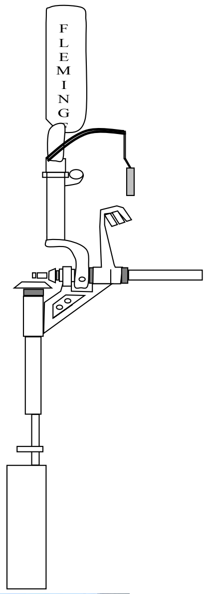
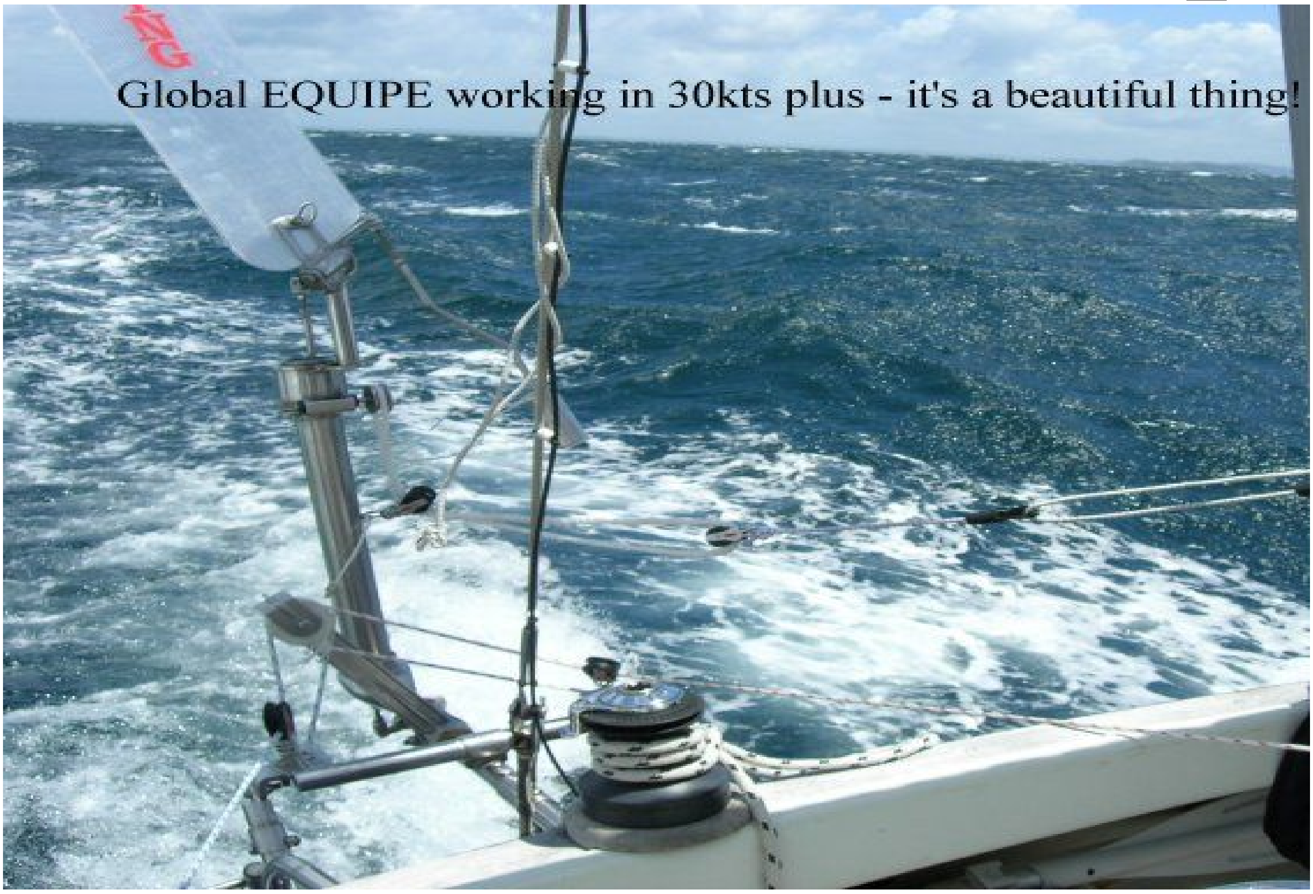


FLEMING GLOBAL EQUIP AND OFFSHORE

Installation, Operation and Maintenance Manual



Fleming Marine Eng & Sales
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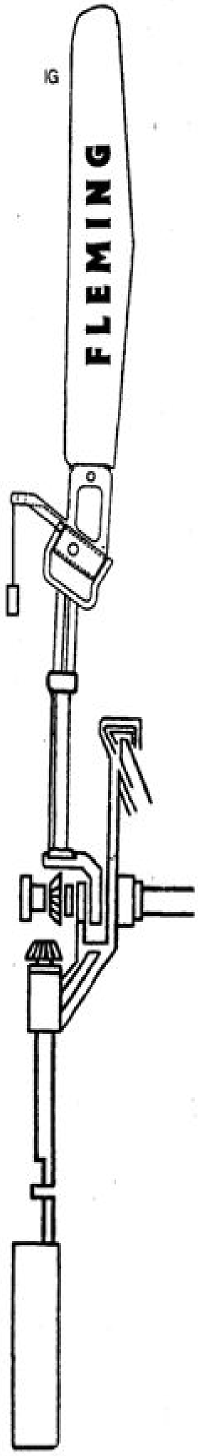
Manufactured by FLEMING MARINE ENGINEERING AND SALES

The Next Generation

Mechanical Self Steering for the Ocean Going Pocket Cruiser



This all new design is a FLEMING light weight marvel incorporating stainless steel castings in a superbly engineered system. It has been designed around "Price and Weight" for owners of pocket cruisers who have looked for, but never found a true blue water system to meet their needs, It contains no wood, plastic or corrosive aluminum. It is truly the next generation of mechanical self steering systems for smaller vessels. Having achieved a strength/weight breakthrough, it joins the bench-mark trends set by our larger models, the Global 401 and 501. It has excellent light air sensitivity, lifetime construction warranty and unbeatable price in a small, smart, stylish, southern ocean strong design.

- ✔ **Price – It is priced for the budget conscience smaller vessel.**
- ✔ **Small – Lightweight, blue water system and right sized for pocket cruisers.**
- ✔ **Strong – All stainless steel 2205 and 17-4 PH alloy castings and 316L stainless steel tubing. Lifetime Construction Warranty.**
- ✔ **Smart – Over 37 years of Fleming wind vane design evolution provides a new benchmark in a highly efficient system.**
- ✔ **Stylish – Elegant streamline design that is user friendly.**
- ✔ **Southern Ocean – Born of demands of the Southern Oceans to give confidence world wide.**
- ✔ **Now with factory direct sales and service in both the United States and Australia.**

SHAFTING.	FROM 3/4 to 1 INCH DEPENDING ON THE MODEL.
BEARINGS.	DELRIN SLEEVE, ROLLER, BALL DEPENDS ON MODEL
WEIGHT.	FROM 40LBS (16LILOS) TO 45LB(20KILOS).
CASTINGS	DUPLEX 2205 STAINLESS STEEL .
TUBING	316 GRADE STAINLESS STEEL

Pole to pole…
There and back for 40 years

FLEMING SELF STEERING SYSTEMS

GLOBAL EQUIP 350 AND 400
GLOBAL OFFSHORE 401 AND 501

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ABN – 94751 563 834
A.C.N 103 622 251

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Fleming Marine Eng & Sales trades under Advanced Engineering Solutions Pty Ltd.
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SECTION 1

INTRODUCTION

Congratulations on the delivery of your new FLEMING wind vane. Be sure to check that the supplied parts agree with the packing list and there is no apparent shipping damage. Please advise the factory in the event of either.

Your new FLEMING Self Steering unit has been developed over many years of wind vane design evolution. It is built using the finest materials presently available for its purpose and long term durability in the marine environment, with the use of cast stainless steel components and exotic alloys to achieve this. To ensure it does the best self-steering job for your purpose, take a few minutes to carefully read and understand this manual and be aware of the regular maintenance. This will ensure the vane will keep doing its job year after year over thousands of ocean miles.

The unit has its own design features and is fastened with a three point stern attachment to transfer the stern loading. Various mounting systems can be supplied to suit any stern, but in all situations the servo will disconnect from the frame via two bolts in a few minutes, folding on itself for easy bunk stowage.

I trust that the FLEMING self steering system will become a reliable, tireless, and uncomplaining crew member, and enhance any sailing endeavour you may undertake.

Thank you for trusting Fleming Marine Eng & Sales with your self-steering requirements.

Good sailing

Fleming Marine

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BRIEF HISTORY OF SELF STEERING

This summary is confined to the mechanical servo system as opposed to our auxiliary rig. The Fleming Self Steering systems have made a significant contribution for over 40 years, with continual development of the product. Self Steering Servo Systems are a relatively modern concept. The very first vanes were used to control model sailing yachts during the 1920's in the United Kingdom. The airfoil was attached directly to the rudder and seemed to work well. In the 1930's, the first full size unit was fitted to a motor yacht, which crossed the Atlantic. It was not until the 1950's that people really started building and improving self-steering for sailing yachts. Things really moved ahead when the Observer Newspaper announced a challenge for a single-handed race across the Atlantic. This race was known as the OSTAR (Observer Single-handed Trans Atlantic Race).

The race did wonders for the development of mechanical self-steering in a very short time. All competitors found the need for such a device. An Englishman, Col. H G Hasler is recognized as the first person to develop the modern servo system. The French, not to be outdone, soon developed a design that incorporated a horizontal axis air foil in contrast with Col. Hasler's vertical axis design. The horizontal axis air foil was a marked improvement as the foil movement was proportional to wind change.

Modern units still use gears, gudgeons, cams, push rods etc., to achieve the steering process. We owe a debt of gratitude to these early pioneers, both manufacturers and clients alike, for their innovative ideas.

In a small way, over the past three decades, FLEMING created innovative designs and manufactured a wide range of servos and auxiliary rudder systems for which he received the prestigious Australia Design Award.

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A SERVO PENDULUM – HOW IT WORKS

The FLEMING design uses the “servo pendulum” mechanical self-steering system. It is the most widely used type due to its efficient use of the vessel’s main rudder for steering. Even though servo systems are the most widely used, they are still the least understood. The casual observer might believe the long servo blade attached to the system is a rudder that directly steers the vessel. This is in fact not the case. The blade is a servo pendulum, hence the name “servo pendulum system”.

Servo power – have you ever rowed a dinghy? The oar is quite small compared to the dinghy, yet it has enough mechanical advantage to move the dinghy along with little effort. Even at a very slow speed, if you take one oar and put the blade into the water parallel to the flow of the water (feathered), the flow going past it creates very little drag and the dinghy continues to move ahead. However, when the oar is rotated, even slightly, across the flow of water, the increased drag causes a violent sideways thrust, turning the dinghy around the oar. The water flowing past the oar crates hydrodynamic energy. This is what it is all about.

A sailing yacht behaves the same way. The “dinghy oar” in our example above, is the same as the servo pendulum rudder suspended in the water behind the vessel. When the vessel is moving this rudder rotates on its vertical axis, pressure is created and the servo rudder is pushed sideways. This pulls on lines attached to the servo pendulum. These lines are connected to the yacht’s steering system and steer the yacht through its main rudder. The harder the wind blows the more the yacht has forward motion through the water, creating hydrodynamic energy. More servo power is then developed to steer the yacht.

