

FABRIC FOILS

The Journal of Sailmaking

Industrial Sewing Machines for the Sailmaker / Part II

By Jim Grant

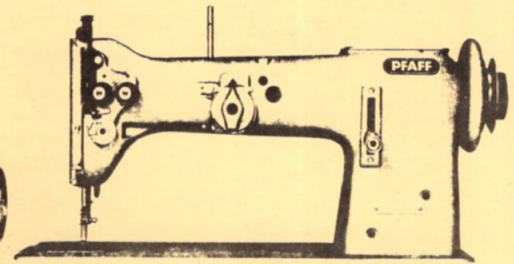
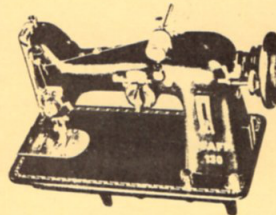
In the last issue we considered the feed mechanisms, the bobbin designs, and the stitch types characteristic of sewing machines used for sailmaking and canvas work. That article serves as an appropriate introduction for a survey of the actual machines in use. There is no single machine (not even the one that we sell) that can be said to offer everything a sailmaker needs. Unfortunately, sailmakers' needs are so varied that a machine characteristic that is an advantage in one task can become a serious limitation in another. But it is possible to choose a machine that will best serve a particular user's needs. I want to review the advantages and disadvantages of some of the most popular machines in use.

The following machines will be considered — note that they are all lockstitch zigzag machines:

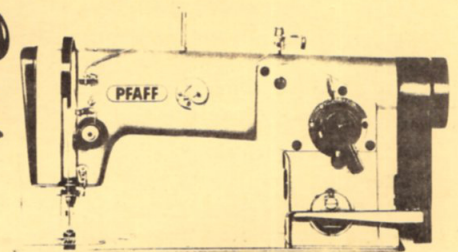
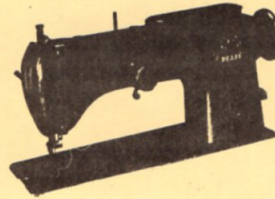
Pfaff 130, 138, 238, 438
Consew 99, 146RB
Brother 652
Singer 107, 143
Singer Centurion
Singer 20U
Bernina 217-25
Jentschmann 98-2-8-650
Adler

I put the Pfaff machines first because we started out as Pfaff dealers many years ago. These West German machines have a reputation for an excellent medium-duty zigzag bobbin hook design. The 130 is actually a home machine no longer in production. Indeed, it is the first zigzag home machine produced by Pfaff. They accomplished this by squeezing the parts from one of their industrial heads into a casing meant for home use. The casing is not even particularly appropriate — access to the bobbin is from the left end of the machine while the bobbin cage faces forward. But this is a minor problem. The Pfaff 130 has an excellent reputation. It is so well constructed that it is often used in a powerstand at 1800 stitches per minute. The feed mechanism on this machine is a bit lighter than would be ideal for sailmaking. And its straight stitch is of very poor quality. Finally, upper tension adjustment is limited and rather coarse.

The other Pfaff machines listed are intended for industrial applications. The 138 is two inches longer than the 130 under the arm, while the 238 and 438 are an additional one inch longer than that. The 138 is known as a "¾-arm" machine while its larger cousins are called "long-arm" machines. Aside from this, the main difference in the machines is their speed capabilities. The 138 will sew 2800 s.p.m., the 238 will sew 3800, and the 438 6000. The increased speed is made possible by bet-



Pfaff 130 | Pfaff 138
Pfaff 238 | Pfaff 438



ter bearing surfaces and better lubrication systems. The 438 has an oil reservoir similar to an automobile crankcase — oil is pumped from there to all parts of the machine. This reservoir is located on the top of the 238. All three share the same design parameters. That includes the shuttle hook in the 130. In addition, there is a swinging needle bar that ties the needle bar solidly into the rest of the machine, making these machines more suitable for medium-duty sewing.

The Consew 99 and 146, as well as the Brother 652, are all mechanical derivations from the Pfaff machines. They have the same shuttle hook design and the same

Continued on page 3

IN THIS ISSUE

Industrial sewing machines (Part 2)	1, 3, 4
Editorial: Whither Sailmaking?	2, 3
What makes a good cruising sail?	4-6
Figure 1: Entry curves	4
Table I: Racing and cruising sail parameters	5
Ask Jim Grant	6
Geometry of Sailmaking (Ted Andresen)	7-9
Figure 2	
Figure 3	
Figure 4	
Figure 5	
Sailwright Moneymaker	9
VIC'S LOFT	10-12
Lofing battens and a way to hold them in place	
Figure 6: Lofing batten	11
Figure 7: Batten clamping pad	12
Tips worth passing on... ..	13
Figure 8:	
Figure 9:	
Figure 10:	
CONNIE'S CORNER	14
Letters to the Editor	15, 16
On the Waterfront (Ann Pencoff)	16
Handy Order Form	17-18
The Advertising Game: The Raudashal Game	19, 20
Figure 11:	
Figure 12:	

EDITORIAL

WHITHER SAILMAKING?

