should be mounted so that the paddle blade is always immersed to some degree, but as little as possible of the pendulum shaft should be immersed at any time.

Ultimately this is a compromise which is best decided by observing the wake of the boat on different points of sail and in different conditions. This could be done, for example, by using a clearly marked yardstick to assess the level of the wake. If this level varies considerably there will be times when the pendulum shaft is immersed to some degree. This is no cause for panic. The MONITOR is built to withstand great loads. However, there is no point in increasing these loads unnecessarily and we have found that the common tendency is to mount the vane gear too low rather than too high.

3.2.4 Nameboards and swim ladders
Some owners let the position of a nameboard or a swim ladder, etc., dictate the mounting level of the vane gear. This is definitely a faulty order of priorities, if you intend to make serious use of the self-steering. The windvane tirelessly performs the work of several crew members. Its importance can only be appreciated by sailing a passage with the gear and without it. The correct positioning of the vane is of much greater importance than that of conveniences and embellishments. Usually the MONITOR attachment tubes can be bent or welded so that nameboards and ladders are not disturbed, with the vane gear correctly mounted.

3.2.5 Cruising waterline.
During the entire positioning of the vane gear you should keep in mind that the boat may float differently when loaded for cruising. As a rule of thumb the average cruising boat will ride one inch lower for every 1000 pounds of added weight.

3.3 Frame Installation Checklist

Follow the steps outlined below to mount the vane gear on the stern. Mark the box after each step when you have completed it and are ready to go on to the next in order.

(1) Locate the centerline of the boat on the stern and measure 7½″ each way at approximately 36″ above water (cruising load), if standard installation height is all right for the yacht in question. Otherwise use specially determined level. COMPLETED ☐

(2) Insert the large mounting tubes all the way to the bottom of the sockets of the main frame. Put masking tape over the edges of the angle brackets to prevent scarring the hull. COMPLETED ☐

(3) Use two ropes tied to your pulpit and to each side of the frame to support the vane gear at the right level above the water. Center the tubes on the marks made previously, then rotate the tubes until the angle brackets fit flush against the hull. Check inside the hull in the area where the bracket bolts will be through bolted to make sure that there are no problems in doing so. Use bracket hole as template and drill ONE 5/16″ hole and bolt bracket on ONE SIDE to the hull. COMPLETED ☐

(4) Level the gear athwartships, making sure that it is not tilting to one side or the other. Drill one 5/16″ hole and attach bracket on opposite side with one bolt. COMPLETED ☐

(5) With both upper tubes temporarily attached use the ropes to level the gear in a fore-aft direction. When gear is level rotate windvane 360° checking at different settings around the full circle for clearance of the windvane and counterweight relative to backstay and pulpit or other obstacles. Make sure that you flip the vane as far as possible to each side when checking the clearance around the full circle COMPLETED ☐

(6) The objective is to mount the vane as close to the hull as possible for maximum strength, while still maintaining clearance for the windvane, counterweight and pendulum. Between the MONITOR paddle and the edge of the main rudder the distance should be at least 4″. Establish the shortest possible length of the upper mounting tubes which would still give clearance. If clearance is excessive remove the gear and cut tubes accordingly. COMPLETED ☐

(7) Reinsert the mounting tubes after cutting and make a final check for clearance and alignment. If you have cut one tube longer than the other, the vane will mount crooked. When the upper tubes are all the way into the sockets, mark them with masking tape or a marker at the edge of the socket to make sure that they do not slide out without your noticing it. Now, insert the lower tubes into the clamp tubes that attach to the bottom of the "legs" of the frame. Taking the vane frame as a starting point these tubes should be located on the hull so they slope about 10° down from the vane and spread about 10° out from a straight line over to the hull (not less, but more in either case). The lower tubes should be inserted into the clamp tubes as far as possible. COMPLETED ☐

(8) With the gear level fore and aft, check where the lower tubes should attach to the hull, measure length and cut the tubes if necessary. Before you cut, check inside again to confirm that there are no obstacles to through bolting in the area where the lower brackets will be attached. COMPLETED ☐

(9) Fasten clamp tubes to bottom of frame legs, insert the lower tubes and rotate until angle brackets are flat against the hull. COMPLETED ☐

(10) Locate one hole in one bracket. Drill 5/16″ hole through the stern using bracket as template. Insert bolt and fasten. Drill hole in same place on opposite side of hull for the bracket of the second tube. Fasten with one bolt. COMPLETED ☐

(11) Check again that gear is level in all directions. Drill all remaining holes. Insert a bolt into each hole after it has been drilled to keep alignment of brackets while drilling remaining holes. COMPLETED ☐

(12) Remove all bolts from the upper brackets. Loosen the ropes that hold the vane gear and make it slide back so that you can get to the underside of the brackets. The vane gear is now hanging on the ropes and the lower tubes. Remove the masking tape and apply suitable bedding compound to the underside of the brackets. Reattach the upper mountings with all bracket bolts. COMPLETED ☐

(13) Tighten up on the ropes and then unbolt the lower brackets. Tighten further on the ropes to bring the lower brackets clear of the hull. Remove masking tape, apply bedding compound and reattach with all bracket bolts. COMPLETED ☐

(14) Check leveling again. With lower tube clamps loose, fine adjustments can be made. Also the upper tubes can be moved slightly in their sockets. Tighten all bolts. COMPLETED ☐

(15) After final leveling, locate the center punch marks on top of and ¾″ from the edge of the main frame sockets. Use marks to start the drill and drill a 5/16″ hole on each side through both the socket and the upper mounting tube inserted into it. Drilling through stainless is not easy. You should use the slowest possible speed. Do not use dull bits. Buy one new 3/16″ and one new 5/16″ bit. Use a little oil to improve cutting. Dull bits will not cut but will workharden the stainless, making it extremely tough to get through. Take care not to upset the leveling by leaning too hard on the frame when drilling. COMPLETED ☐

(16) Loosen the ropes again and make the vane frame slide back to bring the upper tubes out of their sockets. COMPLETED ☐

(17) Insert the two short ½″ OD × 5/16″ ID spacer tubes into upper large mounting tubes and align spacers with 5/16″ holes. Roll some stiff paper and insert through upper tubes and spacer to keep the spacer aligned when the tubes are reinserted into the frame sockets. Use a sharp knife to cut the paper roll flush with the surface of the mounting tube. COMPLETED ☐

(18) When the frame is in position insert 5/16″ bolts through sockets, tubes and spacers and tighten bolts with lockwasher and nut on the underside of frame. The spacer will prevent the tubes from collapsing when bolts are tightened. COMPLETED ☐

(19) Make final check of alignment and tightness of all bolts. COMPLETED ☐

3.4 Non-standard Frame Attachments

The procedure described in the checklist applies to standard installations. Boomkins, outboard rudders and other structures at the stern may necessitate special arrangements. We try to deliver mounting tubes and modifications to the extent possible, but details of the deck and stern layout may necessitate further work before the vane can be attached.

If necessary, tangs can be welded to the vane frame for attachment of additional tubes or to attach the tubes in a different place. When such welding is required it should be done by the TIG or Heliarc welding process rather than by straight arc welding. The stainless used in the MONITOR is of the 303 and 304 series and the same metal and rods (308 rod) should be used in the welding.

Additional tubing should also be compatible. If additional bending is necessary this can usually be made cheapest by a local muffler shop (Midas or Magic), which should have the necessary tools and experience. Use 1⅞" bending dies. Bends greater than about 30° should not be attemped since they will crimp the tubes too much. If greater angles are needed the tubes should be cut and rewelded to the desired angle.

3.5 Installing the Pendulum Sheet Lines

3.5.1 General hints—pendulum lines

Each boat has its own individual characteristics which affect the proper installation of the pendulum lines. It is not possible to treat in detail each of the thousand ways and more in which the pendulum lines can be connected to the boats steering. Instead, we will concentrate on GENERAL GUIDELINES.

Having pendulum lines leading into the cockpit is the most common objection to the servo-pendulum type of windvane steering. Many installations serve to scare the uninitiated with a virtual web of blocks and ropes.

The fact is that some planning and extra care can yield sheet leads that are efficient, hardly noticeable and which require a minimum of service. This is especially true with wheel steering, when the lines can often be led inside the hull through lazarette, lockers or coamings, before coming onto the wheel.

Aside from neatness and unobtrusiveness, your main objective in installing the pendulum sheets should be to achieve MINIMUM FRICTION, CHAFE and SLACK.

All three aspects are negatively affected by leads that include many turns and blocks. The STRAIGHTEST LEAD IS THE BEST.

FIXED BLOCKS GIVE LESS SLACK and should be preferred, but great care has to be taken in mounting the blocks, so that the leads are fair and chafe is avoided.

The blocks on either side of the tiller should be mounted loose to allow them to move, to compensate for different angles of the pendulum lines, as the tiller is moved from side to side.

Excessive slack wastes the corrections of the windvane. However, THE PENDULUM LINES SHOULD NOT BE OVERTIGHTENED. Overtightening makes the blocks unwilling to turn and will affect light air performance negatively.

Very long sheet leads are sometimes necessary with center cockpits. Using WIRE instead of rope is a possibility, which may be superior in a large center cockpit yacht. However, it is recommended to use wire for the long lead from the stern to the cockpit, but not on the vane gear or at the 90° turn by the cockpit onto the wheel. Wire is excellent in the straight lead, but wears and causes high friction when taken through sharp angles.

After thousands of miles the lines, even in the best installations will eventually wear. It is actually an advantage of the pendulum system that most of the strain and wear is absorbed by a relatively cheap and easily replaceable rope.

A good practice, to avoid having to change the entire line, is to LEAVE YOURSELF SOME EXTRA ROPE AT THE ENDS when first making the installation. By slipping the line through the leads and tying a new stopknot at the pendulum you can change the chafe points and get much longer service from the same rope.

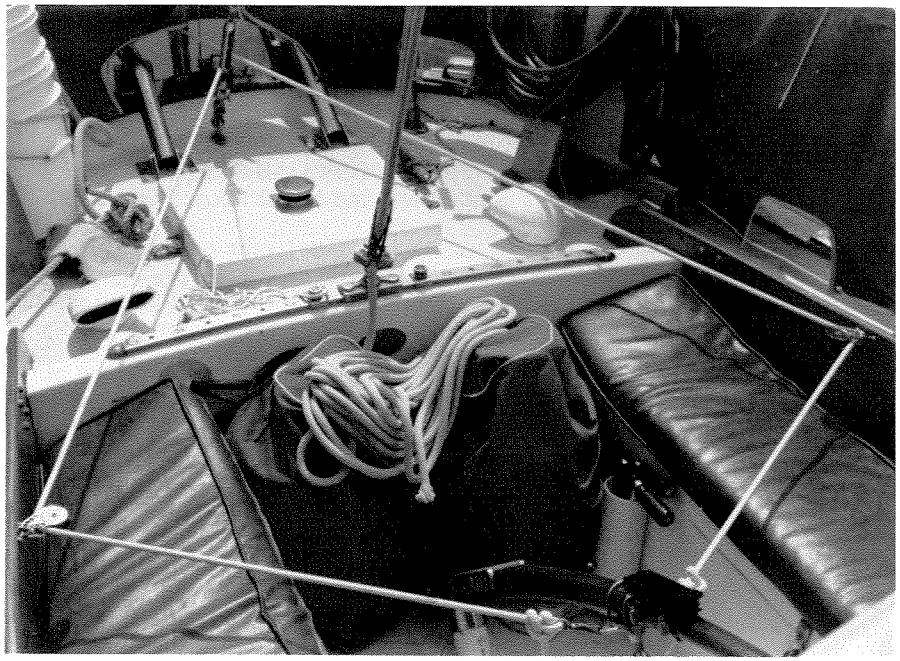
In both tiller and wheel installations it is very useful to MARK THE PENDULUM LINES with tape or a dye marker against a benchmark on the boat SO THAT YOU KNOW WHEN THE PENDULUM IS CENTERED BETWEEN THE FRAME LEGS. If you engage the gear with the pendulum off center it will be unable to give you proper and equal corrections on both sides of the desired course.