If you now make a right turn across the wind, still at 4 units of forward velocity, the wind pressure felt on the left side of your face will be the 10 units of true wind (for simplicity in the example, disregard the effect of rapid forward velocity).

When turning with your back to the wind and travelling at 4 units of forward velocity, the wind felt on the back of the head would be 6 units of wind pressure (10-4), still called apparent wind velocity. It is clear the air foil sees less apparent wind and therefore less wind pressure sailing across and especially downwind on any given day.

When the vessel deviates off its set course, the direction of the apparent wind also changes and the air foil presents on side to the wind.

The resulting wind pressure then pushes the air foil sideways around its inclined horizontal axis; however this is very low power. This then moves the pushrod up and down, driving the gear mechanism and rotating the servo rudder around its vertical axis. Add the forward motion of the yacht and the hydrodynamic power developed is substantial. The energy developed by the water flowing past the submerged rotated servo rudder causes it to deflect sideways (dinghy and oar example).

The faster the vessel moves, the more power is developed. The deflection is transmitted to the main steering rudder via control lines to the wheel or tiller. In this way, the main rudder steers the yacht. When the servo rudder has pulled the yacht back on the original course, the apparent wind will then be back to zero and the air foil will stand upright, reversing the pushrod movement. The servo rudder feathers and moves back buy its own negative buoyancy to its central position. The vessel will continue sailing uninterrupted for hundreds of miles if the apparent wind and pressure remain constant. When either one changes, only minor adjustments are required to maintain course.

A hull speed of 2.5 knots will operate the FLEMING mechanical servo system. When the vessel is on course, the air foil will quiver upright around its vertical position. Every effort should be made to trim the sails in order to balance the yacht. There may be a little bias in the wind vane needed to compensate for normal weather helm.

INSTALLING THE UNIT

Refer to installation sketches before commencing the installation. You will require a good marking pen and measuring tape.

- **Mark centre of the vessel** and establish the vertical line you wish to install unit so the servo rudder will be exposed 4"/100 mm, more or less is fine but not preferred. The unit can be offset up to 12" providing it has been supplied to suit.
- Mark the centre hull lug position to suit the design requirements.
- Connect frame and unit together, and then on the ground loft the stern profile shape and measurements, including the push pit height and angles. Envisage when the entire assembly is fitted to the chosen position and that the airfoil can be **rotated a full 360 degrees** without fouling the push pit or other stern clutter (e.g. BBQ, radar arches etc.).
- Fit centre hull lug and **drill only one top hole**. Bolt up to allow some swing.
- Fit main frame as supplied into the lug and bolt together. Rope the frame to the push pit and secure it **horizontal to the water and straight fore and aft** to ensure the installed unit will sit correctly. **Check again that the airfoil will rotate 360 degrees** without hindrance.
- Measure side tubes by establishing correct hull lug positions, 45 degrees down (more ok). 0 – 10 degrees maximum out. **Greater than 10 degrees out may foul the servo arm operation**, check before proceeding. Extreme counter sterns may be better suited to above deck mounting. These installations may require custom support brackets not supplied with this kit.
- Bolt one side tube (welded socket end) to an ear on the frame. Fit the joining **U casting under the ear, round end down**, fit support socket outside.
- Slip a lug/socket assembly to the bottom end and offer up to the hull, rotate the socket until the lug fits flat onto hull. **Do not drill hull yet as this position will move a little.** Measure correct tube length, remove, and cut.
- Offer lug/socket assembly up again. Rotate until the lug fits flat onto the hull and mark the socket hole position on the tube. **Do not drill hull.**
- Remove, drill, and fasten the bottom socket to the tube**.**
- Offer lug/socket assembly up again (final time). The hull lug should sit flat on the hull if you have been careful. Drill and fasten **one hole only**.
- Carry out the same procedure for the other side.
- Check the mounting assembly is installed **horizontally and in line fore and aft.** A little adjustment is possible via one bolt only connection.

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SAILING WITH YOUR FLEMING WIND VANE

When a yacht moves through the water it is subject to the following forces, **side slip – leeway, weather helm, yawing, and rolling**. To create the motion, a **thrust** (wind pressure on the sails) is required. The hull's **resistance** must equal **thrust** to achieve a steady forward motion. In other words, action equals reaction. As the **wind** pressure increased the relationship between the **thrust** and the hull **resistance** remains constant, maintaining a forward motion. As the **wind** pressure increases the relationship between the **thrust** and hull **resistance** do not act in the same line, so another equal and opposite force is required to keep the vessel sailing on a straight course. The opposite force is the **keel rudder couple**, allowing the vessel to move ahead with minimum side slip and **rudder** deflection.

As illustrated in the force diagram, as the **wind** pressure increases an adjustment is required to the **keel rudder couple** to maintain the preset course as the **weather helm** has increased turning movement requiring more **rudder deflection**. A better way to reduce the new turning movement and maintaining the set course without increasing rudder deflection is to adjust the sail trim, so the vessel sails more upright. An excessive weather helm is always introduced when driving the vessel too hard. Remember our "go fast" racing days? Rail down, two men on the helm, the rudder stalled and the yacht still charged up windward with a mind of its own. In similar circumstances your vane will also lose control.

When using your new FLEMING wind vane the following rules apply:

1. When the yacht sails to windward, the sails in front of the mast tend to push the bow away from the wind direction.
2. When the yacht sails to windward, the sails behind the mast tend to drive the bow up into the wind.
3. When the yacht is running downwind, the same conditions apply but to a lesser extent. As the rudder and keel are nearly in line, with minimal heel, it requires less rudder deflection.
4. Rudder deflection can be further reduced by sailing wing and wing (main and head sail opposite tack), or further improved by using only head sails to pull the yacht through the water. Directional stability is excellent when the rudder is well aft of the sail power, pulling rather than pushing the hull.

5. All vessels behave a little differently, experiment to get the best results from your vane.
6. Yachts with long keels will track well but will pull back on course more slowly. The oscillation across the set course is always a few degrees more for this type of vessel. After hundreds of miles of ocean sailing with the vane controlling the helm, any noticeable track deviation will not be a factor.
7. Vessels with short keels and aft hung rudders track extremely well and react very quickly to the "helmsman" or wind vane signal.
8. Regardless of yacht type, continuous sail plan balance is important to enable the vane to steer the yacht with minimum heel and rudder deflection.

Running
There is less apparent wind and therefore wind pressure to the air foil on this point of sail. Since the minimum required hull speed is around 2.5 knots, you will need enough wind to achieve this for your particular vessel. To operate the wind vane, turn the counter weight to face windward (aft), via the course setting line and dial in either the tiller or the wheel drum. Use the standard foil unless storm conditions.

Reaching
On any given day, this point of sail always provides more apparent wind than running. You may find the smaller air foil is sufficient when the larger light air foil may be needed downwind. To operate the system, again turn the counter weight windward, via the course setting line, allowing a little servo bias to compensate for the normal weather helm

Beating to Weather
This point of sail provides the highest apparent wind vane therefore wind pressure. Most vessels will tack to weather with a well balanced sail plan requiring only minimum of help from the unit. To operate, again turn the counter weight windward, via the course setting line, allowing for a little servo bias to compensate for the normal weather helm.

A common question is:
How much wind is needed to operate the wind vane? A quick way to find out how much wind your vessel needs is to motor slowly along and hold the air foil to one extreme. When the servo starts to deflect, that's your hull speed. Relate this to the amount of wind pressure (just sailing, no engine) to achieve the same hull speed. For your vessel, this is your "starting point".

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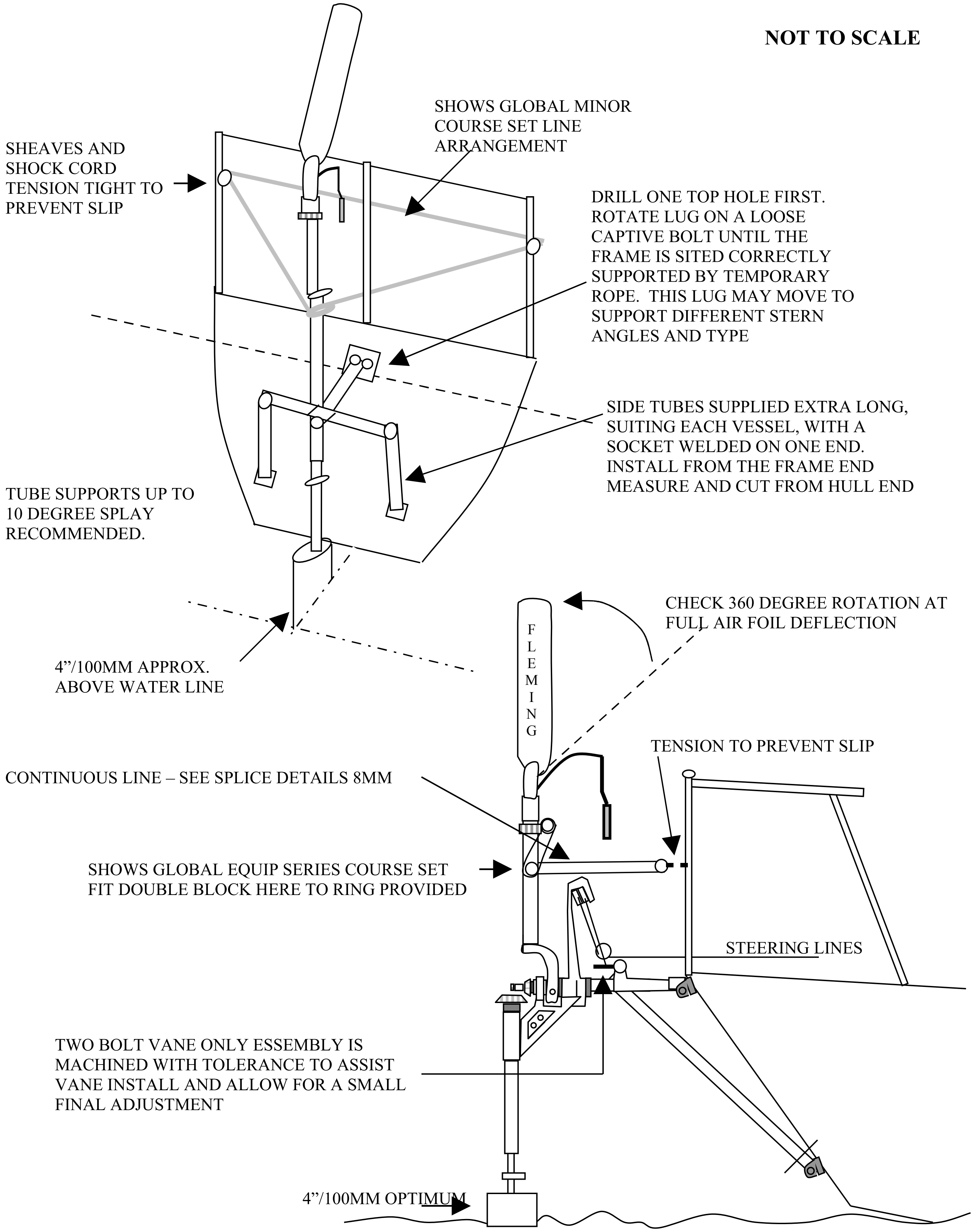
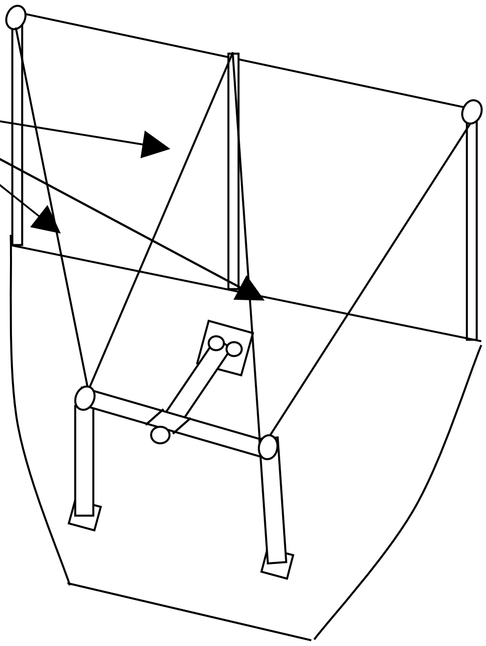
INSTALLATION SKETCHES