This column gives me a chance every three months to sit back and reflect about the business of sailmaking. It is an opportunity that not many sailmakers have. They are, for the most part, busy meeting deadlines and selling the sails that create new deadlines. So I have a serious responsibility here — I must think ahead for all of us. The responsibility is "serious" in another sense — it is seldom likely that the future will be friendly. All of us, after all, fear and dread change. It is, if nothing else, uncertain. And the future is sure to bring change. Let me devote just a few paragraphs here to sailmaking's future.

It is, I am afraid, not a bright future. Ours is one of the few surviving crafts that remains very much an art. Individual craftsmanship and ingenuity is obvious and usually well rewarded. Generally speaking, success in this business comes to small lofts that do custom work at relatively high prices. As I have indicated in earlier issues of **Fabric Foils** the large production lofts are often in serious financial trouble these days. Even when the boating business booms, there has always been a place for individual craftsmen in sailmaking. But I doubt very much if this condition will last more than another 20 to 30 years.

This statement is grounded in the fact that the materials with which we work are undergoing fundamental change. This change began with the introduction of rayon, nylon, and polyester some 23 years ago. Synthetics have, of course, taken over the sailmaking business. Because they are so much more predictable and consistent than natural fiber-based materials, they simplified sailmaking. There is no question but that the Sailwright Academy, Sailrite Kits, and even this journal all owe their existence to the fact that sailmaking is easier (or, as I said earlier, more predictable) today than it was just 30 or 40 years ago.

The same fact accounts in part for the enormous growth of sailing and professional sailmaking. Thus far all of us have benefitted from the "synthetic" revolution.

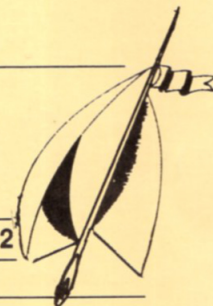
But let us consider where that revolution is taking us. Bainbridge has just introduced a "Polyknit" mylar-coated fabric. This material is highly experimental at this point, but I believe that it nevertheless portends the future. A knit matrix can offer multidirectional reinforcement to a mylar coating. And it can be manufactured in a loose matrix that is nevertheless consistent. The weak point in sails of this material are the seams — the coarse matrix just does not provide for good support at needle holes. So the tendency is to design the fabric as wide as possible. Coating techniques now limit that width to about 54 inches.

There are only technical limitations to prevent the knitting of entire sails. (Mike Oliveau first suggested this possibility, so far as I know, some nine years ago.) The mylar coating could be applied after they are knit-

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IN FUTURE ISSUES

Battens and Their Use
The Function of Leech and Foot Lines
Evaluating Sail Shape
The Use of Draft Stripes
Working with Nylon Spinnaker Cloth
Cutting Sailcloth — Tools and Techniques
Sewing Machine Needles and Stitch Quality
Edge Tape Application
Lifting a Tri-Radial Spinnaker
Continuous Support Tapes
Measuring for a Bimini
Estimating Forestay Sag
Lateral Resistance and Center of Effort in Sail Design
Tell Tails and Their Use
The Use of Mast Bend
Sailboard Sails
Sail Twist — What It Is and How To Use It
The Shelf Foot / Loose Foot Mainsail

ted. The shape of the sail could be carefully controlled by the knitting machine just as the shape of sweaters and skirts is controlled now. It would be a matter of simple mathematics. There would remain a little work on the edges and corners, done probably, at least for a while, in the traditional way with sewing machines (although I expect adhesives to supplant sewing machines in the next few years), and the sailmaker's trade as we know it will disappear.

Unfortunately, there may be very little place for craftsmen in the future. Start-up costs are now very low as I indicate later in this issue. They will be very high when huge knitting machines are required. Indeed, I see the cloth manufacturers gradually becoming the sailmakers of the future. They will send sail blanks to "sail con-

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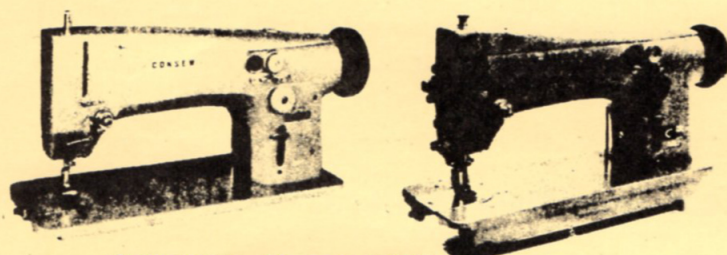
Industrial Sewing Machines for the Sailmaker

Continued from page 1

swinging needle bar. The Consew machines are both long-arm size while the Brother has a $\frac{3}{4}$ -arm like the Pfaff 138. About the only difference between the Consews is that the 146 has a walking foot mechanism. It is one of the very few walking foot zigzag machines produced. This makes it quite appropriate for seaming operations but quite awkward for anything else. The Consews both run at 3800 stitches per minute — they have a gravity-feed oil reservoir on the top of the machine.

