

# The Windvane Self-Steering Handbook

Bill Morris



*A comprehensive, user-friendly introduction  
to the long-distance sailor's best friend, including:*

• How vane gears work • How to choose the right one for your boat • How to

# The Windvane Self-Steering Handbook

**Bill Morris**

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# Preface and Acknowledgments

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**M**ounted on a workbench in a machine shop, a modern servopendulum gear might appear to be just a bunch of stainless steel tubes or aluminum extrusions pointing this way and that, like some art nouveau rendition of Medusa. You dip the airvane to one side with your finger, the servo blade turns a little, and then you notice that the blade also swings freely back and forth, now rotating through two axes, even as you manipulate the airvane. “How the heck can this thing steer a boat?” was my naive response when I first set eyes on the Fleming steering gear I was about to purchase. It was early June, and my girlfriend and I had driven to San Diego to pick up the vane gear in preparation for my single-handed mini-shakedown cruise to Ensenada that summer. We looked in the shop, and seeing no one there, walked across the shop floor to a sparkling new windvane mounted on a workbench. As we studied the mysterious, shiny machine, an unshaven, weather-beaten gentleman walked up behind us. “G’day, mates. I’m Kevin Fleming, and that there is the vane gear you ordered.”

In a deliberate, matter-of-fact style, he explained how the unit was constructed and how it worked, and then shared some of his own sailing experiences under vane steering. Later, when I deployed the gear for the first time just outside Los Angeles Harbor, the boat bashed about, sailing in circles, hopelessly at the tender mercies of a psychotic, stainless steel tyrant. I quickly discovered that I had turned the airvane the wrong way into the wind. The two-day sail to Ensenada was memorable: I knew then that I could sail forever with the vane gear at the helm. Since then, I have sailed nearly 20,000 nautical miles with the vane gear, and am still learning more about this fascinating machine.

In my conversations with Kevin and numerous other vane gear builders, all of them have expressed the same zeal—no, obsession—with their creations and with their lifelong search for the perfect vane gear design. They have spent years experimenting with gear mechanisms, push rods, hydrofoil lift characteristics, and construction in stainless, bronze, and aluminum alloys. So complex is the balance of forces in vane gear steering that the first successful horizontal-axis vane servopendulum did not appear until the mid-1960s, several years after astronauts had already orbited the earth! Since then, a small handful of truly original designs have established themselves in the vane gear industry, and variations of those designs have broadened the family of self-steering gears available for the cruising sailor.

My intention in writing this book was to express briefly and concisely, in simple, unbiased terms, the underpinnings of a science that has remained elusive and esoteric for too long. If I do have a bias, it is that windvane systems are the only reliable means of steering a small vessel, aside from crew taking turns at the helm, on long ocean passages. It is pure folly for shorthanded crew to depend exclusively on an electronic system. I am not in the business of building vane gears, nor do I formally endorse any of the products I discuss in the ensuing pages. My first goal here is to point out the mechanical and navigational advantages of a vane steering system. More than a mere option for shorthanded crew, vane gear steering is a natural extension of sailing itself. My second goal is to give sailors some idea of the range of windvane steering products available to them, including sizes, prices, and contact information. However, I have avoided proposing any formal rating system, since the vane gear each one of us selects depends on vessel size, transom configuration, type of main steering, and personal preference. Finally, it is important that cruisers learn how to install, maintain, repair, and modify vane gears for best performance—and even build a vane gear if they have the time and inclination. When we are hundreds of miles from modern repair services or an airport where we could receive shipments of parts, we learn to improvise with the tools at hand.

The research for this book has drawn from an assortment of sailing friends, windvane manufacturers, and secondary sources. First, I owe a huge thanks to fellow sailors Scott and Wendy Bannerot of *Élan* (Florida) for their explicit details on maintaining and modifying a vintage Aries vane gear, and ultimately convincing me to finish this book. Hans Faber of *Born Free* (Stockholm) explained the delicate engineering characteristics that make a servopendulum gear function while I smoked his cigars and drank his Scotch in French Polynesia; our conversations helped inspire me to write a book about windvane self-steering. It was serendipitous that I met Tony and Mitsuyo Williams on the Catalina 42 *Windriver* at the Balboa Yacht Club in Panama; they related to me the story of how they had helped bring about the creation of Scanmar International's "Swing Gate" Monitor mounting system. For their knowledge