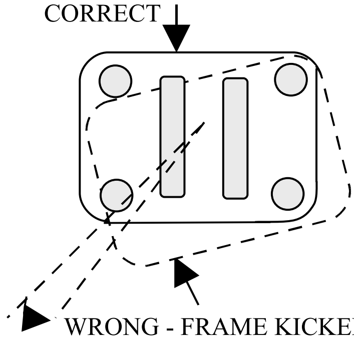
NOT TO SCALE



INSTALLATION SKETCHES

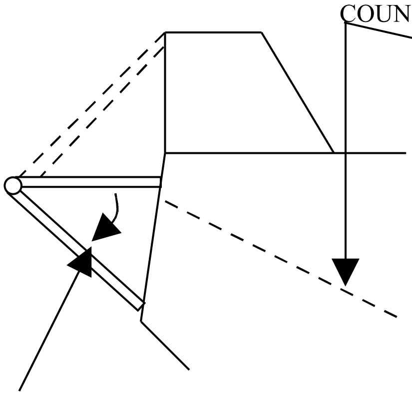
1. FITTING FRAME

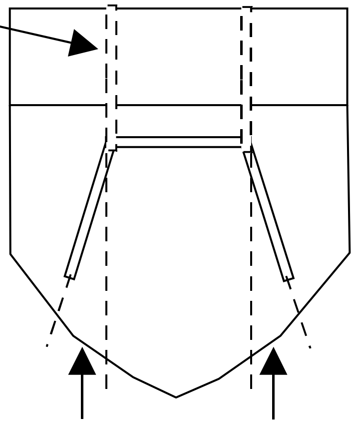




DRILL ONE TOP HOLE FIRST. ROTATE LUG ON A LOOSE CAPTIVE BOLT UNTIL THE FRAME IS SITTING CORRECTLY, SUPPORTED BY TEMPORARY ROPE. THIS LUG MAY MOVE TO SUIT DIFFERENT STERN ANGLES AND TYPES.

ALTERNATIVE TUBE SUPPORTS FOR EXTREME COUNTER



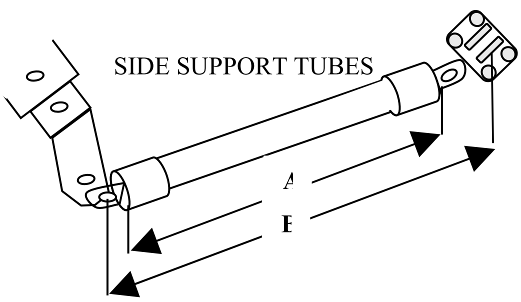


2. FIT SIDE TUBE SUPPORTS

SIDE TUBE INSTALL DETAILS

1. MAXIMUM 10 DEGREE OUT. MORE MAY FOUL SERVO ARM ACTION. CHECK OKAY BEFORE PROCEEDING
2. CASTING INSTALLS UNDER WING ROUND END DOWN
3. LOCATE HULL POSITION USING THESE ANGLES
4. DIAGRAM **B** IS LUG BOLT ON POSITION
5. DIAGRAM **A** IS ACTUAL TUBE LENGTH

FIT CASTING UNDER WING ROUND END DOWN



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INSTALLING CONTROL LINES FROM UNIT TO WHEEL OR TILLER

1. Use low stretch line - 30 ft of 5/16" included with vane. We have found through experience that this kind is best and easy to replace worldwide.
2. Lines should be run through pulley sheaves fitted in the servo arm as shown and terminated at the wind vane frame by tying a knot under the through hold) aft hole to aft sheaves, forward hole to forward sheaves). Run line over the top of vane servo pulleys, not under and don't cross. For optimum performance, lines should be lead from the pulleys on the cross arm straightforward to transom (10 to 15 degrees variation from perpendicular is ok). From here, it is run to the tiller or wheel using shortest route possible to minimize friction.
3. If using a wheel with our stainless steel adapter clutch, approximately 3 turns of line should be wound on this clutch (5 turns on the aluminium adapter). Then, both ends lead back to wind vane through the required blocks, and then terminated to wind vane after passing up over servo arm pulley sheaves. Also suggested is a two line attachment arrangement. This is one line wrapped 3 turns around the clutch and with eyes on both ends. Line from the wind vane can be attached to the eyes and slack removed.
4. When running control lines, DO NOT use free hanging double swivel pulleys to change direction of both lines. Use single pulleys or double fixed turning blocks, which can be fastened to the hull and do not remove.
5. Ensure the control line is tight, but not overly tight. To ensure vane sensitivity, move the wheel slowly side to side removing any line slackness.
6. For all units, course setting line is wrapped around course setting knob with ¼" line through a pulley and spliced into a continuous loop. This leads to the cockpit or is positioned on the vessel to suit the owner's requirements and tensioned with shock cord to the pulley. Worm drive rotates either direction.
7. It is important when using the wheel drum that the lines are run around correctly e.g. wind vane moves to port, wheel moves to starboard and vice versa.

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For optimum performance, control lines form the unit should be led directly forward to turning blocks on the vessel's hull. This allows the swivel blocks fitted to the cross arm to properly follow the movement of the servo rudder lever. NB Lines can be led slightly upward provided they are kept in the fore and aft line.

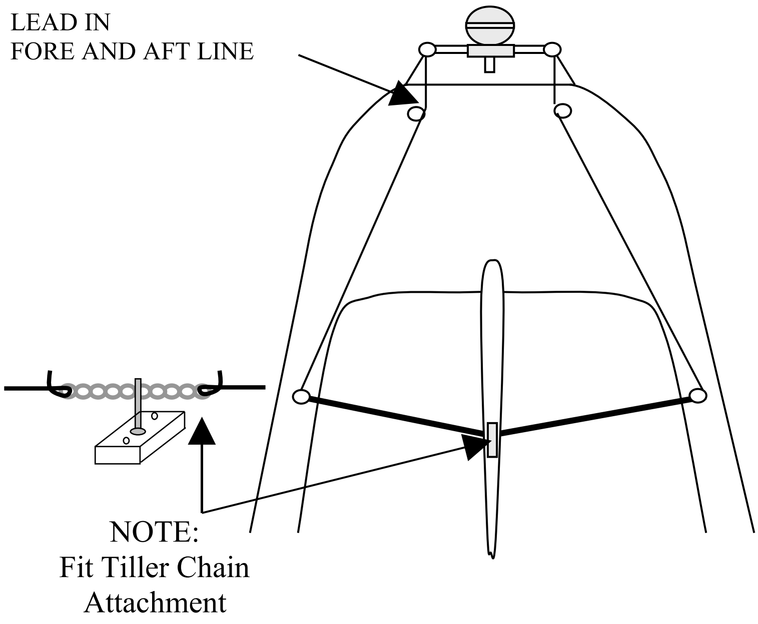
Control lines should always be led along the deck through fixed turning blocks. The lines should be a good quality, pre-stretched, 8 mm braided cord. Twine can be used to obtain the correct length for the control lines and to position the lead blocks.

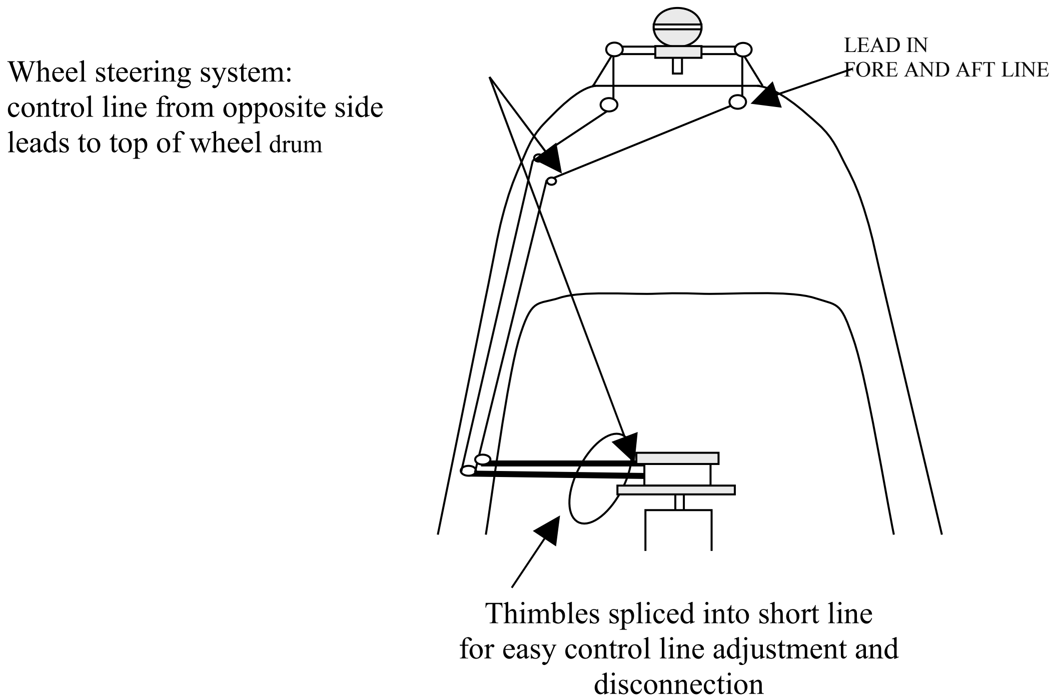
Threading the control lines

1. Beginning at a lead block on the hull, thread a control line aft through the block fitted at the end of the unit's cross are.
2. Lead it up and over the top of a sheave in the servo rudder lever. In this example the starboard line has been led through the forward sheave so the port side line is threaded through the after sheave.
3. The line is then led back down toward the same cross arm block through which it was first threaded.

Depending on the sheave used in the servo arm, the end of the line is threaded through the forward or aft hole and a figure of eight knot used to tie off the end.

CONNECTING THE CONTROL LINES





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WHEEL DRUMS

Our new stainless steel wheel drums will fit on either the front or back of the steering wheel. (Order to suit your requirements). It will slip over the shaft and hub on most designs, if not; a packer may be required (not included). Supplied as standard are 3 U-bolt fasteners. Run between 3 and 5 turns around the wheel drum to prevent slipping. We suggest using the rope arrangement (wheels) to incorporate a cockpit join to provide easy line tensioning and disconnection

SHOWS THIMBAL DISCONNECT ON ORIGINAL WHEEL DRUM

INSIDE WHEEL

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CHAIN/TILLER CONNECTION
EMERGENCY
INSTEAD OF A WHEEL DRUM

SHOWS STAINLESS STEEL WHEEL
DRUM FITTED OUSITE THE WHEEL
WITH THIMBAL CONNECTION

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SHOWS ROPE ROUTING REQUIREMENTS FOR GLOBAL 3 SERIES

SAIL CHECK LIST — Before you set sail!