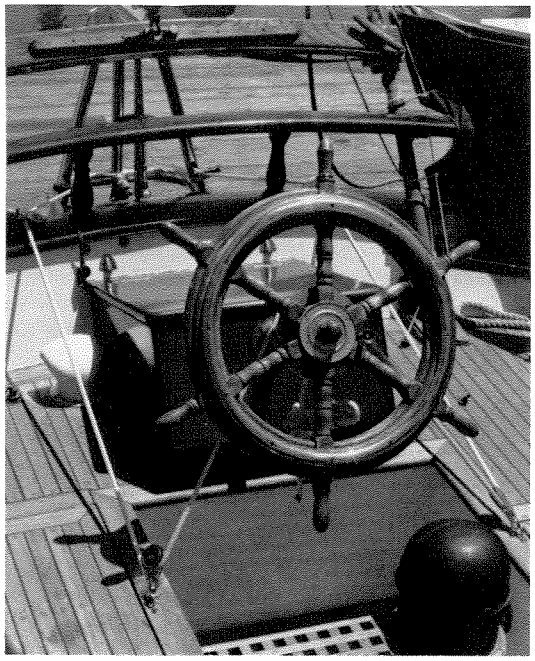
3.5.2 Tiller installation

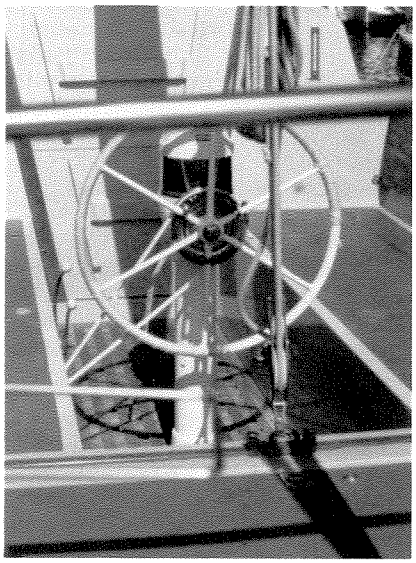
It is possible to lead the pendulum lines to the tiller BACKWARD, in which case the MONITOR will not work at all.

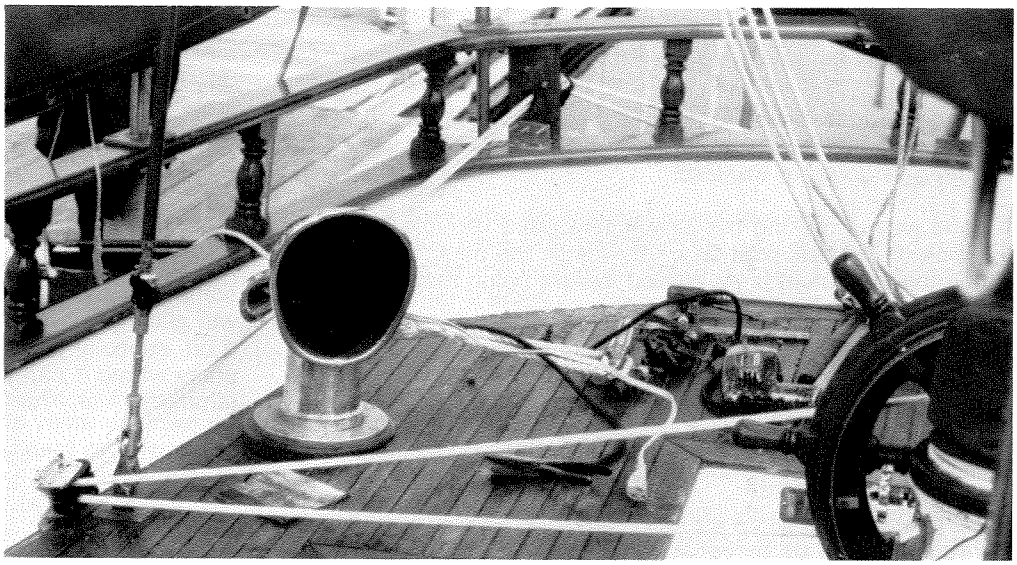
THE PENDULUM LINES MUST BE CROSSED before connecting them to the tiller. This is usually easiest and best done right at the vane frame. The starboard line is led to the port side of the hull and vice versa.

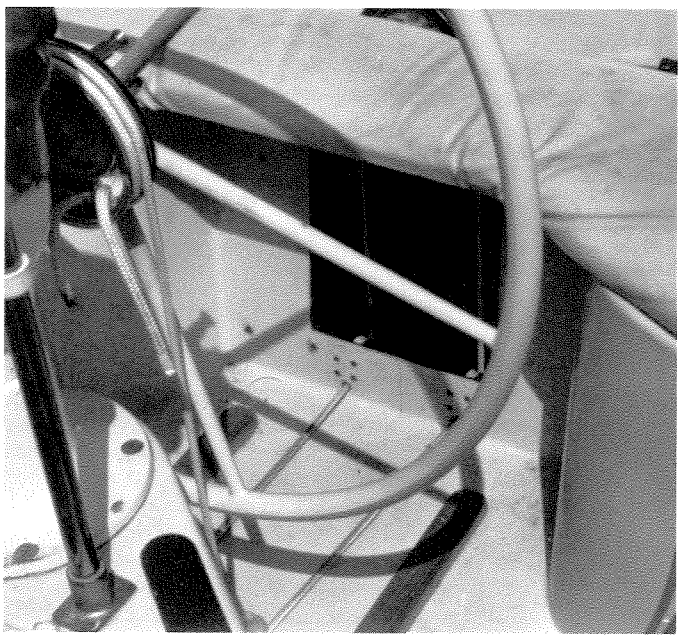
The two blocks on the adjustable plates on the frame are a great help in fairleading the crossing of the pendulum lines smoothly. It depends on the boat's characteristics where the pendulum lines should be connected to the tiller, but 20-30" from the rudder shaft is a working rule of

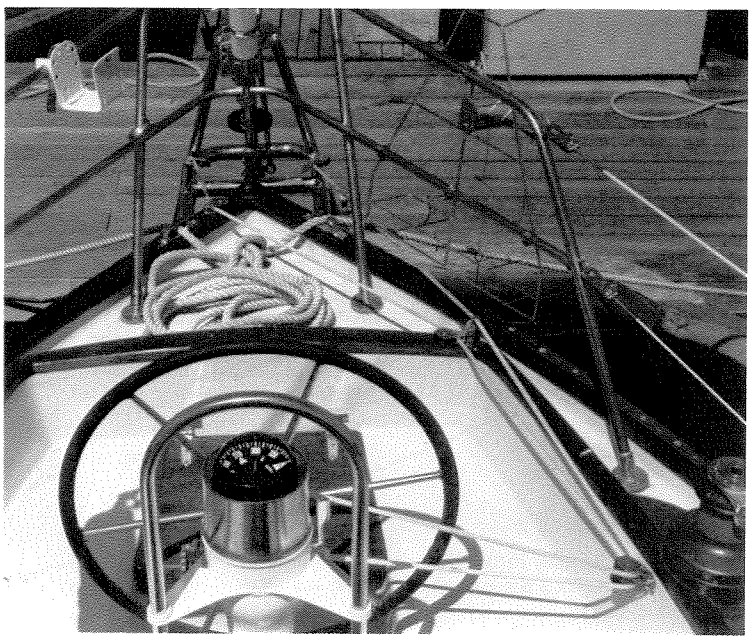












thumb. The blocks that lead the pendulum lines over to the tiller should be mounted aft of the intended attachment point on the tiller so that the radius of the swing of the tiller is approximated by the pendulum lines. This gives the least slack as the tiller moves from side to side.

The pendulum lines are connected to the tiller by means of a plate with a quick release pin with eyes on either side for tying on the lines.

Clamp the two threaded rods supplied to the top side of the tiller. Bend the rods to fit the shape of the tiller and attach the quick release plate with washers and hex nuts.

It is advantageous to mount the quick release fitting as described on the underside of the tiller, if possible. When you detach the pendulum lines they are then underneath the tiller and out of the way.

On some boats it could be of great advantage to be able to vary the attachment point. The further away from the rudder shaft the lines are attached, the less will be the rudder movement caused by a movement of the pendulum. Also the correction will get more leverage the further along the tiller it is applied.

Moving the lines further forward along the tiller can sometimes give better downwind performance, preventing the vane gear from oversteering.

Moving the lines closer to the rudder shaft will give you greater rudder movements and could be desirable when reaching or going to weather.

A good way of making the attachment point variable is to use one or two fairleads on a track(s) on the tiller, through which the pendulum lines are led, before being made fast by, for example, jam cleats.

3.5.3 Wheel installation

The wheel adaptor drum is fastened with the clamps provided to the spokes of the wheel. In case of a pedestal steering the drum mounts between the wheel and the pedestal with the clutch pin facing the helmsman.

If the adaptor cannot be clamped onto the wheel it can always be bolted on by separating the fixed inner part from the moving drum and bolting the fixed part to the wheel, after which the adaptor is reassembled.

The locking pin should be lined up with the rudder center mark on the boat's wheel as nearly as possible.

As with a tiller it is possible to lead the pendulum lines BACKWARDS onto the wheel adaptor, which makes the gear inoperable.

WITH WHEEL STEERING THE LINES SHOULD NOT BE CROSSED, but it is possible to lead both pendulum lines on either the starboard or port side, as well as leading the port line on the port side and the starboard line on the starboard side.

If the lines are led on the starboard side, the starboard sheet should pass over the top of the drum and the port sheet under the drum.

If the lines are led on the port side of the boat, the port sheet should pass over the top of the drum and the starboard sheet under the drum.

If the pendulum sheets are led from both sides, both should pass over the top of the drum.

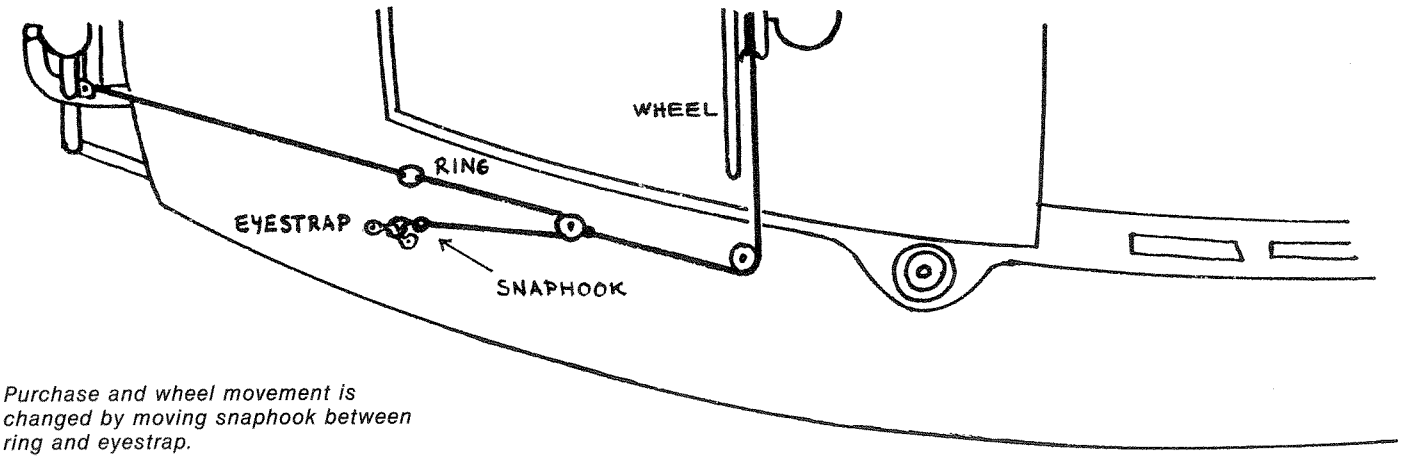
In order to avoid overrides and jamming, sheets should not go more than three-quarters of the circumference of the drum before passing through the holes inside the drum, which will rotate a half turn to port or starboard. When the pendulum is straight down and centered between the frame legs the two holes in the inside face of the drum should be midway between the sheets.

Secure the pendulum sheets by tying them together with a square knot on the inside of the drum. The way to achieve tension on the lines is to tie the knot with the lines off the drum. Tie the lines a bit short. Then peel them back on the drum while moving the drum the way you would get a bicycle chain back on its sprocket.