and experience with homebuilt trim-tab gears, I thank Bill Bailey of *Apollo* (Honolulu); David Webb, formerly of *Arcady* (San Pedro); and Bruce Wells of *Pyxis* (Queensland). Frank and Kaye Pearce of *Gingerbread Man* (Queensland) helped me get a close look at the process of rebuilding and customizing a vintage RVG trim-tab unit. I learned lots about the operation of Aries and Sailomat vane gears from David Berg of *Kismet* (Pago Pago) while he shared fun stories and poignant observations based on years of experience with those systems. David's wife Mary collected numerous articles on vane gear steering in cruising magazines, contributing greatly to my research. Laurent Clarot of *Banana Split* (New Caledonia) provided an opportunity to study the ins and outs of installing a Cape Horn vane gear to the sugar-scoop transom of a 42-foot ketch. Tom and Dee Bridgman showed me how to operate a Hydrovane aboard *Axe Calibre* (Axmouth, England), helping me to appreciate the inner workings of this incredible apparatus. Jack Dunn of *Fair Rose* (Queensland) gave me a copy of John Letcher's *Self-Steering for Sailing Craft* for my birthday—after I had spent two years looking for the book—and helped point me in the right direction for gathering more information on NACA foil profiles and rudder balance. I also deeply appreciate Charles Doane's technical review of the manuscript and providing me with valuable feedback that helped bring this book to fruition, and the work of legendary technical artist Jim Sollers.

The following individuals provided valuable technical advice, published materials, photographs, and insight regarding manufactured vane gear systems: Hans Bernwall, Scanmar International; John and Karen Curry, Hydrovane Self-Steering; Kevin Fleming, Fleming Self-Steering Systems; Peter Förthmann, Windpilot; Yves Gélinais, Cape Horn Marine Products; Dr. Stellan Knöös, Sailomat; and Peter Matthiesen, Aries Denmark.

Finally, Deborah Oliver, Jon Eaton, Molly Mulhern, and Janet Robbins of International Marine weathered the storm with their patience, guidance, and creative input while working around my sailing schedule; for all their efforts, I owe them great thanks.

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# Introduction

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**T**he *Windvane Self-Steering Handbook* is exactly what the title suggests: a comprehensive manual to help you understand the practical aspects of sailboat self-steering based on power from the wind. A few other books dedicated to this subject have appeared in the English language over the last four decades, certainly the most widely known of which is John Letcher's *Self-Steering for Sailing Craft*, published by International Marine in 1974. Letcher gave us one of the best dissertations in existence regarding sheet-to-tiller steering, and prophesized a new generation of windvane steering devices. To would-be vane gear designers, he wrote, "Achieving successful windvane self-steering is not nearly as easy as it looks." Of his own attempt at designing and building a vane gear for his boat, he said, "My first satisfactory permanent installation took an astonishing 175 hours to design, build, and install—which is more than one-eighth of the time it took to design and build the boat!" In considering a vane gear design for our vessels, whether we buy a manufactured unit or build one ourselves, we should take to heart another of Letcher's memorable quotes: "Probably no installation will completely satisfy all the ideals; everyone has to make his own bargain with the devil."

In the last thirty years, true to Letcher's prophecy, countless new products have appeared on the windvane market, and vane gear designers have competed to offer stronger, lighter, and more efficient designs to cruising sailors. For this text I have taken great care to showcase products that have distinguished themselves as market leaders. The list of ten models, along with some of their variations, is based solely on my subjective judgment, not on any quantitative analysis of engineering specifications, durability, price, annual sales, or other objective

criteria. I am sure there are other very fine vane gears available to sailors, and I encourage you to learn more about them.

I have tried to keep explanations in this book as simple and straightforward as possible. The descriptions of self-steering technology are from the point of view of a cruising sailor, not a marine engineer. Any theory you find in these pages is not meant simply to satisfy your intellectual curiosity, but to assist you on the practical level in selecting, installing, and maintaining a wind-powered steering system. To that end, the book is light on NACA lift principles, foil cavitation, and rudder balance, but heavy on sail rig balance and galvanic corrosion. In the last chapter are sketches and explanatory notes on the West End horizontal-vane auxiliary-rudder trim-tab system. Though of my own rough design, it is in truth an interpretation of other vertical- and horizontal-vane designs I have observed and studied over the years.