1. Are the control lines tight? When you **move the wheel slightly**, the wind vane servo arm should immediately move **without showing any slack** in the control lines. Slack line will cause erratic course control, especially reaching and running, but may not be apparent in heavy windward sailing.

2. Are the control lines run correctly? When the wheel is moved to starboard, the servo rudder should move to port.

3. Is the main steering system friction or wear free? Will it affect the vane's performance in light airs? To check for excessive friction in the steering system, stand behind the wheel and place a finger on a spoke at the out rum. Rotate the wheel without undue pressure or pain on the finger. If this is uncomfortable, the vane will not be as sensitive in light air.

4. Do you have the correct airfoil fitted? If it is less than 20 knots true, use the taller light airfoil. **Counter weight needs to point into the apparent wind.**

5. Is the vane bolted on correctly? See "**installing the unit**" information.

6. Has the trust washer (split) at the small gear been adjusted? It should hold the small gear snugly into the large gear but without pressure.

7. Check all the fasteners on the wind vane to make sure they are all tight.

8. The vane should correctly align with the turret vertical and the control line transfer arm assembly horizontal.

9. Swing up servo pendulum rudder to port and starboard to ensure the frame installation is correct and does not foul servo movement.

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CHECKING WIND VANE INSTALLATION WITH THE ENGINE

By checking the operation of your wind vane while under power, you can observe correct installation and operation without the added confusion of setting and trimming sails.

1. Motor your yacht through the water at 2 or 3 knots. Counterweight forward or into the apparent wind.

2. While motoring, deflect the airfoil slowly to one side. The servo rudder will slowly move out to the same side as the airfoil. **If the airfoil is manually moved to the left then the wheel turns to the right or vice versa**.

3. The servo rudder should move immediately as the airfoil is moved. This indicates that the lines are tensioned correctly.

4. Try this test at 2 knots, 2.5 knots, and 3 knots. When the servo rudder sweeps out at this low hull speed, it indicates that enough hydrodynamic power has been developed to steer your yacht.

   What is the amount of wind needed to attain this hull speed for your yacht? Larger vessels may require more wind than small vessels to attain this minimum hull speed of 2 or 3 knots. **This is the low-end starting point for any servo pendulum system to steering a yacht effectively**.

5. While doing this test, you may not see the servo rudder sweeping more to one side. This is the effect of the prop wash and will not be apparent while sailing.

6. If the servo rudder acts as described above, the wind vane will dot its job when sailing. Now follow the operating instructions while sailing and you will know that the wind vane is rigged properly and it is just a matter of setting the leading edge of the airfoil (counter weight leading) into the apparent wind and test under sailing conditions.

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SAILING WITH YOUR FLEMING WIND VANE

Your new Fleming Wind Vane has been designed and built to work in a wide range of wind and sea conditions. However, like any form of automatic steering, it is **not proactive** and can not anticipate what is about to happen, so it is **up to the operator** to keep an eye on sail balance and changing wind and sea conditions. The wind vane will in fact often steer a better course than a tired and exhausted helmsman, especially at night when light or violent apparent wind changes affect the airfoil before sensed by the crew. At the other extreme, sailing down wind, especially at night, a breaking rough wave could and often does completely overwhelm the wind vane and perhaps the vessel, often with disastrous results. By all accounts, it does happen, **so do not tempt fate.** In these conditions, the vessel **must be hand steered** and handled accordingly.

Having said this, before you can even start to make sense of your new vane's operation, it is important to clearly understand the forces that are present as your yacht moves forward. Acting simultaneously or separately with various degrees of authority, depending on sea, wind and wave conditions.

When a yacht moves through water, it is subject to the following forces:
THRUST is the force moving it forward provided by its sails.
RESISTANCE is provided by the hull's friction.
SIDE SLIP - falling off to leeward - commonly called **LEEWAY.**
LEEHELM is the tendency for the yacht to fall off to weather.
WEATHERHELM is the tendency for the vessel to round up.
YAW – common term – is the tendency of the yacht to oscillate around the steered course "bow up bow down".
ROLLING is the constant hull motion cause d by wave and sea conditions.

Let's deal with the forward motion disregarding the other forces at this stage. To create a forward motion a **thrust** is provided by the sails and the **resistance** is provided by the hull's wetted surface. The vessel will gain velocity until the resistance equals the thrust at which time it will continue at a constant forward velocity. Action equals reaction. This is **Newton's First Law.**

If the thrust applied is directly behind the vessel, action on the centre line for example, (mast only no sails) the vessel will behave differently than it does when sails are added. In which case, the thrust and resistance are not acting in the same line to prevent the vessel turning on its axis. This requires another correcting force provided by the **keel** and **rudder**.

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So what do the words FORCE, TORQUE, MOMENT AND COUPLE mean and how do they relate? When two forces are not acting in the same line, a turning TORQUE or MOMENT is produced tending to rotate the object they act upon. When these two forces are closely related, a concept called a COUPLE is produced.

There are a range of sketches in this manual to assist you setting up and using your wind vane. These show forces present with different sail plans, rigs, wind and sea conditions, and the action to be taken.

SUMMARY - SAILING YACHT & REACTION SKETCHES

GENERAL RULES THAT APPLY: -

- When the yacht sails to windward, the sails in front of the mast tend to push bow away from the wind.
- When the yacht sails to windward, the sails behind the mast tend to push the bow up into the wind.
- Correct sail trim with minimum heel and hull wetted surface requires less rudder correction and servo deflection.
- Increasing wind normally requires a reefed mainsail to maintain the original balance preventing "bow up".
- Down wind pulling sails (jibs etc) normally requires less rudder correction than pushing sails (mainsail).
- Long keel vessels oscillate across the course slower and longer than short keel vessels.
- The more the yacht heels, the more YAW, the more rudder correction required.
- Down wind rolling will cause YAW (bow and bow down) requiring extra rudder correction.
- Reaching across the wind (sheets eased) the yacht behaves (as to windward) requiring less rudder correction but the push/pull actions needs careful set up and no rope slackness.
- Ketches and Yawls behave differently than a one mast vessel - refer diagrams page - and will require different sail balance techniques.

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WIND DIRECTION SETTING THE VANE

On any given day, a sailing yacht can be subjected to quite different sea conditions, wind strengths, and directions. The wind direction can change from ahead to abeam, or to astern as the yacht navigates its course. Naturally not always in this set order. However, what does not chant is the need to adjust the sails for each situation along with a small tweak to the self-steering gear.

WINDWARD SAILING OR "BEATING TO WEATHER"

This point of sail provides the highest apparent wind and therefore the most wind pressure is available to move the airfoil Most vessels will track very nicely to windward with minimum adjustment to the rudder when the sail plan is adjusted to suit the day's conditions and allowing for 10/15 degree inclination.

To operate the vane, turn the counter weight to windward, and adjust it until the airfoil is slightly inclined to windward, away from the upright neutral position. The servo rudder will be sweeping out from centre, probably around 25/35 degrees. If it is operating at its extreme usable angel (45 degrees) excess weather helm is present and must be reduced by adjusting the sail plan. The servo rudder will lose control over 45 degrees and must do its steering inside this angle.

REACHING

On any given day, this point of sailing always provides more apparent wind than running but less than beating to weather. The wind vane is set up the same way as for beating by adjusting the counter weight accordingly. This point of sailing requires a push pull action so **the control lines must be tight** to provide instant steering feedback to wind changes. **If not, the steering will be erratic**. The same control line set up will not show up on the other points of sail on the same day sailing in the same weather.

RUNNING

As there is less apparent wind on any given day on this point of sail, it will be the least responsive compared with the other point. In any event, the vessel must be travelling through the water at 2 to 2.5 knots before enough hydrodynamic energy is generated by the water flow to operate the servo rudder. The amount of air to achieve this will depend on the size of the vessel. To set the vane up, turn the counter weight into the wind (face it aft), the airfoil swings around its top upright position and the servo will sweep from side to side across the centre line. It may tend to sweep more on one side which indicates the vessel is trying to turn around its centre of gravity or the main sail is overpowering the Jib or vice versa. Pulling sails will always be better than pushing sails down wind.

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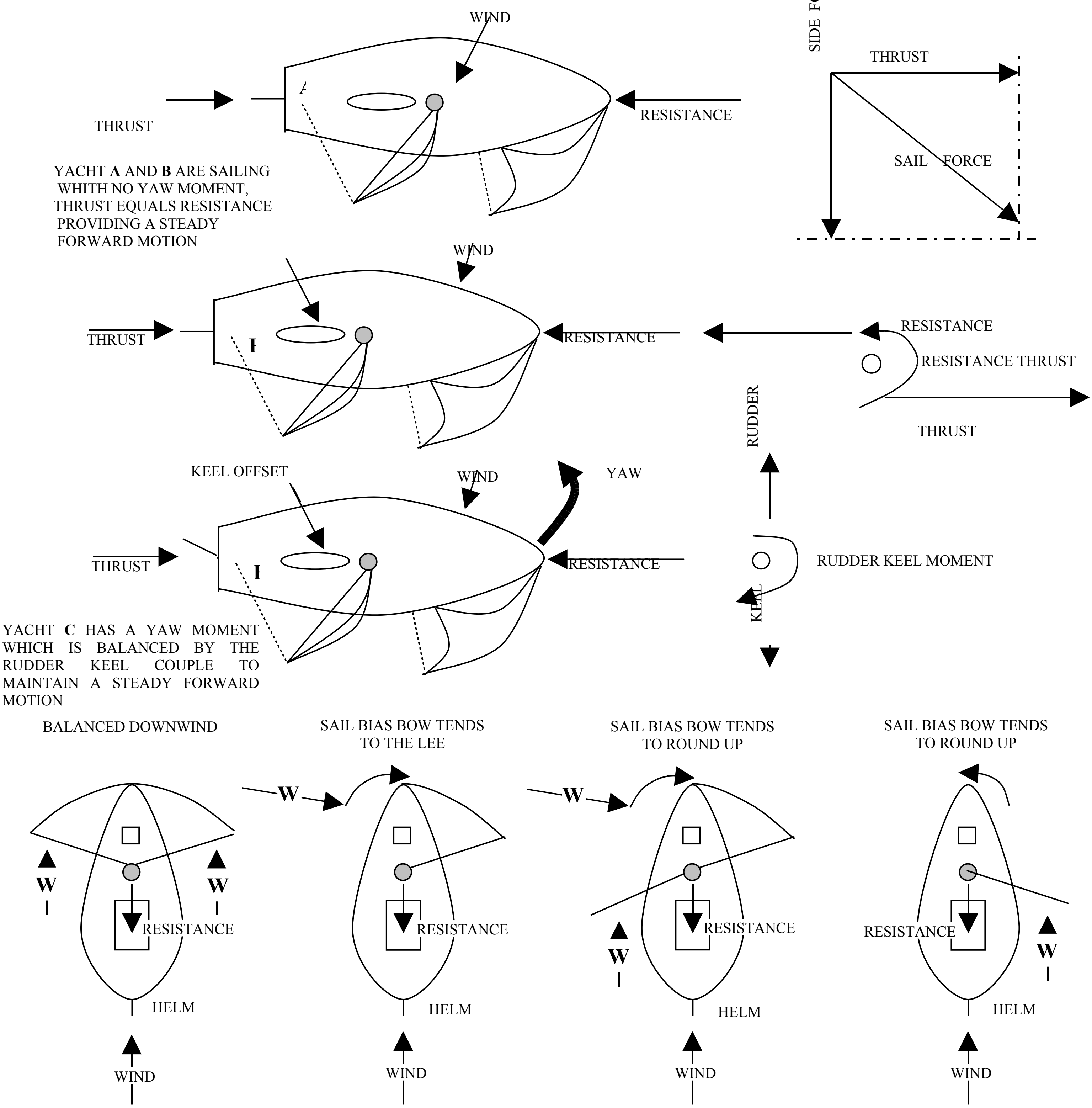
FORCE DIAGRAMS
AS APPLIES TO THE SAILING VESSEL