If possible it is not a bad practice to break the lines at some point in the lead from the vane to the wheel. This will allow easy retensioning of the lines, which will stretch a bit, especially in the beginning. The break should be in a place where it can be moved by the pendulum without jamming in any fairleading blocks.

An additional advantage of breaking the pendulum sheet lines is that they can be easily removed when not in use.

On some boats it may be desirable to have less movement of the wheel than the drum diameter offers. In such cases a purchase arrangement is recommended in the lead from the vane to the wheel. This will provide lesser but stronger movements of the wheel for a given pendulum movement. Such a purchase arrangement can also be set up so that you can shift between a straight lead and the purchase arrangement.



Purchase and wheel movement is changed by moving snaphook between ring and eyestrap.

3.6 Installing the Windvane Control Line

The windvane is controlled by means of a line around the pulley mounted on the vane control shaft. THIS LINE MUST BE INSTALLED AND KEPT UNDER TENSION when you are using the vane gear. Otherwise the windvane may gradually change its setting and take the boat off the desired course.

The pulley can be adjusted to the proper level on the vane control shaft by means of a set screw. The control line can be led practically anywhere on the boat from where you wish to manipulate the windvane for a course adjustment.

In general the line is led so that it can be easily worked from the helsman's position or all the way around the cockpit past the companionway. The latter method makes it possible to control the windvane without going on deck.

To keep tension on the control line when the windvane is used, the line can be left open ended and secured by jam cleats. A better method perhaps is to splice the line into an endless loop. Before the splice is made the line is passed through the necessary fairleads. The last fairlead is put on the line but left unattached to the boat. The line is spliced a bit short and the last fairlead is secured to create the necessary tension to keep the windvane from resetting itself.

If a thin line is used it can be taken one turn around the pulley before returning inboard.

4. SAILING WITH THE MONITOR

4.1 Becoming a Vane Sailor

As stated at the outset of this manual, vane sailing is not a push-button phenomenon. During the years we have supplied this type of equipment we have heard more than once from new vane owners, who think that their gear does not work. After a few friendly hints and some more experimenting the new vane sailor will admit that the vane gear works on some points of sail, but not as well as he had expected. Meeting the same person a year or so later he shakes your hand with great feeling. The vane gear is now fantastic and he has named it "Bob" in token of the closeness between himself and his most appreciated crew.

This part of the MONITOR manual will hopefully make your own introduction a bit speedier. We discuss the problem of balancing the boat for self-steering in depth after giving a standard operating checklist and some hints for your first sail.

4.2 Standard Operating Procedure Checklist

4.2.1 Ready the gear
Mount the windvane and lower the pendulum. Keeping the vane mounted and the pendulum lowered when the gear is not in use is generally not recommended. All this leads to is increased wear and chance of damage.

When mounting the windvane at sea, make sure you are well supported and have a good grip on it. You should not attempt to lower the pendulum and engage the latch when the boat is travelling fast. Slow the yacht as much as possible by rounding up and/or releasing sheets. Otherwise you may cause great twisting loads on the latch mechanism before you manage to latch the pendulum.

4.2.2 Assume the desired heading

4.2.3 Balance the boat for the desired point of sail
Balancing the boat for self-steering is crucial to performance and will be treated at length in the following. In essence this involves choosing a sail combination and trimming the chosen sails to make the boat want to stay on the desired heading. If a wave or a gust takes the boat off course, the sails should work to bring the boat back, aiding the vane gear instead of fighting it.

4.2.4 Trim the windvane and engage the vane gear
With the boat sailing on course, use the remote windvane control to turn the vane's leading edge into the wind. The leading edge is the one nearest the lead counterweight. The leading edge is pointing into the wind when the vane is upright. This is the neutral position indicating that the yacht is on course.

When the vane is tuned, engage the gear by connecting the pendulum sheet lines to the tiller or to the wheel by engaging the wheel adaptor. Before you engage the pendulum, make sure that it is in the center or neutral position. Especially with the wheel adaptor it is useful to mark the pendulum lines against a benchmark on the boat to let you know when the pendulum is in the center, between the "legs" of the frame.

4.2.5 Fine tune for optimum course-holding
After you have engaged the vane gear you should remain at the steering station to check the self-steering performance for a while.

If the vane gear is constantly working to keep the boat from deviating to one side of the course only, things will have to be improved. The same is true if the boat spends very little time on the desired heading and most of it criss-crossing between generous margins on each side.

What you should strive for is to have the boat staying close to the course line. Deviations should be small and on BOTH sides of the course line as well as quickly corrected by the vane gear. This can usually be achieved by fine-trimming, which involves readjusting the sails, compensating with the main rudder and tinkering with the vane gear itself.

Since fine-tuning is an important aspect of ultimate vane performance it will also be treated more in depth in the following. Here, we just want to point out that if there is any remaining imbalance after the gear has been engaged you should always try to work it out by SAIL TRIM FIRST, by adjusting the RUDDER LAST. The objective of balancing should be to have as neutral helm as possible, trying to steer the boat with sails alone. This will insure that the boat keeps on self-steering over a much wider range of conditions than if large imbalances are compensated by letting the vane gear work the boat's rudder around a biased setting.

4.3 Your First Sail with the MONITOR

Especially if you have never sailed with a vane gear before, you should find the following hints helpful during your first trial.

Choose a day with DECENT BREEZE, 10-15 knots or so, if possible. Trying the vane gear out with too much or too little wind is going to complicate your observation of what the vane is doing.

DO NOT OVERCANVAS. If your boat can be sailed decently well on a jib alone you should SET A JIB ONLY, at least for starters. Not having to deal with a lot of sheets, potentially gybing booms and a boat that rushes on with her lee rail under, is going to greatly help you in concentrating on the vane gear and making it work on all points of sail. Also, you will avoid the problem of balancing the boat for self-steering until you are familiar with the workings and operation of the windvane.

START BY SAILING UPWIND, without really pinching. Turn the leading edge of the windvane (the edge at the side of the black counterweight) into the wind to bring the vane upright and engage the pendulum lines on your tiller or wheel.

LET THE BOAT SETTLE DOWN with the self-steering controlling it. Even if the boat is not going exactly where you intended, give it a couple of minutes to assume a steady heading. Go aft and observe the way the windvane moves and how this movement sends the pendulum swinging and the boat's own rudder turning.

MOVE THE WINDVANE SETTING SLIGHTLY WITH THE LEADING EDGE POINTING FURTHER UPWIND and observe how the boat is taken closer to the wind. Once again give the boat and the control system time to settle down. Retrim your sail sheet if necessary.

When you are satisfied that the boat is sailing well on course, change the windvane setting again with the leading edge pointing further downwind than when you started out. Retrim your jib sheet as the vane makes the boat bear off, and let the boat settle down on the new course.

Go through all points of sail in a similar fashion.

Remember always to let the boat and the vane gear settle down after you have made a change. The most common mistake is to change too many things too fast, which prevents you from understanding what is happening and why.

4.4 Balancing for Self-steering

4.4.1 Problem boats and easy ones
Obviously not all boats are the same in terms of the ease with which they can be made to self-steer.

Factors which make a boat easy for the vane gear to handle are moderate size, good course stability, moderate response to rudder, little or no helm on all points of sail, medium displacement, a steering system which turns easily and with little friction, and a sail plan which allows many alternative sail combinations.

Problems are introduced by large size and displacement, binding and friction in the steering system, very light displacement with accompanying fin keels and spade rudders, and a rig which does not allow many options for sail combinations and trim.

This is not to say that such boats cannot be steered by the MONITOR. However, they do require more insight and seamanship from the operator, which is the subject of the following discussion.

4.4.2 Light airs
"Does it work in light winds?"

This is a standard question to anyone involved with windvanes. Obviously, – since the vane gear takes it signals from the wind and its power from the boat's movement through the water, – it has to blow and the boat has to move for the vane gear to work.

How little it can blow and how slow the boat can travel with the gear still functioning also depends a lot on the boat itself, on the skill of the operator and on the point of sail in question.

If the boat is very large it will generally take more force from the vane gear to operate its rudder. The same is true if there is a lot of resistance to free turning in the boat's steering system. The vane gear has much less power in light airs and the key to making it work is to reduce undue binding and friction. Light air performance can be vastly improved by balancing and fine tuning. In general, the gear will do a better job in light airs on a small or moderate size boat, remaining functionable down to about one knot of boat speed with the corresponding wind strength. However, a good sailor, balancing his boat properly, can also make the vane gear steer a large yacht in surprisingly light conditions.

4.4.3 Running
"Does it work downwind?"

This question is as common as the one about light winds.

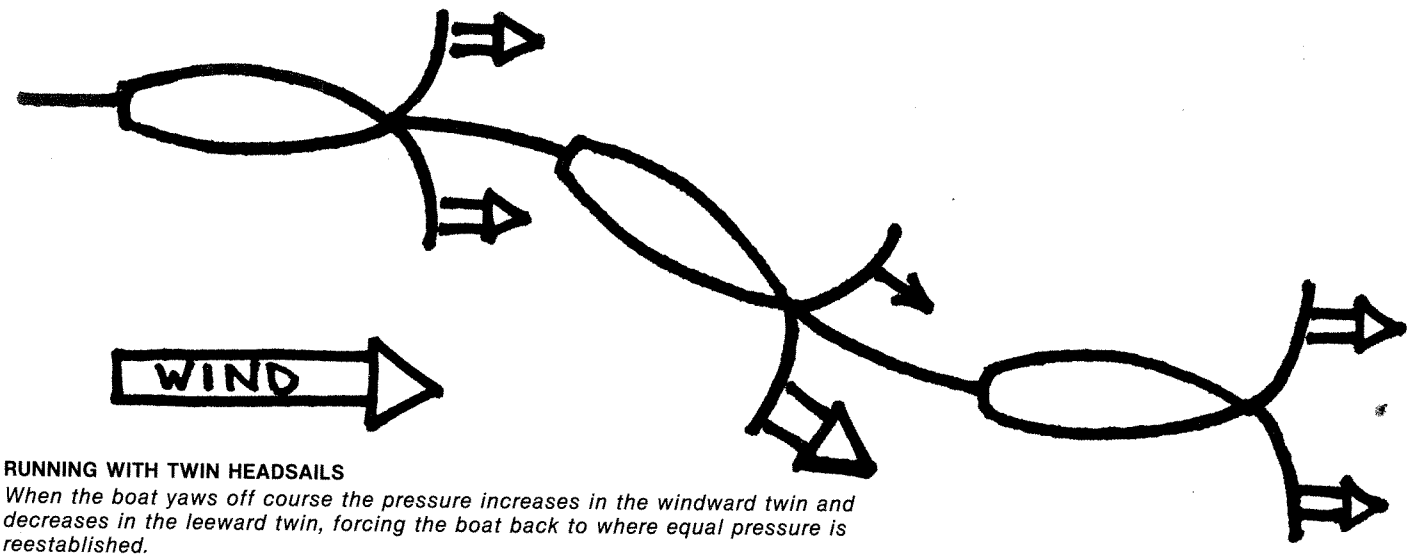
The problem with self-steering when sailing downwind is that you are moving in the same direction as the wind. Consequently, THE WIND VELOCITY AVAILABLE TO THE WINDVANE FOR CORRECT SIGNALS IS DECREASED BY THE SPEED OF THE BOAT.

Whereas the servo-pendulum has ample power from the movement of the boat, the signals from the windvane become weaker, take longer to appear, longer to return to neutral and sometimes become outright erratic or too weak to fight the frictional resistance in the self-steering system. This results in the boat being steered in a serpents course, constantly crossing and recrossing the desired heading. If too much canvas is carried, especially aft of the mast, the vane gear may not be able to prevent the boat from rounding up completely.

It follows that the faster a yacht can run before a given wind, the worse the problem becomes. The extreme case is that of a planing boat, which will run in bursts at the same speed as the wind, giving the windvane no wind at all from which to cue its signals. Such a boat is usually of very light displacement, with fin keel and spade rudder, which further aggravates the problem, since it will respond very quickly and dramatically to any faulty windvane signals caused by lack of adequate wind on the vane.

THE FIRST AND FOREMOST REMEDY TO DOWNWIND PROBLEMS IS TO USE THE RIGHT SAILS AND THE RIGHT AMOUNT OF SAIL.