Even as I write about, say, balancing a sail rig or building an emergency rudder, I sometimes fail at controlling the impulse to tell a story. The anecdotes and bits of sardonic humor are meant to make a point, and to lighten up what otherwise could be some rather dry reading. Here and there you will encounter snippets of my sailing experiences and those of others as well. In this way you gain from the accumulated experience of other sailors who have found ways to solve difficult problems related to self-steering. The father of a childhood friend once admonished me, "Pain is the greatest teacher." For years I argued with that statement in my mind, putting faith in all the psychobabble I had learned in college. The wisdom of my elders began to make a lot more sense when I left Los Angeles Harbor in a 30-foot sailboat, cruised down the coast of Mexico and Central America, and headed out across the Pacific Ocean. When reflecting on mistakes made before and during a hellacious gale between Tonga and Fiji, I recall one of my grandmother's favorite sayings: "Once burned, twice taught."

Common sense tells us that when we open the toolbox to work on our boats, we are totally accountable for whatever job we undertake. By following the suggestions in this book, you assume full responsibility for any damage incurred by vessel or vane gear, or by any equipment you elect to use. You also assume full responsibility for any personal injury resulting from procedures followed in this text. Furthermore, I cannot guarantee the proper operation of any system or mechanical device covered in this book; there are too many variables involved for anyone except the manufacturer, installer, and skipper to answer for the functioning of a particular onboard system.

I have done my level best to ensure the accuracy of all the information in this volume. But even after extensive research and communication with individual vane gear builders, errors may have found ways to creep into the writing. For this I apologize. Changes in prices, measurements, design, construction materials, and other such details are inevitable, and may have occurred between this

writing and the time of publication. Again, I encourage you to keep abreast of the most recent changes, especially if you are planning to buy a new vane gear.

The use of a few terms deserves some clarification here. Among sailors, *vane*, *airvane*, *windvane*, and *airfoil* are used as synonyms. However, there is some disagreement on the technical accuracy of using the terms interchangeably. According to the current *Merriam-Webster's Collegiate Dictionary* (11th ed.), the term *airfoil* denotes "a body (as an airplane wing or propeller blade) designed to provide a desired reaction force when in motion relative to the surrounding air." The same dictionary defines *vane* as "a movable device attached to an elevated object (as a spire) for showing the direction of the wind," or "a thin flat or curved object that is rotated about an axis by a flow of fluid . . ." Vanes, or airvanes, then, appear to be a subset of airfoils. To eliminate confusion, *airvane* and *vane* in this text refer to a tall, flat, or wedge-shaped object standing atop a self-steering apparatus for the purpose of harnessing the wind's power. Occasionally, you will find the word *foil* indicating a *hydrofoil*. Where the term *foil* appears alone, its application should be clear from the context.

To indicate the whole self-steering apparatus in a generic sense, I use the terms *vane gear*, *self-steering gear*, *windvane self-steering*, and similar combinations whose definitions should be, again, eminently obvious by their context in the paragraph. Submerged foils have varied purposes, and I have tried to be clear as to their discrete applications. In the self-steering literature, you will also see the terms *servo blade*, *blade*, *servo oar*, *servo paddle*, and *servopendulum* used as equivalents; for our purposes, however, the *servo blade* is the submerged foil essential to all *servopendulum* vane gears. The term *servopendulum* may refer to either the servo blade and shaft, or to the class of devices built on this principle.

## WHAT YOU WILL FIND IN THIS BOOK

The following summary is meant to acquaint you with the contents of this text. As with many technical and quasitechnical books, you need not read every page of every chapter in order that the desired information gel and make sense. If you are familiar with the workings of vane gear systems, but want to learn more about purchasing a previously owned unit, you may elect to start with chapter 6, Purchasing a Used Vane Gear. If you need specific information on repairing your vane gear or would like to make some modifications to the unit, you might wish to consult chapter 9, Maintenance and Repair, or chapter 10, Customizing Your Vane Gear, and so on. Refer to the figures and illustrations as you read, pointing to the various components with a pencil as you follow the descriptions.

### Chapter 1. An Overview of Sailboat Self-Steering

Which is the better type of steering for a sailboat: windvane or autopilot?