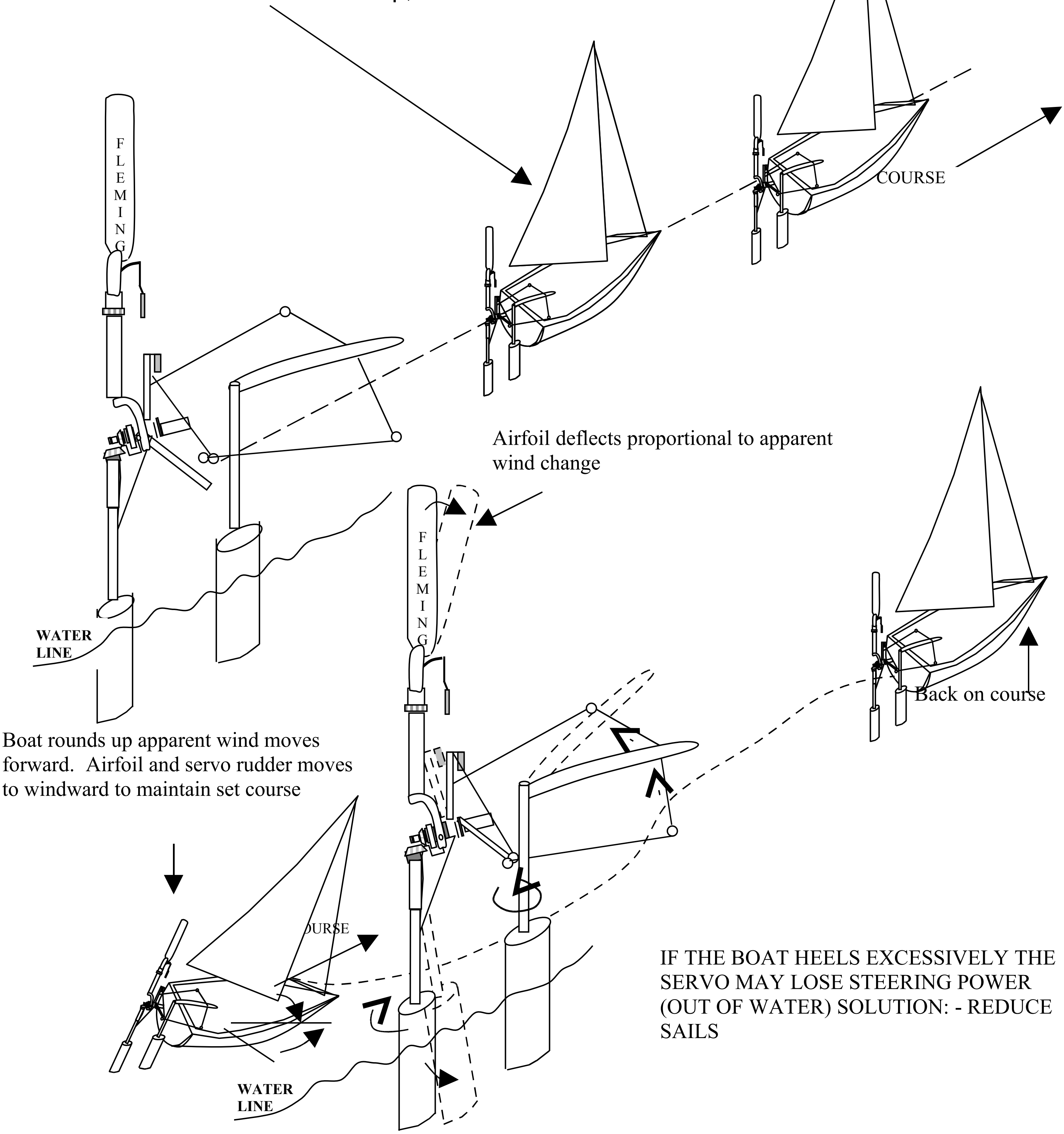
Examples are given for this important point of sailing
Twin headsails – best method
A single headsail – this rig can cause the vessel to turn to the lee
Wing & wing – especially with relatively small cutter rig Yankees can cause the vessel to round up.
Use a Genoa or MPS headsail in light conditions.

Yacht on course (beating):

Airfoil will have slight bias to windward to hold against minimum weather helm with well balanced sails. Heel approximately 0 – 10 degree maximum. Airfoil will move around this slight upright position.

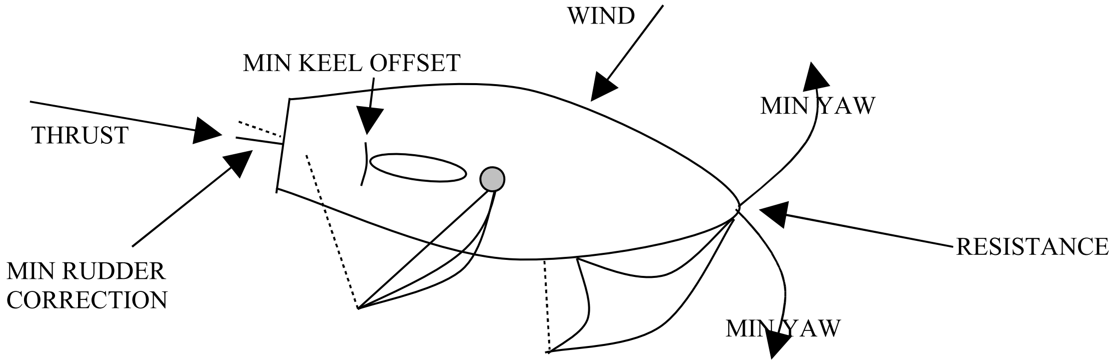
Solution:

If the boat tries to round up, reset vane and/or rebalance sails.

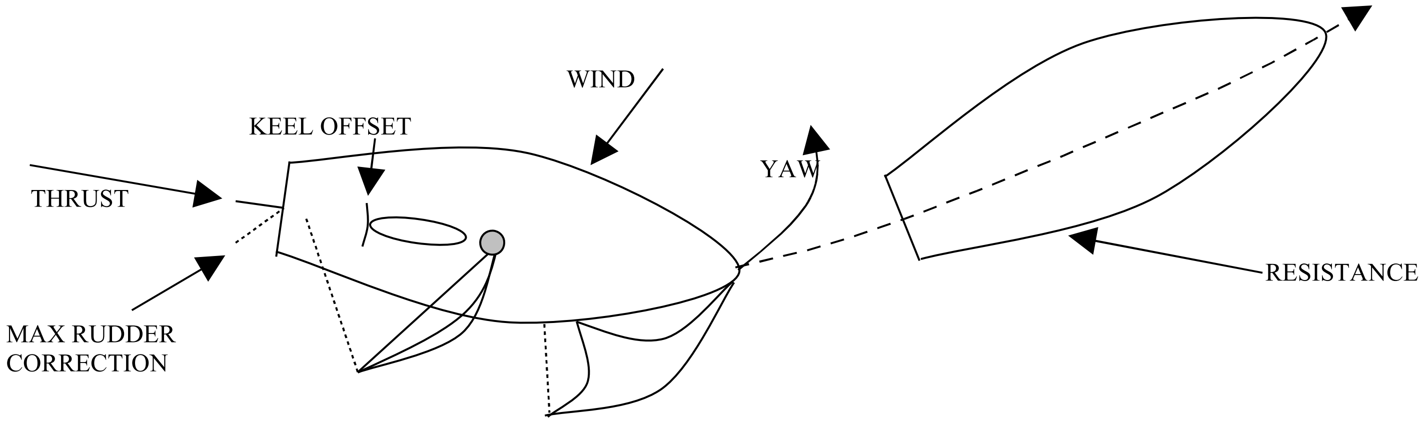


WINDWARD SAILING

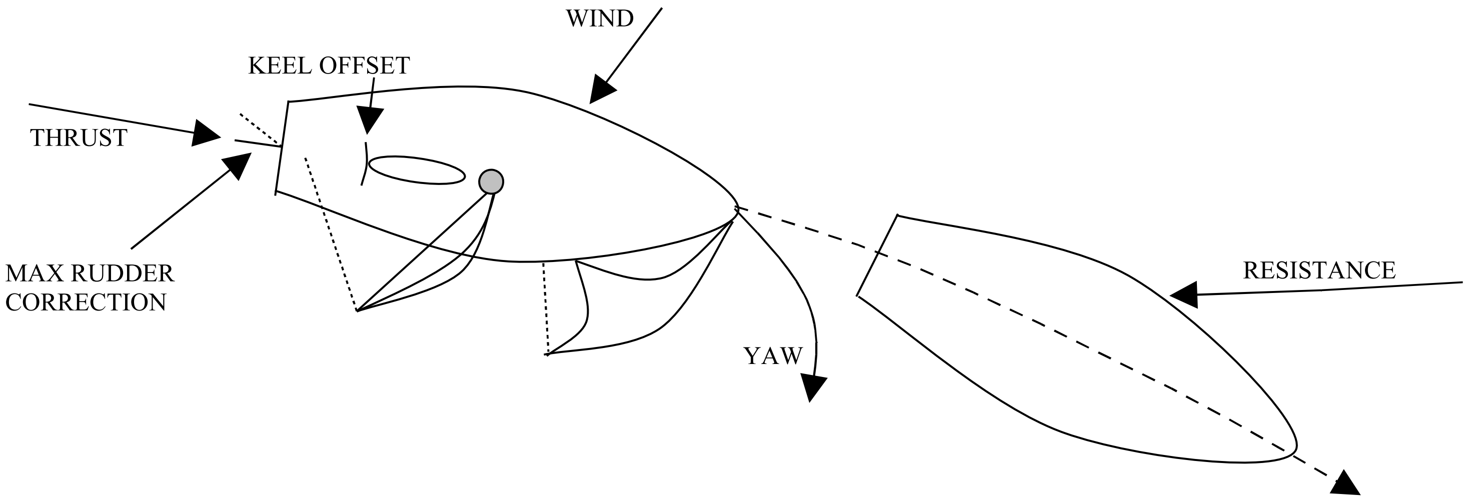
These general rules apply, although may differ with various rigs and conditions etc. if the servo "controls" but is fully deflected, rebalance the rig.



Balanced rig - vessel sails to windward with minimum heel and rudder correction heel approximately 10/15. (Minimum servo deflection) - **solution** – correct.