Before the advent of mechanical vane gears, boats were sailed around the world, self-steering most of the way downwind in the trades by the use of twin headsails on poles. The trick is to sheet the twins a little bit looser than you would for maximum efficiency alone. If the boat



RUNNING WITH TWIN HEADSAILS
When the boat yaws off course the pressure increases in the windward twin and decreases in the leeward twin, forcing the boat back to where equal pressure is reestablished.

wants to round up, the leeward sail starts spilling wind. Instead the pressure from the windward sail gradually increases, acting like a giant finger which gently nudges the boat back on course again, until both sails are drawing equally.

If you are going to do a lot of downwind cruising it could pay off to set the boat up for twin headsails. Combined with the MONITOR this rig gives excellent self-steering, even on problem boats, as well as being efficient and very safe and easy to manage. The only possible disadvantage is that the boat rolls more than when the main is used. The easiest way to rig for twins is to double the headstay, using a triangular stainless or bronze plate at the top and bottom to spread the two stays about 2-3″ apart. This way you can use an existing jib and genoa for twins. When the boat is beating to weather the headsail should be hanked on BOTH of the two headstays to prevent sagging.

IF THE MAIN IS CARRIED THERE SHOULD ALWAYS BE A FORESAIL POLED OUT ON THE OPPOSITE SIDE TO COUNTERACT THE MAIN. Although this set-up could not be used for self-steering by itself, it will be a quite adequate sail combination for self-steering on almost any yacht using the MONITOR. The reason why the main and a poled out jib is not equivalent to the twin jib set-up is twofold. First, because of the boat's shrouds the main cannot be eased as far forward as a jib, which prevents the main from spilling its wind when the boat wanders off course to windward. Instead it will continue to exert increasing pressure for the boat to round up. The other reason is that the pressure from the main is much further

PANACHE, a 40′ ultralight displacement racer, was the fastest monohull in the 1980 single-handed Trans Pacific Race. Using elastic cord limiters as discussed in 4.5.3 the MONITOR was made to steer under spinnaker for hours on end, even with the boat surfing.

aft than that from a jib, always tending to point the bow upwind whenever the main is drawing.

If you have to reduce sail, the main is what should come down, leaving the poled-out jib hoisted. Although the pressure from a single jib is on one side of the yacht only, it is concentrated at the bow, which provides much better balance and lets the vane gear handle the boat with relative ease.

Let us assume instead that only the main is carried. If the wind is fresh, steering will be like walking a tight rope. A very attentive helmsman may be able to keep the boat on course by instantly countering every move away from the course line. The choice of sail makes the boat increasingly imbalanced as it deviates from the desired heading. Once off course, the boat also gets out of hand. Even full rudder will not keep it from rounding up or gybing once the process has begun. The pressure from the wind is concentrated behind the mast, making the boat want to point into the wind as soon as it gets a little bit off its precarious equilibrium of sailing more or less dead downwind.

The situation can be likened to moving a cart by pushing it from behind with a stick (mainsail only) versus pulling it from ahead with a string (jib or twin jibs). It is practically impossible to keep the cart going where you want it with the stick, especially if any kind of speed is involved. As we all know, a cart will follow nicely when we pull it from ahead.

The spinnaker is set ahead of the mast and gives good balance, — as long as nothing goes wrong. The trouble is that a lot of things can go wrong. Problem number one is the tremendous power of the spinnaker, which makes the boat move faster downwind and consequently worsens the problem of the weakness in the vane's signals. Since the sail is not hanked onto any controlling stay or track it will continue to exert pressure long after a poled-out foresail would spill its wind. Because of the size of the sail this pressure can be enormous and completely overpower the boat's rudder, as anyone knows who has experienced his first spinnaker broach. Therefore, the spinnaker should be used with caution in combination with a mechanical vane gear.

To sum up the discussion: SAILS AT THE BOW GIVE THE BEST BALANCE AND SELF-STEERING DOWNWIND. PREFERABLY THESE SHOULD BE POLED OUT ON EACH SIDE OF THE HULL. IF THE MAIN IS USED IT SHOULD ALWAYS BE COUNTERBALANCED BY A POLED-OUT FORESAIL ON THE OPPOSITE SIDE. OVERCANVASSING SHOULD BE AVOIDED, ESPECIALLY USING A SPINNAKER IN HARD WEATHER WHEN IT CAN EASILY LEAD TO BROACHING.

4.4.4 Reaching

Seldom or never do we get asked whether the MONITOR works well on a reach. The fact is that reaching can be harder for the vane gear than other points of sail. Whereas a boat can be made to steer downwind as well as upwind by itself, achieving this can be a nearly impossible task on a reach in gusty weather. With a one-masted rig there are few options available for using sails well fore and aft to create pressures, which make the boat return to the desired heading, after it has swung off course.

With a two-masted rig, especially when the boat has a bowsprit, the mizzen and the jib can be worked to bring the boat back on course when it bears off or starts going to weather. Even so, this is tricky to do and the margins within which the yacht travels could be wide.

CONSEQUENTLY, THE VANE GEAR IS MOST NEEDED WHEN REACHING. However, faulty sail trim can overpower the gear and it is necessary to understand how to create the best possible balance. The greatest problem seems to be to keep the yacht from rounding up when the wind increases in strength.

Twin headsails or main and a poled-out jib can be carried to about 35-40° away from straight downwind and will provide the best self-steering as long as they can be kept. After that the windward pole must come down.

Again, using the main alone is not the way to go. Although you can try to compensate for the resulting great weather helm with the rudder before you engage the vane gear, any increase or decrease in wind strength is likely to change the balance so much that the limited correction the vane gear is capable of is not enough to hold the boat on course. Again, you must strive to balance the boat with the sails first and never use the rudder for compensating a great lack of balance. The rudder should be used for fine tuning after the boat has been set up to sail on course as much by itself as possible.

If only one sail is used, a headsail should be the choice. However, the effect of a headsail on a reach is not necessarily to push the bow downwind, — unless it is hoisted very far out on a long bowsprit.

When the wind increases, a lot of boats will experience increased weather helm, even with only the headsail set. However, this weather helm is very mild compared to what the mainsail would induce under similar circumstances and the vane gear can easily hold the boat on course.

When both main and headsail are used, both sails may work to bring the bow to weather. To limit weather helm and great increases in weather helm in a gust, both sails, — but especially the main, — should be SHEETED CONSIDERABLY LOOSER than you would do in a racing situation. This will slow the boat so little that it will not even be noticeable. The effect is to make the sails spill their wind at a much earlier point, when the boat wants to round up. The weather helm decreases and the vane gear is capable of pulling the yacht back on course.

If you continue to have problems the remedy is to reduce sail area, chiefly the main, and continue to release more sheet, even though the leeches may flutter a bit.

If the boat allows it, you can use a small staysail jib to aid in pulling the bow down when the yacht starts to round up. This jib should be backed (sheeted to windward). When the bow moves to windward the other sails start spilling their wind, whereas the pressure on the backed jib increases, aiding the vane by pushing the bow back on course.

If the boat has a bowsprit, a small jib sheeted flat or even backed to weather is a very powerful means of balancing the boat and counteracting weather helm.

When the wind drops considerably the boat wants to bear off downwind, especially if a lot of weather helm has been compensated for on the main rudder. This is one of the chief reasons why the rudder should not be a primary fac-

tor in balancing the boat. In this case carrying the main is actually of help. As the boat veers off, the main will cover the headsail(s) and catch all the wind, moving the pressure behind the mast and making the boat want to round up again.

THE CLUES TO SUCCESSFUL SELF-STEERING ON A REACH ARE TO AVOID EXCESSIVE CANVAS, TO RELY MORE ON THE HEADSAILS FOR POWER, TO SHEET THE SAILS LOOSELY AND AVOID USING THE MAIN RUDDER RATHER THAN SAIL TRIM FOR BALANCING THE YACHT.

4.4.5 Hard to weather

Most yachts can easily be made to self-steer when hard on the wind, without using the vane gear, Consequently, the vane will have little problem in keeping the yacht on course. As the movement is towards the wind, the velocity of the wind working the windvane sensor increases by the speed of the boat. The vane's signals will be true and strong.

THE BEST PERFORMANCE WILL BE GUARANTEED BY NOT KEEPING TOO MUCH SAIL AREA AND BY NOT SHEETING THE SAILS TOO HARD. Overcanvassing and oversheeting will only heel the boat unnecessarily and will induce great weather helm, which may become impossible for the vane to control in a gust, in which case the boat will round up into the eye of the wind.

4.4.6 Give it a chance

Armed with these hints on balancing the boat on different points of sail you should have no difficulty in making the vane gear steer your boat. After you have used it for a while it will steer even better and you will have learned a thing or two about sailing and balancing your boat that you did not know before. Just give everything a chance to work out and remember that bit of learning is necessary to get the most from your vane. The pain will be a lot less than the gain.

4.5 Fine Tuning Hints

After you have set the boat up with the vane gear steering you should remain in the cockpit for a couple of minutes, observing the behavior of the yacht.

Ideally, as stated earlier, the boat should stay on the desired heading, deviations should be small and quickly corrected, and the vane gear should not be fighting to keep the boat from wandering off on one side of the course line only.

If the boat has a persistent tendency to luff or bear off it is not properly balanced. Sails have to be sheeted in or out, reduced or changed completely. A small adjustment of the boat's rudder may help, but again, large imbalances should not be compensated on the rudder.

USUALLY, RELEASING THE MAINSHEET A BIT WORKS WONDERS IN TAMING TENDENCIES TO ROUND UP.

4.5.1 The downwind problem

Sailing downwind in light airs, especially on a fast, quick reacting fin-keeler, you may experience a tendency for the gear to let the boat wander too far off course before it reacts. Once the windvane has given its signal sending the boat back towards course, the same tardy reaction makes the yacht cross to the other side of the course line and results in a repeated serpentine movement around the desired direction.

The reason, again, is that the windvane has very little wind to take its cue from. Normally, when it is blowing strongly on the windvane, this will keep the vane upright, as long as the leading edge if facing into the wind.

As the wind becomes very weak downwind, the vane becomes increasingly affected by other factors. When the boat rolls from side to side, the vane, without strong apparent wind to control it, remains upright with the boat rolling about it, producing faulty signals to the watervane pendulum. In effect the windvane is gimballed, remaining vertical when the boat rolls.

The pendulum gets rotated by the faulty signal and sent to one side or the other, producing in turn a faulty movement of the ship's rudder. Normally, the apparent wind would force the vane upright and inhibit the undesired movement of the boat's rudder. However, when the yacht is moving fast downwind, with little apparent wind on the windvane, the watervane can remain in its swung out position. Pressure from the wake on the pendulum and inertia keep it in the faulty position until the boat has gone considerably off course and the windvane gets a correct cue from the strengthening apparent wind.

Once you understand the cause of this problem several cures become apparent.

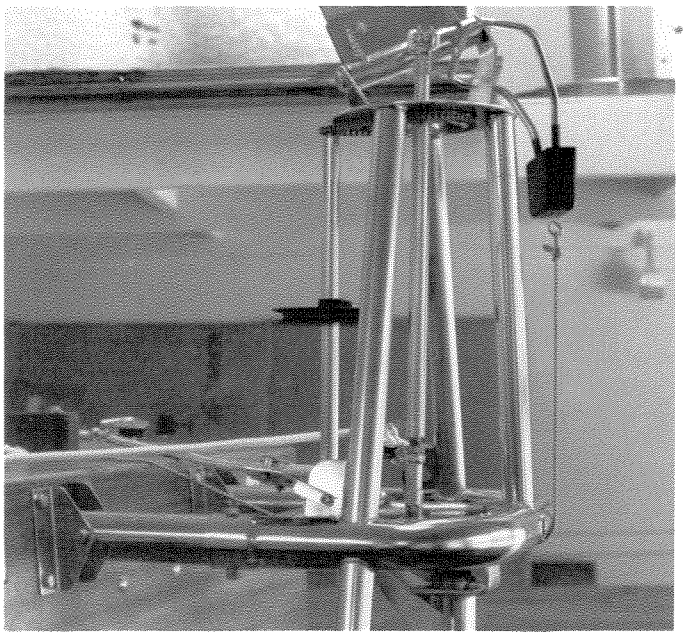
4.5.2 Improving the windvane

Downwind and light air performance would definitely benefit from a special windvane. As such a vane would be too fragile for all around service, it would have to be specially made by the individual owner. Any vane that has HIGHER ASPECT, LARGER SURFACE AREA, LESS WEIGHT and BETTER AERODYNAMIC SHAPE than the standard MONITOR windvane will improve performance through greater power and accuracy.