Sailors argue heatedly over this question, but for most, installing both systems on the average sailing vessel seems to be the preferred strategy. The chapter starts with a look at both sides of this question, while maintaining that a windvane steering gear is an essential system on vessels under roughly 45 LOA, regardless of whatever other self-steering arrangements are on the vessel. We will also take a quick tour through windvane self-steering history, highlighting major events and turning points over the last century that have led to the many fine windvane systems available on the market today.

## **Chapter 2. Wind-Powered Self-Steering Systems: How They Work**

This chapter gives a quick summary of the main components and operating theory behind sheet-to-tiller steering and each of the several types of vane gear systems. The first of the vane gears is the vertical-vane trim-tab gear, generally homebuilt for either a transom-mounted main rudder or auxiliary rudder. The next is the horizontal-vane trim tab, a more complex evolution of the vertical drive, and available through at least one manufacturer. In the same manner as its predecessor, the horizontal-vane trim tab may be mounted on the main rudder or on an auxiliary rudder. More for history's sake than anything else, you will find a description of Blondie Hasler's vertical-vane servopendulum, which in its time was a groundbreaking innovation in modern mechanical self-steering. You will also learn how the contemporary servopendulum operates, combining Hasler's pendulum blade and Marcel Gianoli's horizontally mounted airvane to control a sailing vessel's main rudder.

## **Chapter 3. Materials and Fabrication Methods**

For those who are curious about the alloys and polymers entering into the construction of different vane gears, this chapter will be of special interest. Topics covered include the galvanic series, or nobility scale, with special emphasis on bronze, brass, stainless steel, and aluminum alloys. The discussion will also look at the ways metals are manufactured and fabricated: casting, tubing, brazing, welding, and machining. Many parts, such as bearings and bushings, are made of plastics for their corrosion resistance. We will review the applications of nylon, Delrin, Torlon, and Teflon in marine hardware. Finally, we will look at different methods used by vane gear builders to construct vane steerers. The object here is to inform you rather than to endorse or denigrate a particular type of construction.

## **Chapter 4. Selecting the Right System**

Assuming you have made the decision to purchase a windvane steering system, you must decide which manufacturer and model of vane gear best suits your needs. In some cases, as with a long, low, overhanging mizzen boom, or on a 120-foot, three-masted schooner, a vane gear is simply out of the ques-



tion. You may find that a certain type of gear or a particular manufacturer offers more steering sensitivity in light winds, or that some model is more easily adapted to your vessel's swim step or stern rail gate. Other salient issues are vessel size, the steering unit's weight and size, materials and construction, the builder's reputation, and price. The author is not qualified to pass comparative judgment on the many different units available on the market. But a summary of things to look for can help equip you to make the best decision for you and your vessel.

## **Chapter 5. Vane Gear Specifications**

Of obvious importance to anyone seriously considering the purchase of a new or used vane gear, this chapter covers construction details of ten of the best-known manufactured vane gears. Illustrations offer a conceptual idea of how each vane gear functions. You will also find notes on materials used in construction and a description of each vane system's internal gearing or transmission system. Other data include the approximate dimensions and weight of each model, along with its current price (in U.S. dollars). While reading this chapter, pay special attention to how each unit functions, how it would fit and look on your vessel (if you do not already own a vane gear), and what types of metals and plastics have gone into its construction. Some alloys and polymers require special care and handling to get the most service and longevity out of them.

## **Chapter 6. Purchasing a Used Vane Gear**

For cruisers on a shoestring budget, a list of tips will assist in finding and purchasing a previously loved windvane. Some units may be so old that the manufacturers no longer provide the necessary repair parts; some companies may even have gone out of business. You will also find that there are various ways to locate these machines, which tend to be hot items in the used boat equipment market. Cruiser swap meets, marine newspapers, and Internet sites can help you get equipped at a considerable savings. We will also look at issues of quality, condition, repairability, and parts availability. Often, what you can no longer buy can still be easily fabricated by a machinist or welder.

## **Chapter 7. Installation**

Naturally, this matter is best covered by the operator's manual included with each new unit. This chapter distills what has been gleaned from several of these manuals and includes a few pointers from experienced windvane owners. We will look at airflow, overhead clearance, placement of blocks and lines, alignment, and related topics. What may not be covered in your owner's manual is how to reinforce the hull to accept the weight and twisting action of the vane gear. Another matter the manufacturer will expect you to know in most