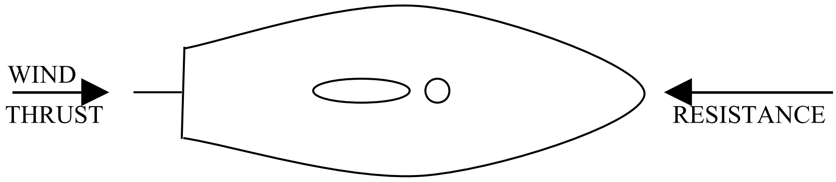
Mainsail overpowers head sail, heel increases, keel off set increases, vessel rounds up, more rudder deflection required, maximum servo deflection, say lose steering control – **solution** – detune main.



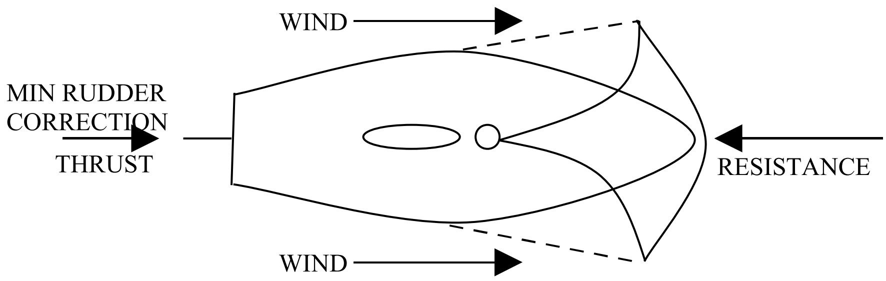
Head sail overpowers the mainsail, heel increases and the keel offset increases, vessel falls off the leeward. More rudder deflection required, servo may lose control – **solution** – spill the head sail or go smaller.

DOWNWIND SAILING

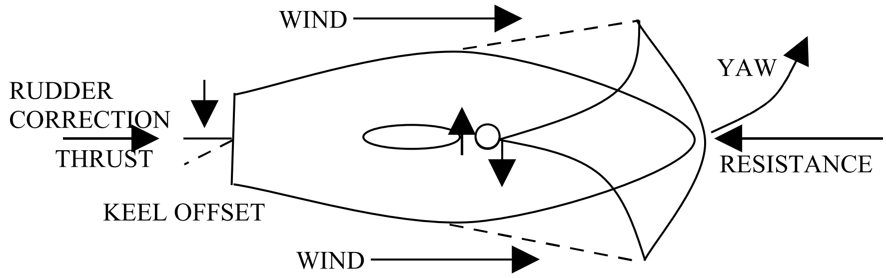
In general pulling sails is better balance than pushing sails, less turning moment with minimum rudder and servo deflection. A reefed main with working headsails often does the job as wind increases.



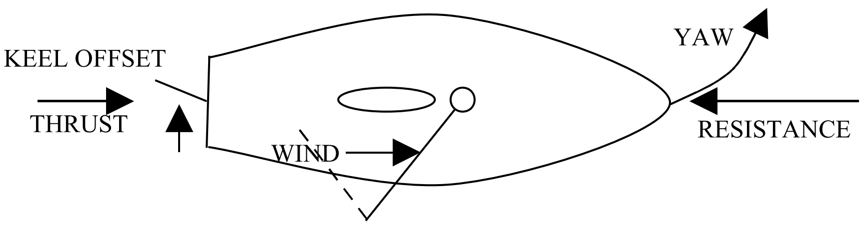
Bare poles (storm)
Running down wind
No turning moment
Minimum servo correction
Keel centre
Solution:
Min servo deflection



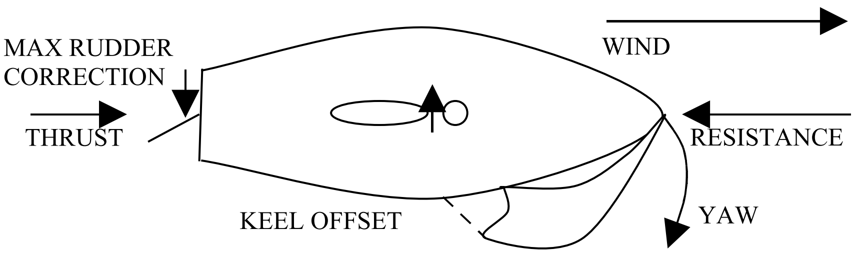
Running down wind
Balanced head sails
Min turning moment
Keel centre
Solution:
Minimum servo deflection



Running down wind
Rolling causes yaw to weather or leeward
The vane will attempt to steer back to set course.
Keel offset increases
Solution:
Re-adjust vane set



Running down wind
Main only
Vessel may yaw to winward
Large servo and keel offset
Solution:
Ease main



Running down wind
Headsails only
Vessel may yaw to leeward
Keel offset increases
Solution:
Reduce sail

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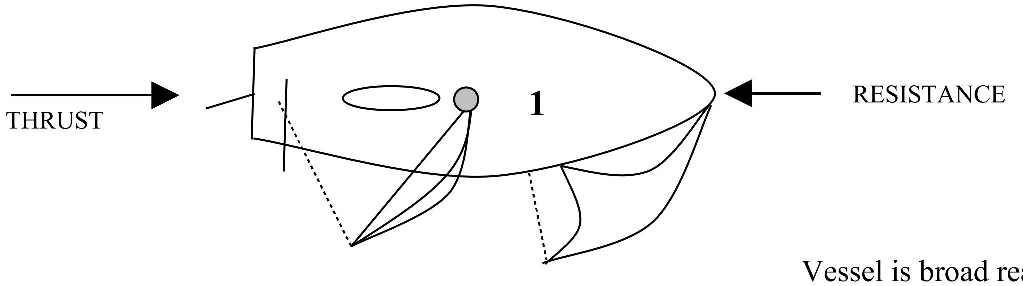
BROAD REACHING

This lazy enjoyable point of sailing often causes vane steering problems as shown in sketch 3. The type of vessel will have an effect e.g. stiff hulls with short rigs will not roll as much as narrow hulls with tall rigs. Steep cross seas when the vessel loses the wind between waves aggravates this problem. **Solution**: set a course more to windward to ensure the roll and yaw is within vanes set capability (e.g. watch the airfoil does not back wind).

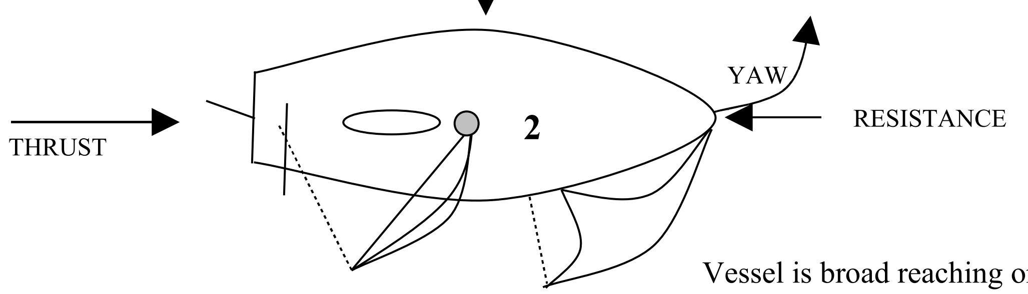
BROAD REACHING ON A SET COURSE
The sails are trimmed and the rudder set to balance the existing thrust/resistance couple.

The rudder is set to balance a small weather helm as per example 1.



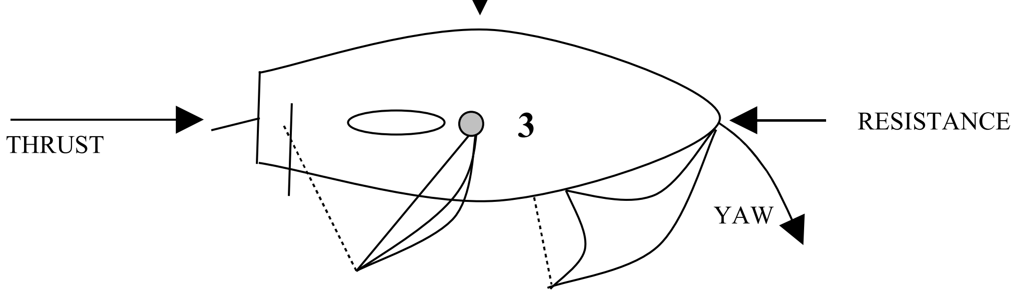
Vessel is broad reaching on a set course (sketch 1)
Vessel rolls to leeward, causing a yaw to windward

Solution: airfoil will reset vane servo deflection to new apparent wind.



Vessel is broad reaching on a set course (sketch 1 & 2)
Vessel rolls to windward (stands the boat further upright) causes a yaw to leeward, further turning the vessel off the wind.

It may not return to the set course
Solution: re-set the airfoil



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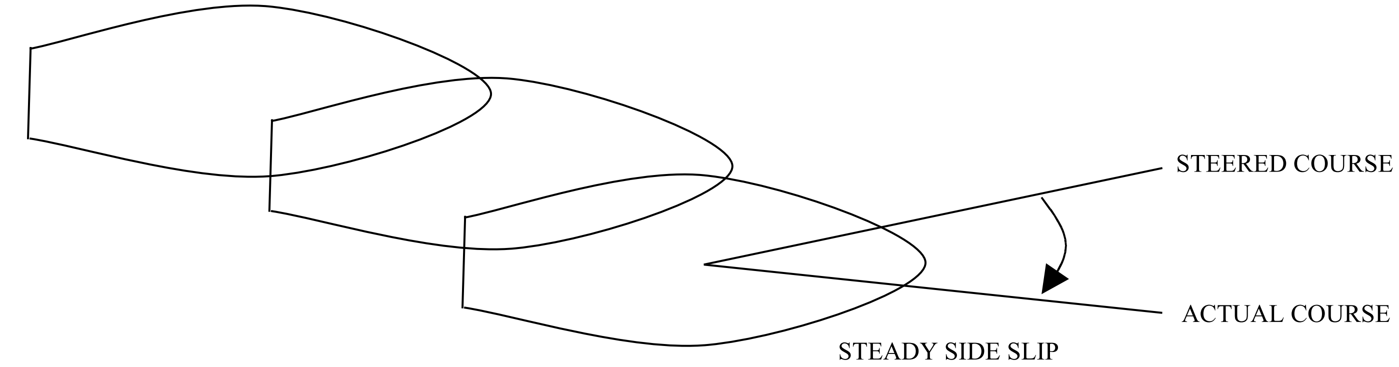
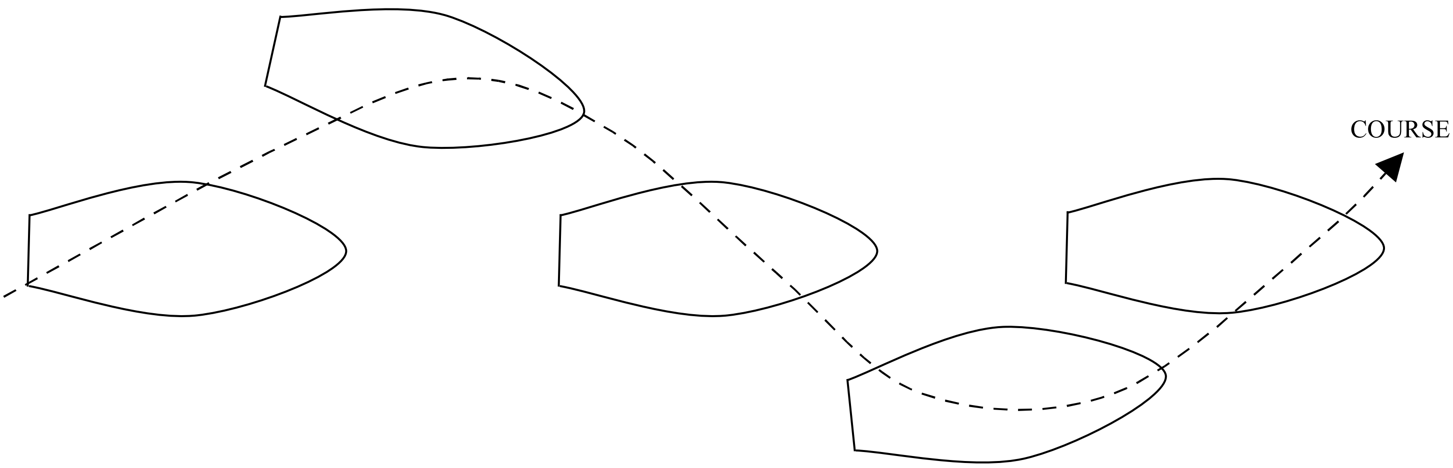
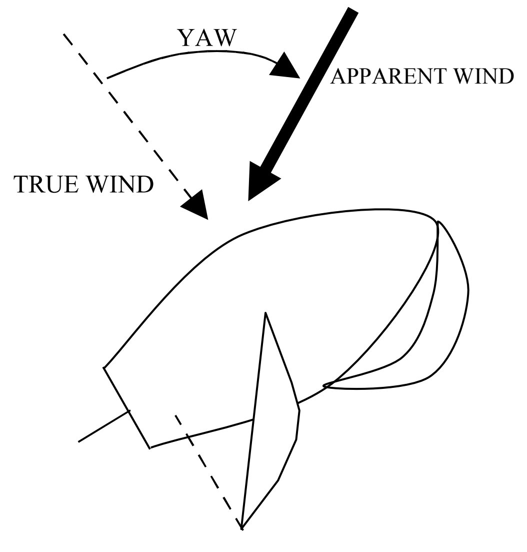
YAW, ROLL AND SIDE SLIP