Such a vane could be built, for example, using foam or using the same technique involved in building a model airplane wing.

4.5.3 Preventing faulty signals

One way, which has produced very good results, even on ultralight displacement boats running with a spinnaker, is to use an elastic cord to bring the vane upright any time the apparent wind is not strong enough to produce true signals.



The way to do this is to tie a shock cord from the counterweight to the vane frame. THIS CORD WILL HAVE THE EFFECT OF KEEPING THE VANE UPRIGHT WHEN THE BOAT'S MOTION MIGHT OTHERWISE PRODUCE FAULTY SIGNALS. IT WILL ALSO RETURN THE VANE TO THE NEUTRAL, UPRIGHT POSITION WHEN WATER PRESSURE AND INERTIA MIGHT OTHERWISE KEEP THE WINDVANE AND THE PENDULUM TOO LONG IN AN ADJUSTING MODE.

The elastic cord will also have the tendency to make it harder for a true signal to be given by the windvane. However, this seems to be a smaller problem than that of dealing with the effects of faulty signals.

Proper cord and proper tension have to be decided by experimentation on each individual boat and may vary for different conditions.

4.5.4 Preventing faulty ruddder movements

Limiting the movement of the windvane with a fixed string or even with a shockcord as described above has the effect of limiting the rotation of the pendulum. Consequently the pendulum will swing less to either side of the center and will produce smaller rudder movements. The end result may be that the boat gets steered straighter downwind.

Another way to prevent oversteering may be to voluntarily allow some slack in the pendulum lines. Rudder movement can also be decreased by moving the pendulum lines further away from the shaft on a tiller steered boat or by introducing a purchase system in the pendulum line leads on a wheel steered boat.

5. MAINTENANCE AND PROBLEM SOLVING

5.1 Appearance

The MONITOR is made of AISI 303 and 304 stainless steel. After fabrication the individual stainless parts are electropolished in a chemical bath to remove impurities from the surface and welds of the metal. The last step is the assembly of the individual parts to make a finished vane gear.

Stainless steel is a very hard metal alloy, with a much harder surface than regular steel. Any time that stainless is handled with regular tools the stainless picks up surface contamination from the softer material in these tools. After some use in salt water this contamination bleeds out as a light surface rust on the vane gear.

In spite of the electropolish this contamination is nearly impossible to avoid in a highly fabricated gear such as the MONITOR. However, you should be aware than some surface bleeding on the MONITOR is not a sign of inferior stainless or dangerous corrosion. Furthermore, after each cleaning, less and less of the brown surface bleeding will reappear and it will eventually be gone altogether.

Consequently, we recommend using a stainless cleaner on the gear whenever it seems to need it, especially during the first year of use. Your favorite brand will do the job. For a really fast and easy job you can brush on a strong rust remover, such as Naval Jelly, which is rinsed off with water after a couple of minutes. Just be careful not to get any strong chemicals on the plastic sheaves and other plastic components of the MONITOR. NEVER USE STEEL WOOL to clean the MONITOR.

5.2 Regular Maintenance

The pendulum sheet lines are the hardest working part of the MONITOR vane gear. Inspect your lines frequently and readjust leads for minimum wear if there is a problem. You can keep a set of pendulum lines much longer by changing the chafe points frequently rather than waiting until the lines are nearly gone.

The MONITOR's stainless construction and the materials of its bearings and bushings make greasing unnecessary. You should actually AVOID PUTTING GREASE INTO BEARINGS, as most greases will emulsify or form a hard paste after working together with any quantity of salt water.

The MONITOR bearings and bushings are made from materials that work better with water on them. Maintenance consists of hosing the gear with fresh water when you have the opportunity. Take care to flush all places with bearings to clean out salt deposits.

5.3 Preventing Problems and Damage

5.3.1 Collision—Removing the servo-paddle

As the vane gear is mounted outboard of the hull it is vulnerable to collision. Unfortunately, vanes sometimes get damaged by being run into by other, less than expert skippers. This can happen in a marina as well as in an anchorage. Even a bump may do a lot of damage when it is being executed by a yacht weighing several tons.

Always be aware of the danger to your vane gear from collision. If possible berth your boat stern in. Be ready to fend off in crowded situations. Consider leaving the pendulum in the "down" position when you may get run into or drifted into. The frame is very strong and can take a lot more impact than the pendulum. Always plan your own maneuvers with the vane gear in mind.

If you are not using the vane gear for a long period of time, or if there is a serious possibility that the pendulum may get damaged, you should take the paddle itself off the gear. This is very easily done by taking out the latch hinge pin (76) and removing the paddle.

5.3.2 Friction and binding

Friction, especially friction and binding that interferes with the windvane's ability to rotate the servo-pendulum, is a deadly enemy of light air performance. Friction and binding may result from salt build-up in the vane's bearings. However, this problem usually disappears after some water has flushed through after a bit of use.

Friction and binding may also be the result of collision. Really hard impact on the pendulum can distort the bottom part of the master gearset, making it bind. Similar problems can be created in any or several other moving parts of the vane gear.

In some boats the yacht's own steering is the culprit. The vane gear is very powerful in a hard blow, when the boat is moving fast, but in light airs performance drops dramatically if the boat's own steering has a lot of friction. Everything possible should be done to free the movement of the boat's own rudder, whether tiller or wheel steered.

If the vane gear seems to have problems in controlling the

course, assuming that the boat has been properly balanced, friction and binding are the first reasons to suspect. All moving parts should be checked, from the windvane through pushrod, gearset and pendulum, all the way to the boat's own rudder.

5.3.3 Remove the windvane
Certain small measures will help greatly in keeping your vane gear in good working order.

When you have finished a sail with the MONITOR, remove the windvane from the fitting that holds it in place on top of the vane gear. Leaving it on is probably not going to hurt either the windvane or the bearings and fittings that hold it. These parts are as strong as the rest of the gear. However, it is not doing much good to have the windvane banging from endstop to endstop for days and weeks on end and eventually there will be some wear as well as aging of the windvane from exposure, if it is never dismounted. It is a much better idea to store the windvane inside the boat whenever it is not being used.

If you make a practice of removing the vane at sea it is a good idea to secure it with a lanyard, which would also prevent loss of the windvane should it work itself loose when in use.

5.3.4 Safety line on pendulum
The MONITOR pendulum is stronger than that of any other servo-pendulum vane gear. Riding behind the hull, protected by the boat's own keel and rudder from forward impact and by its own ability to swing from sideways impact, chances are very small that the pendulum will get damaged.

However, if the pendulum should sustain a very hard blow it has been provided with a safety break tube in its middle. This tube is weaker than the rest of the pendulum and will buckle or break before more serious damage is caused by impact.

You are strongly advised to secure the bottom part of the pendulum, below the safety tube, with a line so that you do not lose any part on collision. Such a line is also useful in pulling the pendulum out of the water to store it in the unlatched "up" position. The securing line is best tied on just under the lower bolt for the safety tube connection.

5.3.5 Hard weather
Hard winds and fast speeds make the MONITOR very powerful. People have reported using the gear in extreme storm conditions. The time when you would have to take over would be when the boat is threatened by dangerous waves. The windvane cannot see a freak wave and in very big seas there can actually be a lack of wind in the trough between two waves, which interferes with the steering ability of the vane gear.

In really bad weather the vane gear itself is actually better protected as long as it is engaged. The strain of big waves hitting the pendulum is taken by the pendulum lines and the resistance from the boat's own rudder will act as a shock absorber through these lines.

Under extreme storm conditions, whether you are trying to heave-to or forced to run before the wind, it is questionable if you should unlatch the pendulum and store it in the "up" position. The latch part of the gear is definitely weaker in the unlatched condition, especially when the paddle is floating behind the gear, before it has been secured in the "up" position.

Heaving-to you are probably protecting the pendulum better by leaving it down as long as you CLEAT THE PENDULUM LINES OFF TO CENTER THE PENDULUM and prevent it from banging into the frame legs with great force. If you choose to get the paddle out of the water you should still definitely secure it in the middle by cleating the pendulum lines.

When you are forced to run before the wind and hand steer it is also true that the pendulum shaft forms a stronger unit when the pendulum is "down" and latched, if you expect to take seas over the vane gear. Again the pendulum should be centered and the pendulum lines cleated to let the ropes take the major strain.

5.4 TROUBLE SHOOTING GUIDE

PROBLEM	CAUSE	REMEDY
Boat cannot be kept on course at all on any point of sail.	Pendulum lines have been reversed on tiller or wheel.	Check installation of pendulum lines.
	The gear has been severely damaged.	Check that all working parts are free and working properly. Check for breakage in pendulum lines or any other part of the gear.
	The windvane is oriented with leading edge away from wind instead of facing it.	Check windvane setting and reset it if 180° wrong.
Boat is steered on an excessive zigzag course around the desired heading.	Too much sail; faulty sail trim.	Reduce sail and retrim for balance.
	Too much slack in pendulum lines.	Take up slack in pendulum lines.
	Too much friction in working parts of vane gear, pendulum sheet leads or yacht's own steering.	Check for undue friction and binding all the way from windvane to boat's rudder and cure it.
	Too much movement of yacht's rudder.	Move tiller lines farther away from shaft or change purchase ratio with wheel adaptor. Reduce windvane movement with shockcord.
	Windvane is top heavy (paint or moisture absorption).	Check that windvane is not top heavy. Balance with extra lead or shockcord or change vane if necessary.
Persistent deviations to one side only or vane gear unable to control boat on one side of course line.	Too much sail; faulty sail trim.	Reduce sail; retrim for balance.
	Vane pushrod is too long or too short, biasing the angle of the watervane.	Readjust pushrod length and secure with locknut.
	Vane gear has been engaged with the pendulum off-center.	Center pendulum before engaging.
	Too much slack in one pendulum line.	Take up undue slack in pendulum line.
	One pendulum line broken.	Replace line if broken.
	One sided friction or blockage anywhere in working parts from windvane to boat's own rudder.	Check for friction and blockage anywhere from windvane to ship's rudder.
	Watervane has been hit and turned at an angle on pendulum shaft.	Readjust watervane alignment on pendulum shaft if necessary.

6. MAKING REPAIRS

The sea punishes everything on a boat. The windvane is possibly the hardest working equipment of all on a cruising sailboat. Unfortunately, it cannot be engineered with mammoth dimensions, as this would interfere with its ability to steer in anything but a hurricane.

The stainless construction of the MONITOR combines great strength with the necessary lightness to make the gear efficient in all conditions. Stainless steel can be easily welded and worked. Regular handtools are most often all that is needed to make repairs and the corrosion resistant material makes it possible to take the gear apart and reassemble it, even after long use.

Hopefully you will never have to make repairs to your MONITOR but, if you do, the following instructions will enable you to handle even the more complex repairs and replacements.

If there is any chance to do so at all, you should perform more involved surgery on the gear with the vane dismounted from the hull. If you are not used to taking the vane gear apart it is very easy to lose bearings and other parts in the water.

The quickest way to unbolt the gear is to unscrew the bolts that hold the clamp tubes to the frame legs and take out the two bolts that hold the upper tubes between the angle brackets. However, you should remember that there is a compression sleeve around the bolts inside each mounting tube. When you pull the bolt the sleeve is loose and may fall in the water, unless you take care to collect it before it does. Always keep a rope on the gear when you are mounting or unmounting it from the hull.

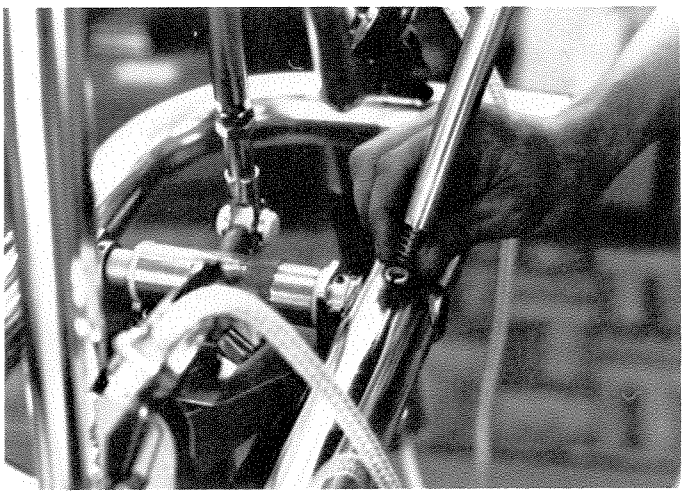
When you are working with stainless you should be aware of some of its unique properties. Stainless work hardens very fast. If you bend a piece back and forth a couple of times it rapidly becomes very hard and brittle where it is being worked. Consequently you should avoid working any part excessively.

Stainless has very high frictional properties. When you run a drill bit on stainless and the bit is not cutting, the intense frictional heat hardens the stainless to the point where practically nothing will cut any more. Consequently you should always run your bit as slowly as possible to avoid overheating the material. Use oil to cool and aid in the cutting action. Immediately stop drilling if the bit is not cutting and change to a new bit. If you need to drill a large hole, start by drilling a smaller hole first.

When stainless is worked with stainless the friction is very high. This is the case, for example, when a bolt is being forced into threads where it does not quite fit. Never continue bolting in such cases as the bolt is very likely to cold weld in the threads, making it impossible to remove.

6.1 Repairing the Windvane Pivoting Assembly

6.1.1 Unmounting the windvane control assembly
To repair the windvane pivoting assembly you should take the disc base (11) off the gear. In order to do this you first have to take off the vane control shaft (20). This is done by unbolting the plate (16) that holds the upper end of the shaft. Keep downwards pressure on the shaft (20) as it is very easy to lose the spring (25) and washer (23) at the bottom of the shaft if the shaft accidentally gets out of

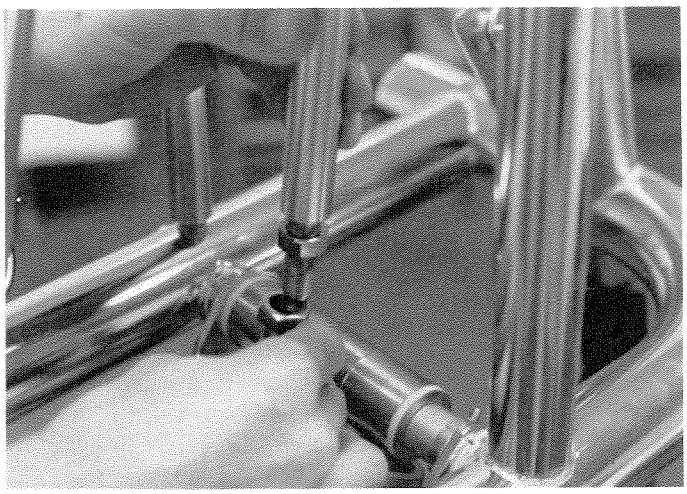


the nylon bushing (15) in the frame. Unless you are extremely careful, it is also very easy to lose small parts at the upper end of the shaft.

The chain (18) cannot be lost as it is captive around the pushrod (57).

6.1.2 Disconnecting the pushrod
After you have dismounted the vane control shaft (20) you have to disassemble the pushrod (57). This is done by loosening the locknut (56) and rotating the shaft (57) until the lower fork (80) is unscrewed from the shaft. While unscrewing the fork you have to hold on to the chain (18) in order not to lose it.

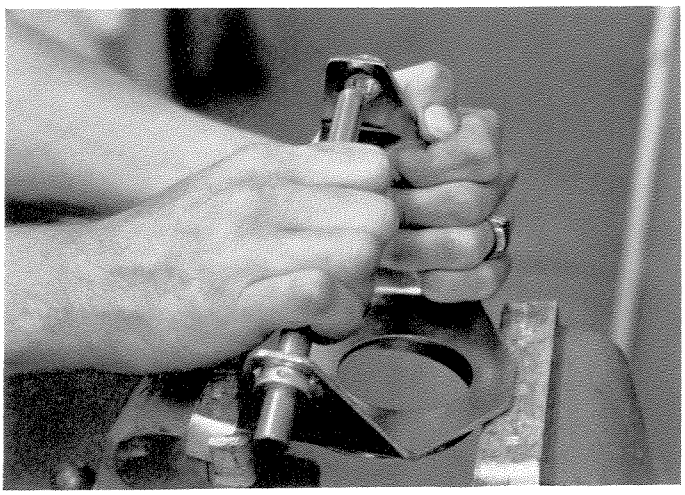
When the control shaft (20) and pushrod (57) have been disconnected you can unscrew the screws (59 & 60) that hold the windvane base disc (11), allowing you to remove the windvane pivoting assembly from the vane gear.



6.1.3 Correct spacing of the windvane yoke
To reassemble the windvane pivoting assembly after damage you may have to start by adjusting the spacing of the yoke (8). Some series of MONITORS have only one hole in the aft end of the shaft (6) for the setscrew (7). In these cases it is very important that you do not insert the windvane rotating tube (5) between the ends of the yoke so that the bearings (2, 3 & 4) are pinched. The minimum inside distance between the ends of the yoke should be about 6¼". However, if the rotating tube (5) is too loose in the yoke the delrin balls (3) may escape from the bearings.

If your windvane shaft (6) has seating holes for the set screws (7) in both ends you do not have to worry too much about the spacing of the yoke as this is automatically controlled by the set screws. As a matter of fact, if your shaft (6) has only one seating hole it is a good idea for you to mark it at the blank end, after you have assembled everything in working order. Then take the shaft (6) out again and make a seating hole for the second set screw also.

6.1.4 Realigning the windvane yoke
To realign the yoke (8) you use the ½" stainless shaft (6). Pass it through one end of the yoke and see if it lines up with the hole in the other end. If not, use the shaft to bend the yoke end until it lines up. Then pass the shaft through the opposite end and repeat the procedure. Keep adjusting the ends until the shaft passes freely through the yoke.

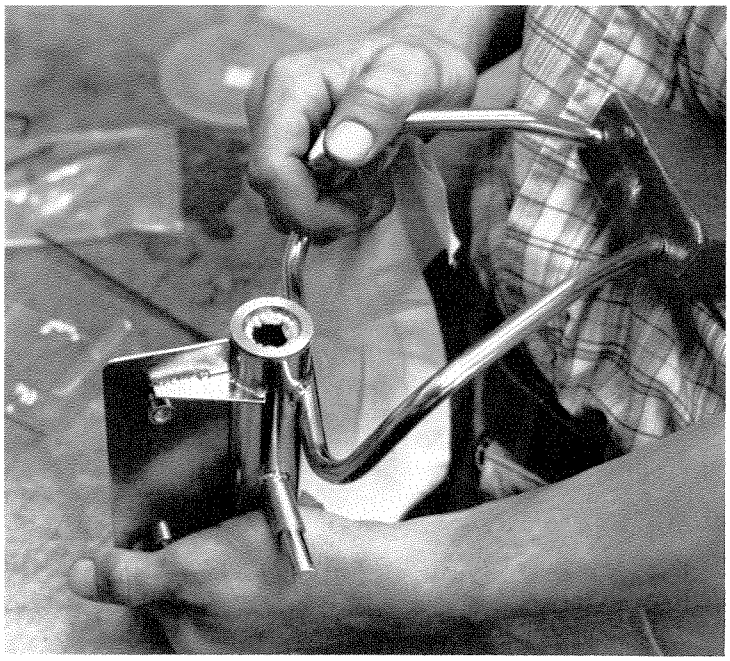


6.1.5 Installing bearing cups

If you have lost the bearing cups (4) from the ends of the rotating tube (5) these should fit tight in the ends of the tube. If the tube is too large, bang it lightly with a hammer to upset its shape somewhat, so that the bearing cups will have to be forced in place and will be held tightly.

6.1.6 Assembling the windvane bearings

To fit the 18 delrin balls (3) at each end you need to use a paste to hold them in place. Do not use grease of any kind. The paste should be water soluble, such as hand-cleaning cream, shaving cream or whatever else is handy and will keep the balls in place. After you have loaded one



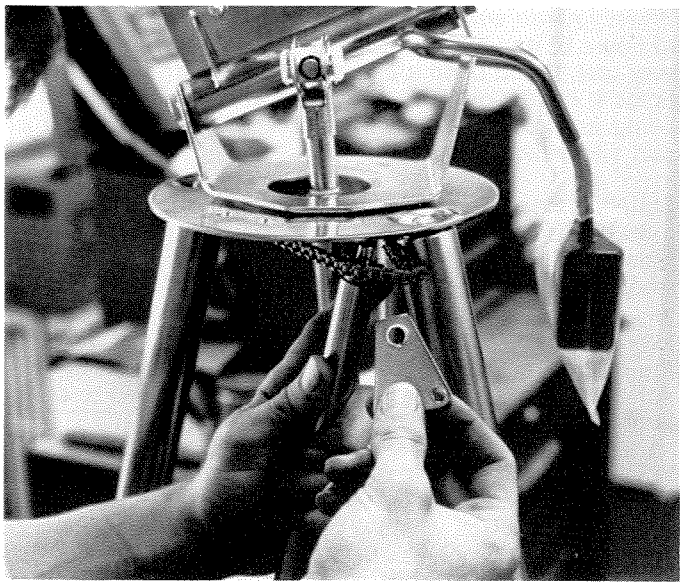
end, complete the bearing by putting the bearing cone (2) over the balls. Keep your finger on the cone (2) and turn the tube (5) over so that it rests on the cone, keeping the balls in place. Repeat the procedure for the other end of the tube and when the second cone is in place put the tube and bearings into the yoke, all the time keeping pressure on the cones, so that the bearings do not split open.

Pass the shaft (6) through the yoke and the bearings and screw the retaining screws (7) into the seating holes on the shaft. Check that everything moves freely and without binding.

6.1.7 Remounting the windvane base and windvane control shaft

Screw the base disc (11) back onto the frame. Put the chain around the pushrod (57) and screw the fork (80) into the end by rotating the rod. Note that one side of the fork has been relieved and has a bigger gap than the other side. The relieved side should face in, towards the gear. If the wrong side is mounted in, the fork end will bind and restrict the movement of the pushrod and windvane.

Slip the chain onto the teeth of the large sprocket. Hold the spring (25) and washer (23) onto the bottom end of the control shaft (20) and insert the end into the nylon bushing (15) in the frame. Keep downwards pressure on the shaft (20) and move it to the side so that the chain can be slipped onto the small sprocket (19) at the upper end. Install the washer (17) and plate (16). Put the plate on with the flange of the nylon bushing (15) facing down towards the washer. Bolt the plate back onto the base (11).



6.2 Pushrod and Gears

6.2.1 Adjusting the length of the pushrod

After unscrewing the lower fork (80) from the pushrod (57) the length of the rod has to be readjusted to insure that the paddle is aligned on the centerline when the windvane is in the upright, neutral position. Several other situations may also require this adjustment.

The easiest way to adjust the length of the rod is to look down through the frame and line up the side of the servo pendulum yoke (26) with the side of the hinge block at the end of the upper pendulum shaft (43). You should check the alignment with the windvane upright but set in several different positions around the full circle. Due to the slightly offset rotation of the upper end of the pushrod (57) in relation to the bottom end, the final adjustment requires averaging between the correct pushrod length at different settings of the windvane.

Lock the locknut (56) hard to prevent the rod from unscrewing from the fork and change the adjustment. Never adjust the pushrod without finally checking proper mesh of the bronze gears as described in 6.4. If the fork end has been completely removed from the gear you must assemble with the wider, relieved side of the fork facing the gear.

6.2.2 Adjusting the angle of the pendulum blade

Normally, when you adjust the windvane pushrod (57) as described in the foregoing you also make the pendulum blade (61) line up on the centerline of the boat. However, if the blade has taken a beating it may have twisted on the lower pendulum shaft (67). In this case you will have to unscrew one or both bolts (76), which will allow you to move the pendulum blade back into alignment.

6.2.3 Gears unmesh—proper mesh of the gears

When adjusting the windvane pushrod (57) and the pendulum blade (61) you should keep in mind that the gears (36 & 37) must mesh in their center when the vane is upright and the pendulum lined up straight fore and aft. If this is not the case the gears may unmesh when the pendulum swings to the side with less gear surface. When the pendulum tries to swing back the gears may bind on their teeth and the lower gear (37) may get forced down, away from the upper gear (36). Even more severe damage to the castings could result from an accidental unmeshing of the gears.