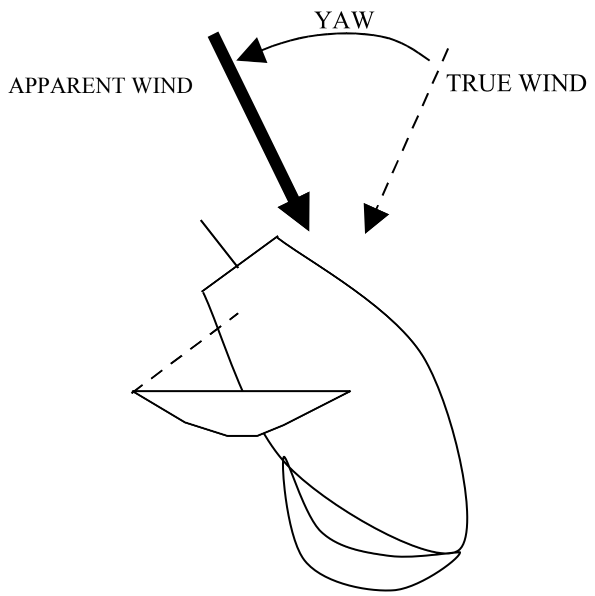




STEADY ROLL, YAW AND SIDE SLIP – quite normal experience averaged over many ocean miles, the vessel will still arrive at the same approximate location



YACHT SAILING TO WINDWARD DRAWS THE APPARENT WIND FORWARD ON ACCELERATION OR LULL IN TRUE WIND - SAILS WILL "BACK WIND"



YACHT SAILING DOWN WIND DRAWS THE APPARENT WIND AFT WHEN SHE DECELERATES OR WHEN WIND PRESSURE INCREASES. YACHTON A RUN THAT ACCELERATES WILL SEE APPARENT WIND DECREASE

SECTION 6

TROUBLE SHOOTING YOUR FLEMING SYSTEM

The **ABC** of satisfying sailing –

Always set the counterweight to windward.
Balance your boat to eliminate excessive weather helm.
Connect your control lines correctly, with a minimum of slack.

Literally thousands of yachts fitted with Fleming Self-Steering Systems are sailing successfully in all of the world's oceans. If your Fleming System is not performing property, the problem can be found in one of these four areas: -

1. Wind Vane Mechanics
2. Installation/Connection
3. Vessel Mechanics
4. Operational errors

1. Wind Vane Mechanics – The wind to water gear train

At the wharf

With the counterweight attached and the servo rudder in the water, the airfoil should move easily with a light touch. When pushed to full deflection to either side it **should re-centre in the upright position smoothly and relatively slowly**. This motion is carefully tested in factory assembly and would only be affected by damage from rough handling during delivery or installation.

If there are concerns, you must decide which part of the drive train is the problem –

a. Detach the counterweight and the airfoil. Carefully remove the E-clip from the airfoil pivot and slip off the bronze bush to detach the push rod. This will allow you to feel the movement of the airfoil pivot casting on its roller bearings. **Its action should be smooth and easy**.

   If the airfoil pivot is binding, loosen the nylock nut on the M10 axle using a pair of 17 mm ring spanners. This nut must be just tight enough to stop the shaft rotating and allow the airfoil to pivot on its bearings. Too tight, and it will squeeze the arms of the airfoil holder casting and jam the pivot. If the axle begins to rotate before the airfoil pivot is free, remove the small delrin washer at the top of the inclined axis. Shave it down or replace with a thinner one. If the "fork" of the air foil top support casting still squeezes the air foil holder castings, remove this top washer altogether. A little movement of the airfoil holder casting on the axis is all right.

b. If the airfoil movement is smooth, the problem must be in the bearings of the horizontal gear.

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Sailing

Is the counterweight set to windward?
Is the airfoil free to swing to full deflection throughout the 360 degree rotation?
If there is less than 20 knots of *apparent wind*, use the larger airfoil.

Pushrod adjustment

The pushrod must be free to turn with light finger pressure. In normal operation the course setting mechanism rotates around the pushrod. Ensure that neither nylock nut (at each end of the pushrod) has been tightened against the upper or lower casting. The pushrod is factory set so that when the airfoil is upright, the servo rudder is centred fore and aft. When the airfoil is deflected to its stops, the servo rudder should rotate to the same angle on each side (very slight variation can be expected).

However, there may be slight variation in the shape of the servo rudder, which will require a final adjustment of the pushrod after the system has been sailed. To make the adjustment, first move the lever of the horizontal gear to determine whether the pushrod has to be lengthened or shortened to put the servo rudder amidships. Then loosen the lock nuts at one end of the pushrod with a pair of open-ended 10 mm spanners and spin the lock nut clear. Finger pressure on the head of the metal thread will hold the screw in the casting so the pushrod tube can be rotated to alter its length. To keep the adjustment threads even, re-lock the loosened nuts and repeat this process at the other end of pushrod.

Note: When making this adjustment, the pushrod must not be set too long. Test pushrod length by swinging the servo arm up to starboard until it “picks-up” the lever on the horizontal gear. Swung to its maximum of 95 degrees the servo arm must contact the bottom turret support casting with the airfoil pivot at the top, still clear of its stop so no strain is placed on the pushrod. In the rare instance where servo rudder alignment cannot be adjusted without the pushrod becoming too long, the gears have been meshed one tooth off position, to correct this problem, see the next subheading …

Gears

Connection between the airfoil and the servo rudder is a “crown wheel and pinion” arrangement. When moved by hand the main vertical gear, atop the servo rudder shaft, should have a very slight amount of play against the teeth of the small horizontal gear driven by the airfoil pushrod. However, when moving the airfoil itself back and forth, the gears should rotate with no noticeable play.

Meshing of the gears is controlled by the position of the split thrust washer, which is set carefully in factory assembly. It can be adjusted by loosening the two small bolts holding the two segments together. When properly set, this split casting holds the horizontal gear lightly in mesh with the vertical gear without thrust pressure. Where the pushrod is too long (see Note above) the mesh of these gears must be adjusted by one tooth. Remove the cast split thrust washer from forward of the pinion gear. Keep the segments together by unscrewing one nut right to the end of its thread and completely removing the other. The horizontal gear can then slide to clear the mesh, be turned one tooth and be re-engaged. Replace the split washer and re-adjust the pushrod length to align the servo rudder.

Servo rudder

- The servo rudder is hollow and designed to provide some floatation. Check its watertight integrity. Any leak must be patched.
- With the yacht at rest in still water, no more than 100 mm of the servo rudder should be exposed. Under way the wake should submerge the servo rudder.
- The shear pin swing assembly should be above the water when under way so that floating debris will strike below the shear pin axis.

2. Installation/Connection

Mounting

Check that all fasteners are tight. Test the mounting of the installation by grasping the ends of the cross arm at the control line blocks. Try to twist and move the unit from side to side. It should be stable with very little or no play.

Control Lines

Control lines must be run per the installation instructions. Check for areas of friction. Control lines should be low-stretch 8 mm braided line, neither too tight nor too loose. Lead blocks should be fixed turning blocks – NEVER double swivel blocks, because the lines move opposite to each other, swivel blocks tend to twist and bind. Use as few blocks as possible with a minimum of turning angles. All mounts for the blocks should be solid.

To test at the wharf, engage the clutch pin and move the wheel or tiller slightly. There should be no slack in the system nor should it bind from being too tight. Move the wheel to starboard, the servo rudder should move to port. Make sure that the line is not slipping on the wheel drum. While under way, if you manually move the airfoil to port the servo rudder should swing to port and the yacht should turn to starboard.

3. Vessel Mechanics

Steering System

Is your vessel's steering system mechanical or hydraulically operated? How many turns from hard over to hard over? The Fleming steering wheel adapter is designed with the correct 'lever' to operate the wheel of a mechanical cable or rod system within the range of 1.5 to 2.5 turns from hard over to hard over.

Tiller steered vessels require the attachment point of the control line to be from 600 to 750 mm from the rudder stock.

Check for excess friction in the vessel's own steering system. With the boat at rest and the Fleming unit disengaged, the wheel or tiller should be **moved easily** through full travel **with the pressure of one finger**.

Is there excessive play when initiating a turn? Play in the yacht's own steering will lessen the wind vane's efficiency. If you discover friction in the vessel's steering system its cause must be eliminated for proper function of your Fleming steering system. A checklist would include: -

- The connection of a compass controlled autopilot system
- Lubrication and adjustment of the steering system
- Inspection of the rudder for stiffness in bearings or attachments

4. Operational Errors

The balance of the yacht

Please refer to **Sailing with your Fleming Wind Vane** for suggestions on adjusting the sail plan. Your Fleming Self-Steering System is a capable device, which reacts rapidly to changes in sailing conditions, but, like every form of automatic steering, the Fleming is only reactive – it cannot anticipate what is to happen. In gusty conditions, constant sheet trim will be required and it may be necessary to reduce sail to avoid excess heeling which gives overpowering weather helm. Try different sail combinations to discover which sails work best in the various conditions and points of sail. Experiment with sheet trim to better balance the helm. Every yacht is different and various sail plans need to be tested to discover the optimum performance.

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SECTION 7

AUTO PILOT ADD ON

The addition of a simple tiller auto pilot to a Fleming Self Steering System has proven to be a very successful way to achieve compass course steering. Combination of the capabilities of the two systems offer genuine low battery load course keeping. The auto pilot only operates the air foil mechanism. Energy to steer the boat comes from the Fleming System's servo rudder.