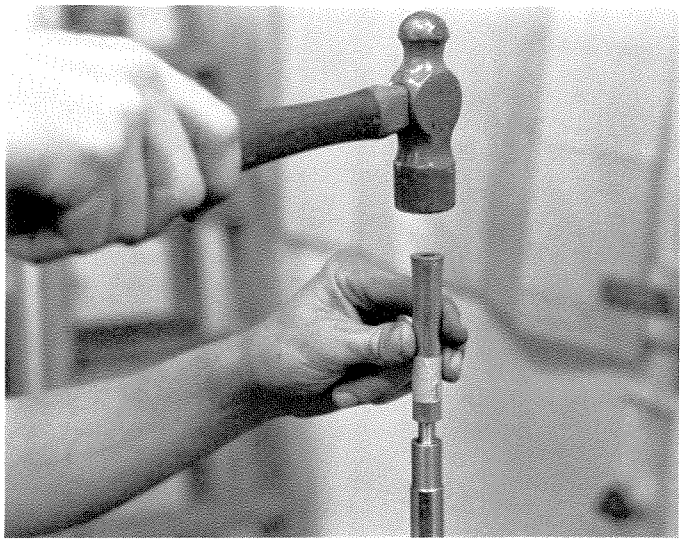
If the gears are not centered when the windvane is upright, undo the locknut (56) and adjust the pushrod until you have centered the gears. Then adjust the pendulum blade as previously described to center it fore and aft, with the windvane upright and the gears properly meshed.

6.2.4 Bending the gears
If the gears have been bent away from each other or are binding due to collision from behind you can often correct their meshing by using a big wrench on the bottom ring gear (37). Unscrew the bottom fork (80) from the windvane pushrod (57) and unmesh the gears turning the ring gear 90° away from its normal position so that you can get at it. Use a small file to clean up damage to the teeth from the wrench. Proceed by trial until you can mesh the gears with no binding and a minimum of slop.

6.2.5 Repairing loose rod ends of windvane pushrod
The ends of the windvane pushrod (57) are hydraulically pressed into the rod tube. Collision may loosen one or both ends. Sometimes the tube may have a slightly oversize inside diameter allowing the ends to work loose over a period of time.

The best way of fixing the rod ends in place is to drill through the tube and the end and pin the two together. However, it is hard to drill through the narrow tube without the use of a drill press. An emergency repair would consist of upsetting the end of the tube slightly so that the end will have to be forced back and held tight. It is a good idea to go through this step even if the two pieces can be pinned together. Epoxy gluing might also improve the hold of an emergency or permanent repair.

Avoid ruining the tip of the rod ends by banging directly on them if you are forcing them back into the pushrod tube. The best way is to use a hollow tube or pipe over the narrow end of the rod end.



6.2.6 Changing the teflon bearing plugs (54)
Very hard impact may crack the teflon bearing plugs (54) for the windvane pushrod. When replacing the plug you should again note that one side of the pushrod forks (80 & 81) has been relieved to prevent the rod from binding. This side, which is wider than the opposite, should be mounted facing in, towards the gear (36) or windvane rotating tube (5).

One washer (75) should be installed on either side of the bearing plug to prevent slop. Complete the assembly by forcing the snap ring (55) into its groove and test pull to make sure that the ring is in the groove and the assembly firmly locked in place.

If the fork ends (80 & 81) bind and limit the amount of rotation of the windvane before it has reached its end stops, use a screwdriver to open the fork ends slightly, after you have checked that the correct side of the fork is turned in, towards the gear or windvane tube.

6.3 Replacing Gears and Pendulum Parts

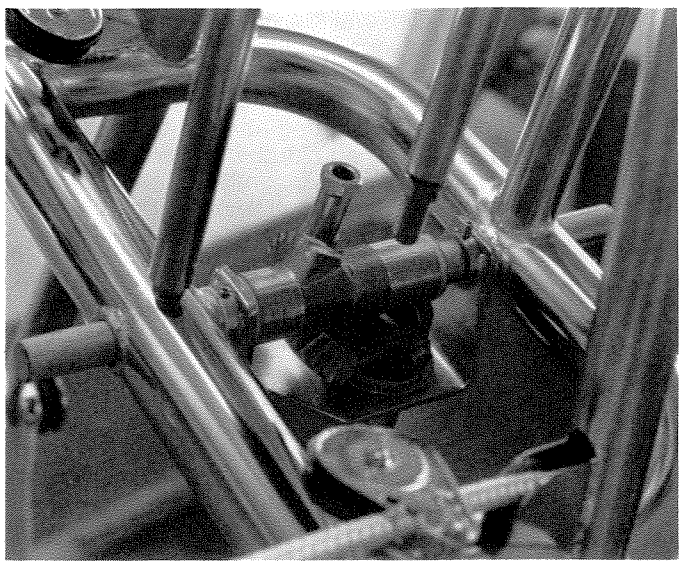
6.3.1 Disassembling the gears and the pendulum
Replacement of the meshed gearset (36 & 37) or the strut (26) and upper pendulum shaft (43) or replacing bearings and washers for these parts should definitely be undertaken with the vane gear unmounted from the hull.

Before taking the vane gear off you should remove the lower part of the pendulum by taking out the hinge pin (76). When the vane gear is in a more controlled environment than the stern of the boat, start by loosening the locknut (56) and unscrewing the bottom fork (80) from the pushrod (57). Then unmesh the gears by rotating the pinion gear (36) to make its teeth face upwards.

The pinion gear (36) rotates on a ¾″ stainless shaft (33) which also carries the pendulum. A setscrew (32) at the aft end of the pendulum yoke (26) keeps the shaft in place in the frame. A similar screw (27) at the forward end of the yoke is not seated in a hole in the shaft (33), but is just tightened against the surface of the shaft. Unscrew the setscrews (32 & 27) to allow removal of the shaft.

If you push the shaft (33) out without any further precautions you will spill the rollers (31) inside the upper gear (36). This may be acceptable when disassembling, as long as you keep track of all the loose parts. However, there is a correct way to remove the shaft (33) without spilling bearings (31), washers (30 & 29) and spacer (28) and this is the only way to put the assembly together again, so you may as well use it from the start.

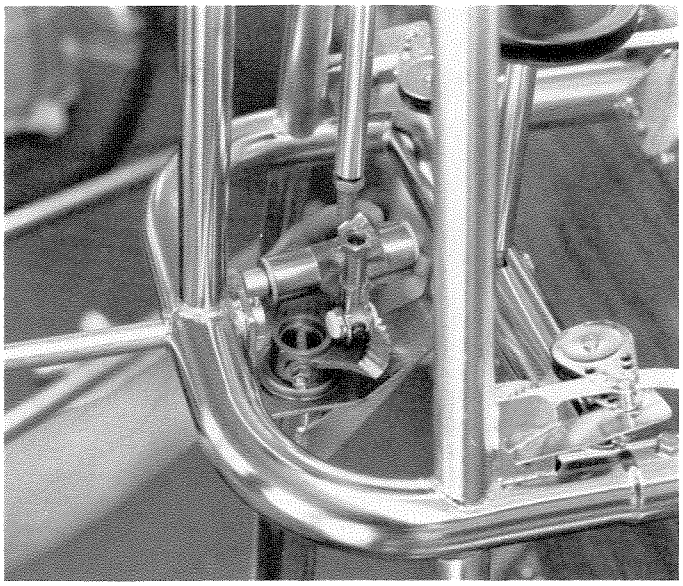
Secure a wood dowel, steel rod or tube with the same diameter (¾″) as the pendulum shaft (33). This piece should be 5″ long, allowing it to fit between the two ends of the pendulum yoke (26). Push the shaft (33) aft, out of the gear and frame, using the shorter piece inserted at the forward end of the frame. Keep one hand on the gear



holding the washers that secure the roller bearings in place against the gear. This also allows you to wiggle the gear a little bit to facilitate pushing the shaft (33) and short piece through.

NEVER PULL ON EITHER THE SHORTER 5″ PIECE OR THE SHAFT (33) as this will leave a gap between the two and allow rollers, washers and spacer to spill. ALWAYS PUSH on one or the other to move them back or forth.

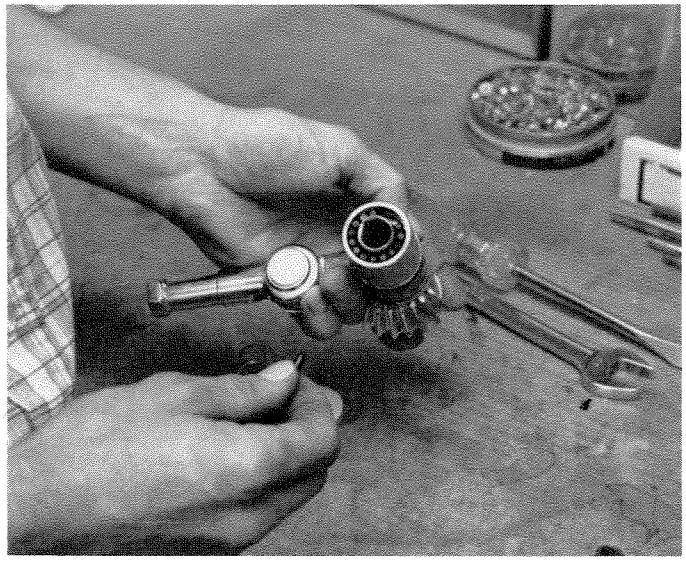
Push the short piece through the frame and the forward end of the pendulum yoke until it is just clear of the yoke. You will need a screwdriver or some other instrument to allow you to keep pushing the short piece through. You can feel when the short piece is just clear of the forward end of the yoke as you will then be able to move the gear (36). If the short piece is the correct length the yoke (26) should now hang on the end of the shaft (33), which will be more or less flush with the inside of the yoke at its aft end. You are now able to remove the gear (36), keeping the spacer and washers pushed against its ends to keep the rollers captive on the short 5″ piece.



If the pendulum needs to be removed also, just pull the rest of the stainless shaft (33) out of the aft end of the yoke to let the pendulum slip out of the frame.

6.3.2 Remounting the pendulum and pinion gear in the frame
To reinstall the pendulum and the gear (37), first make sure that the nylon bushings (34) are in place in the frame with their flanges facing the yoke. Hold the yoke in position in the frame between the bushings (34) and insert the shaft (33) from aft with the seating hole for the setscrew (32) aft and up. Push the shaft (33) through the aft part of the frame and aft end of the yoke, until it is flush with the inside of the yoke. This will keep the pendulum in place while you ready the gear (36).

The gear (37) should now be on the short 5″ piece with the rollers (31) and washers (30 & 29) and spacer (28) in place. Keep the washers pressed against the end of the gear and insert the assembly inside the yoke. Push the ¾″ shaft through the gear, ejecting the short piece on the front side until the seating hole for the setscrew (32) is properly lined up with the hole in the aft end of the yoke. Lock the shaft (33) in place with the setscrews (32 & 27). Mesh the gears and screw the fork end (80) into the windvane pushrod (57), adjusting the rod to proper length as previously described. Make sure that the wide side of the fork faces the gear.



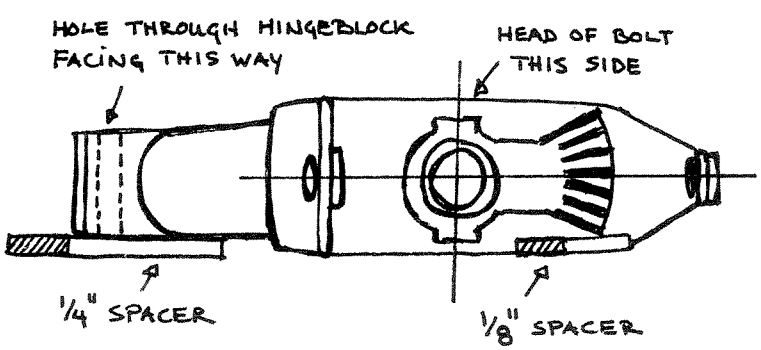
Loading rollers in gear before mounting.

6.3.3 Replacing the ring gear
If the ring gear (37) has been damaged beyond repair a new gear will have to be installed on the top of the upper pendulum shaft (43).

Take the pendulum and the pinion gear (36) out of the frame as described. Take out the bolt which holds the gear onto the shaft (43).

Keep pressure on the large hinge block at the bottom of the shaft (43) to keep rollers (31) of the bottom bearing from escaping between the block and the outside strut. Also keep top washer pushed towards the strut to prevent rollers (31) of top bearing from escaping. Install the new ring gear (37) on top of the shaft, taking care to leave a slight vertical play of the shaft (43) inside the strut to allow the shaft to move freely, without binding.

Lay the assembly flat. With the new ring gear (37) properly fitted the teeth of the gear should face the front side of the yoke and the hole for the hinge pin in the hinge block (43) should be in the opposite direction. Insert a ¼″ spacer under the hinge block and a ⅛″ spacer under the bottom tooth of the ring gear. With the hinge block flush against the spacer and the ring gear tooth touching the ⅛″ inch spacer the gear is in the proper position on the shaft. Drill a 5/16″ hole for the securing bolt, trying as closely as possible to pass through the existing holes in the shaft (43).



Insert the 5/16″ bolt with the head of the bolt on the same side as the horizontal arm of the upper gear (36) and the windvane pushrod (57). Put lock washer and nut on the bolt and tighten.

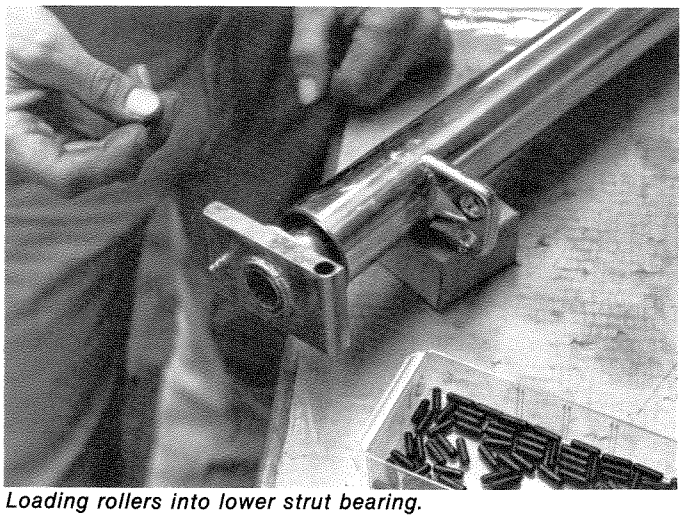
Reassemble the pendulum and pinion gear in the frame as previously described.

6.3.4 Replacing the upper pendulum shaft

To replace the upper pendulum shaft (43), first take the pendulum and pinion gear (37) out of the frame as described. Remove the 5/16″ bolt from the ring gear and take the gear off the shaft. Slide the shaft out of the strut, being careful not to lose the stainless (42) and polyethylene (41) washers at the top and the 23 delrin rollers (31) at each end.

Remove the polethylene washer (41) from the bottom of the shaft (43), noting which side of the washer is facing the hinge block. This side has been reemed to accommodate the weld between the block and the shaft and the washer should be installed on the new shaft in the same fashion.

After installing the bottom washer (41) on the new shaft, insert the shaft in the strut. Turn the shaft with the hinge block up and lift the hinge block away from the strut just enough to load 23 roller bearings (31) into the cup between the strut and the shaft. When the rollers are in place



Loading rollers into lower strut bearing.

push the hinge block flush with the strut to prevent the rollers from escaping. Turn the shaft around keeping pressure on the hinge block and rest the assembly on the block. Load the upper 23 roller bearings into the upper cup and install the polyethylene washer (41) and the stainless washer (42) on top of the pendulum shaft.

Mount the old ring gear on the shaft as previously described, taking care to have some vertical play of the shaft inside the strut. Position spacers as previously described and drill a 5/16″ hole through the side of the shaft (43) which faces up. Insert a short 5/16″ bolt in the hole to keep the gear in position. Turn the assembly over and drill the other side of the shaft. Insert the proper 5/16″ bolt through the ring gear and the two holes drilled separately as previously described. Reinstall pendulum and gear (36) in the frame.

6.3.5 Replacing the pendulum strut

To replace the pendulum strut (26) involves practically identical moves as in replacing the pendulum shaft, except that new holes are not required in the ring gear (37) or shaft (43).

As each yoke (26) varies slightly it may be necessary to bend the ends of the yoke to get a good fit for it inside the frame without binding or slop. It may also be necessary to file the spacer (28) or put a slightly longer spacer in place to prevent binding or undue slop in the fit of the pinion gear (36) between the yoke ends.

6.4 The Latch

6.4.1 Replacing the servo-paddle

Severe damage may make it necessary to replace the entire lower part of the pendulum (61), including the safety tube (67) and the latch (47). In the factory each latch is matched to the hinge block (43) on the upper pendulum shaft. To get a new latch to engage and disengage properly you may have to work on it a little bit also.

The lip of the latch (47) should extend 3/16″-¼″ over the edge of the hinge block, when the pendulum is engaged in the "down" position. If the lip goes further in over the hinge block, the latch will not engage easily or at all, as it will hit the bottom of the hinge block too far in and will not slide up over the rounded bottom edge of the hinge block. This effect should be prevented by a small stop screw (32), which restricts the movement of the latch (47).

If you are having trouble getting the latch to engage properly, this can usually be fixed by hitting the stop screw lightly to bend it slightly further towards the latch, bringing the lip of the latch a bit further out on the hinge block.

Sometimes it is enough to file the bottom edge of the hinge block a bit further to help the latch to engage smoothly.

6.4.2 Latch sticks

If the latch sticks between the plates (44) of the hinge mechanism, this will cause the gear not to engage properly and to disengage by itself, as the latch may be restricted from getting a proper hold on the hinge block. The reason for this is mostly that the hinge plates (44) have deformed slightly due to collision or great strain. Usually it is easy to see where the latch is binding. Use a flat punch to "massage" the hinge plates so that the latch is freed.

7. WARRANTY

For the MONITOR vane gear, SCANMAR MARINE PRODUCTS gives one year of first owner's warranty against defective material and workmanship, provided that the unit is installed and used in accordance with our instructions and common sense. Wear and accidental damages are not covered. This warranty is made by SCANMAR MARINE PRODUCTS in place of all other warranties, express or implied, with respect to the MONITOR vane gear, including, without limitation, any implied warranty of merchantability or fitness for purpose.

You should be extremely aware that a windvane self-steering gear cannot see or hear danger. If the wind changes in strength or direction this will result in a new and potentially dangerous compass course. Good seamanship and watchfulness are always required. SCANMAR MARINE PRODUCTS shall in no event be liable for incidental or consequential damages of any kind; and in no event shall its liability, resulting from any cause whatsoever, exceed the purchase price of the MONITOR vane gear, or, at the election of SCANMAR MARINE PRODUCTS, the repair or replacement of the defective or damaged part.

Warranty coverage starts at the date of purchase. Keep your proof of purchase, which will be requested in case of a warranty claim. In order to qualify for the limited coverage set forth above, the purchaser must fill out and return the Warranty Card supplied with each MONITOR together with two photographs of his installation. These photographs are used to verify correct installation of the unit. Take one picture of the vane gear from behind at about a 45° angle to the centerline, with the windvane mounted and the pendulum down and latched, so that the stationery degree of immersion of the paddle is clearly seen. Also take a separate picture showing the installation of the pendulum sheet lines to the wheel or the tiller.

ADDITIONS - 1984 EDITION

This manual was first created to deal with the problem that vane gears are almost always sold direct and usually installed by the owner or a yard that has little or no experience with the equipment. We feel sure that the MONITOR manual has done a lot to eliminate mistakes in installation and operation. Even so there have been a few misunderstandings also after the manual came into existence. This addition is motivated by such incidents. We want to stress a few issues that are extremely important, because they seem to have a persisting ability to cause problems.

Installation
If you have any doubts about interpreting the instructions for your boat, please, contact us before proceding to install the gear. It is infinitely better to hold off and do the thing right than to eagerly proceed with a faulty installation that will require patching and repairs and starting right over from the beginning.

Pendulum Safety Line
Please, secure a sturdy safety line (approximately 5/16") under the lower bolt (62) for the safety tube (61). Use a double hitch and seize the line so the knot cannot work itself loose. The MONITOR servo-paddle is expensively made and expensive to replace. If the safety tube breaks on overload you will lose the paddle without the safety line. The line will also allow you a convenient way to raise and lower the paddle.

Controlling Line - Windvane
No line is delivered for the pulley (79) and the windvane remote control as this arrangement varies widely from boat to boat. However, you *must* keep a line with some tension on the pulley when using the vane gear. Without this the windvane can slowly change its setting and the course of the boat. The best arrangement is to splice the control line into a loop with a block at the inboard end. Secure the block with a shock cord to a stanchion or whatever is convenient. In this way tension is always maintained and the setting of the windvane is very easy to change.

Check All Fasteners
Vibrations from the boat's engine in particular can cause fasteners on the vane gear to work loose. Especially when beginning to use the gear you should check the tightness of all screws on the machine *frequently*. If you have a persistent problem you should use locktite or similar compound to keep fasteners from backing out.

Secure Compression Sleeves
Spacers are supplied (85) for use inside the mounting tubes to prevent them from collapsing when the bolts are tightened. It is a good idea to secure the spacers in position inside the tubes with some of the sealant that you use when making the installation. This will prevent the spacers from being lost if you remove the gear in the future.

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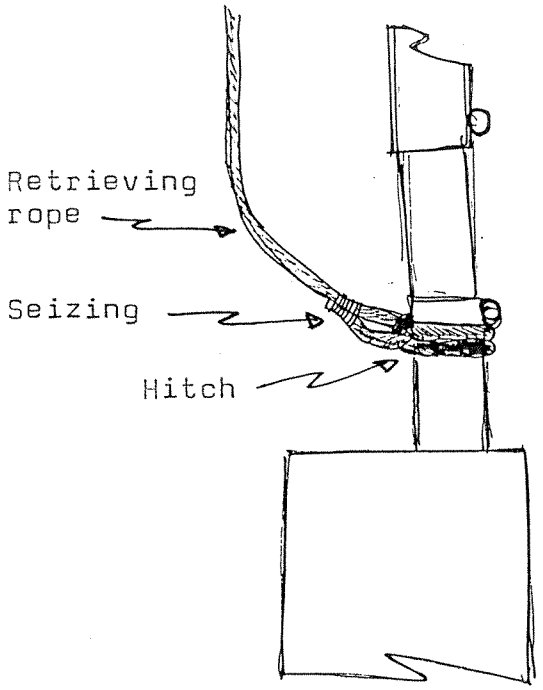
IMPORTANT HINTS IN ADDITION TO THE MONITOR MANUAL



1. Before using the vane gear, install a retrieving line (minimum ¼" thick) below the lower bolt for the safety break-away tube.

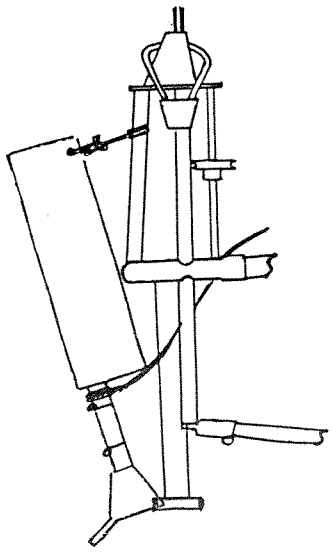
   This line will prevent loss of the paddle in case of failure of the safety tube upon overload. It is also a convenient means of lifting the paddle out of the water.

2. Note that we strongly recommend taking the windvane off (that is, the wooden vane blade) when the vane gear is not going to be used (boat at anchor or in port).

3. After a few hours of use, check all bolts and screws on the gear for tightness. If it is necessary to tighten, check again after an additional couple of hours. Some boats have a persistent problem due to engine vibrations in which case a thread locking compound, such as Locktite, will have to be used.

4. When the paddle is stored in the up position, secure it with a cord between the back tube of the frame and the hole at the bottom of the paddle as illustrated.

   In bad weather at sea it is a good idea to lash the paddle securely to the frame.



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