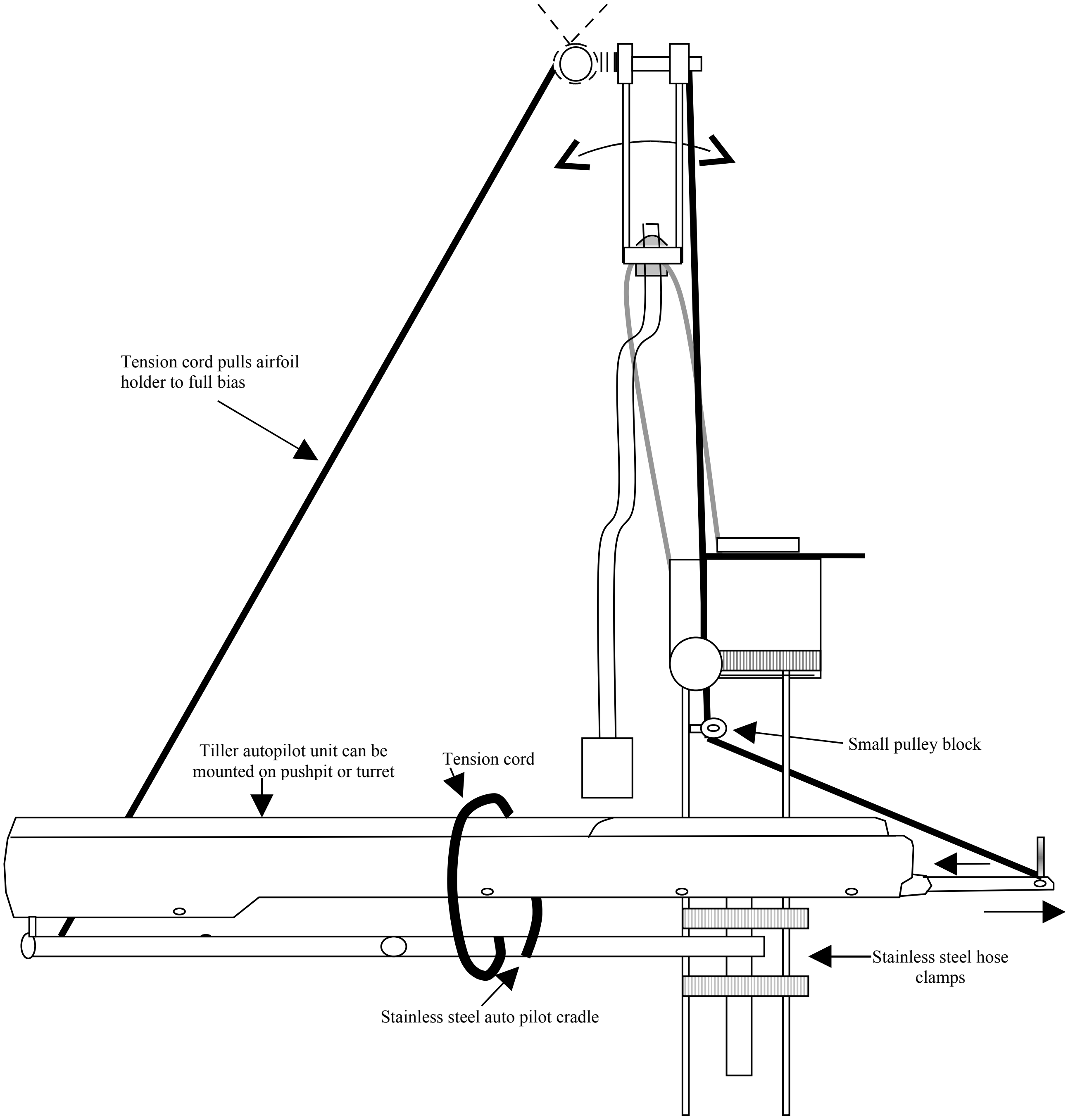
Many clients, convinced by manufacturer's claims first tried to use power driven steering units, but their experiences have shown that in a conventional cruising yacht, it is not cost effective to install the equipment needed to generate this energy.

We suggest that there is value in a tiller auto pilot unit with a remote control pad. This is especially so in the case of centre cockpit craft or double enders where access to the unit to make course adjustments is not easily available.

The sketch illustrates a simple, effective way to install an auto pilot. Some clients have adapted our ideas to fit their tiller units on push pit rails or on the framework which carries solar cells and radar.

It is most important to note that whichever system is used to sail the yacht, neither is a replacement for proper watch-keeping. In fact, in ocean passages, the steering of a compass course will necessitate greater attention to sail trim than allowing the Fleming air foil to maintain yacht's head relative to the wind.

SEE DIAGRAM



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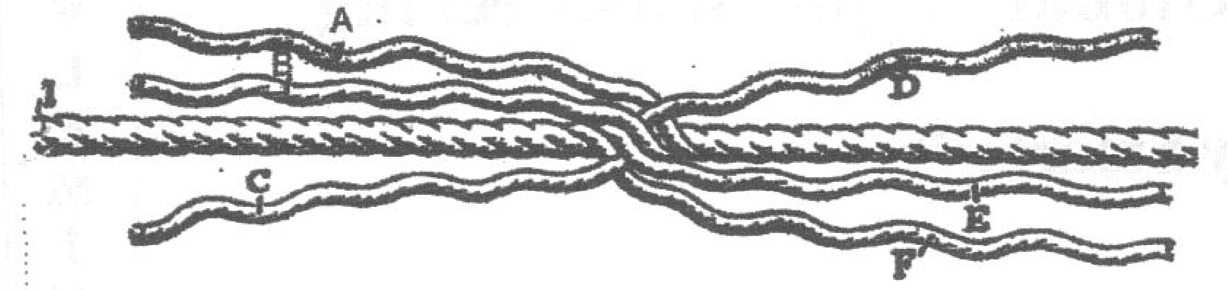
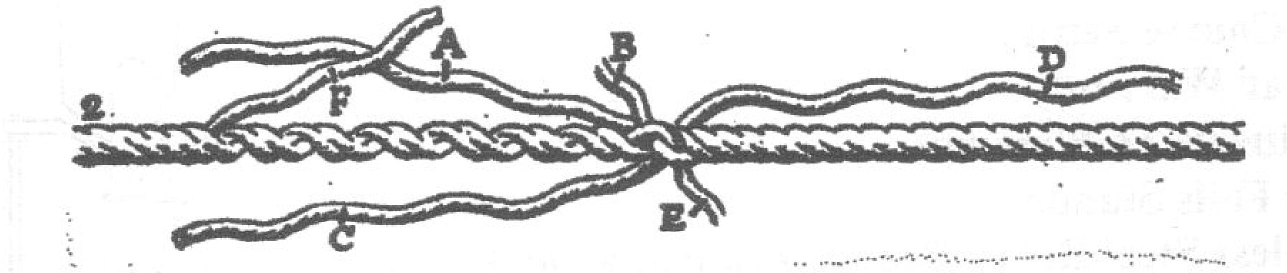
THE LONG SPLICE – FOR THE CONTROL LINE

In setting up the control line from the Fleming System to the cockpit, a long splice is necessary to create a continuous whip. The method below is reproduced from material prepared by rope makers.

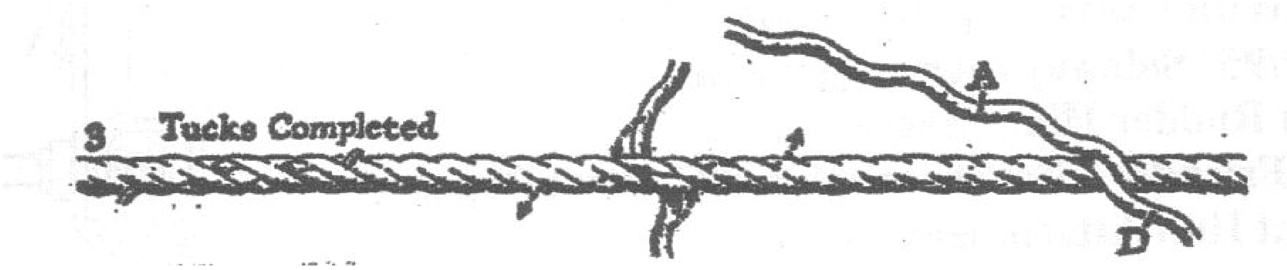
Temporarily whip each strand. Now carefully unlay the strands of ends of the rope for a distance of about 15 to 18 inches and clutch them together as in Diagram 1.



Take the two opposing centre strands, B and E, and tie a left hand hay-knot, as show in Diagram 2.



Do not cut the strands off and do not draw the half-knot up tightly. In Diagram 2 the strands have been lopped off for the sake of clarity. Next unlay strand F, and as you do so lie in strand C, following as closely to F as possible. When you reach a point about 12 inches to the left, tie a half-knot, just as you did with strands B and E and tuck the strands as shown in Diagram 3.



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In a like manner unlay strand A about 12 inches to the right, lying strand D in its place and half-knotting them together. You now have a single span of rope, with three half-knots about 12 inches apart.

When tying the knots the strands should be untwisted a half turn to flatten them a bit and make the knots less bulky. Each strand is tucked once, then half of the yams are cut out underneath and the remaining half are tucked once more. Now roll the splice under your foot to flatten the knots, cut off the strands and the job is done.

This is the critical point where the beginner often goes wrong. You must go over every inch of the splice and examine every strand for tightness or looseness. Each strand must have the same lay and tension throughout or the splice will be worthless. If you find one strand that is looser than the rest it must be unlaid and repositioned. The half-knots should be drawn up snugly without undue tension.

Do not expect the splice to be invisible, although it is possible with a more elaborate technique. It is enough that it be uniformly smooth and even and with a moderate degree of success, it will fly through blocks with the greatest of ease.

SECTION 8

PARTS LIST FOR GLOBAL EQUIP 350 AND 400

PARTS LIST FOR GLOBAL OFFSHORE 401 AND 501

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WARRANTY

FLEMING MODEL: ____________________________

SERIAL NO: ____________________________

DATE: ____________________________

OWNER'S NAME: ____

ADDRESS:____

CITY:______________________STATE:____________________P/CODE_________

COUNTRY:____

VESSEL NAME:____

DOCUMENT OR CF#____

SIGNATURE:________________________________ DATE:___________________

Fleming Marine Engineering and Sales warrants each Fleming Wind Vane to be free of defects in materials and workmanship for a period of 2 years and for the first owner only. The warranty shall become effective upon delivery and shall identify the product as registered by the serial number. This warranty shall remain in effect for the lifetime of the first owner.

Since this warranty applies to defects in material and workmanship, it does not apply to normal worn parts, or the damage caused by neglect, lack of maintenance, accident, abnormal operation or improper installation or service.

Our obligation under this warranty shall be limited to repairing a defective part or, at our option, replacing such part or parts as shall be necessary to remedy any malfunction resulting from defects in material or workmanship as covered by this Warranty. Fleming Marine Engineering and Sales will pay one way"of the return freight" to the clients' original point of sale or an equal freight cost to any new destination. We reserve the right to improve the design of any Product without assuming any obligation to modify any Product previously manufactured. All incidental and/or consequential damages are excluded from this Warranty. Implied warranties are limited to the life of this Warranty.

Fleming Marine Engineering and Sales building Fleming Self-Steering Systems Worldwide.

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