The Brother 652 is a rather recently designed-machine. It has two features that set it apart from the 138 from which it is obviously derived. The first of these is a sliding drive mechanism for the rotary hook that actually gives it a variable speed. This addition to the machine makes possible the second feature — a very wide 12 mm. zigzag stitch that actually works. The Consews above also claim that stitch width, but it is possible only if timing is very carefully set. The Brother variable speed hook reduces the critical character of the hook timing at any stitch width. As width increases, the timing become more critical.

The Singer 107 is the workhorse $\frac{3}{4}$ -arm machine in most lofts across the country. It is no longer in production, but reconditioned and specially modified machines (mostly from the Porter Sewing Machine Company in Beverly, Massachusetts) are readily available. Considering that these machines are 15 or more years old and that they have no engineering distinctions to recommend them, their price (half or more of the Brother 652)



Consew 99 Consew 146RB

is somewhat hard to justify. But they have an excellent reputation as extremely well-built machines that run and run and run. Most of these machines do not reverse —

Editorial (Continued from page 2)

WHITHER SAILMAKING?

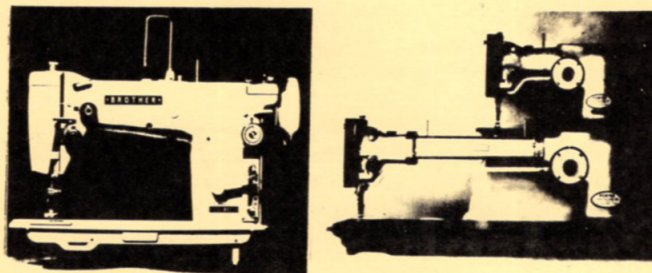
sultants" who will have the responsibility of specifying the design, doing the finishing work, and installing the sail to the customer's satisfaction.

There is a bright lining to this dark cloud. Sails will be much cheaper and that should encourage the growth in popularity of sailing that all of us have benefitted from in the last few years. Indeed, many of us may find our roles as "sail consultants" more satisfying and profitable than as traditional sailmakers.

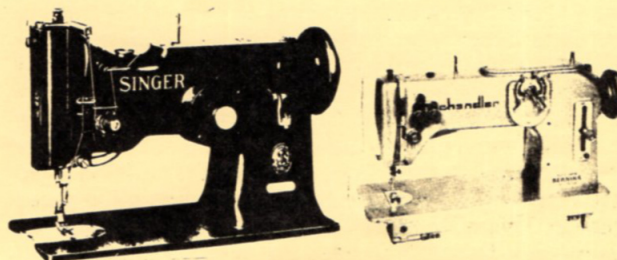
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only the 107W7 model does. Their speed is in the 2000 s.p.m. range.

The Singer 143 is a sister of the 107, intended primarily for lightweight materials such as those used in parachute construction. This machine has all the advantages of the 107 and all of its disadvantages.



Brother 652 Singer 107



Singer 143 Bernina 217-25

The Centurion is Singer's current long-arm industrial machine. As one ad proclaims, "Commonality of design features found in CENTURION lockstitch...machines is the key to greater flexibility and cost effectiveness..." The Centurion is very expensive, and one can wonder whether the modular concept is of any value to sailmakers requiring general purpose machines rather than highly specialized machines that can be modified. I have never talked to a sailmaker who is using a Centurion.

The 20U from Singer is a Japanese import very similar to the Brother 652 in size and speed capability. But it is not, at least in my opinion, so well made. It does have a three-position needle bar, but the stitch width is limited to 5 mm (which means that it has a relatively small feed dog) and timing is far more critical than with the Brother.

The Bernina 217-25 is a $\frac{3}{4}$ -arm machine that can be used for heavy materials. It is heavier and better built than either the Brother 652 or the Singer 20U. But it also costs twice as much as they do. In spite of the fact that it has an upper oil reservoir, the machine is rated at just 2000 s.p.m. This is a machine that I would be proud to sell. Only the anticipated price objections kept us from making the Bernina a part of our sewing machine line. It is also true that the Bernina comes only with a standard 6-mm feed mechanism which limits its capability to handle large pieces of fabric without special puller mechanisms. The Brother machine (which is the heart of our Sailmaker) practically eliminates the need for pullers with its extra-large feed dog.

Continued on page 4

What Makes A Good Cruising

What Makes a Good Cruising Sail?

At the Long Beach Boat Show this year, several people suggested that I don't spend enough time discussing the needs of cruising sailors. It is true that racing tends to occupy sail designers, myself included. Let this be the first of many articles that will reverse that tendency!

All sails are designed for speed. And all sailors are interested in sails that will deliver the best possible performance over the range of conditions for which they are intended. Why, then, an article on cruising sails? As a matter of fact, there are some distinct characteristics of cruising sails. I will consider them here under three heads: sail shape, construction techniques, and fabric selection.

Sail Shape

Cruising sails will be shaped to maximize the performance of the boat just as a racing sail would be. But the conditions under which that shape is intended to perform are quite different in the case of a cruising boat. A boat used for racing can be expected to have an alert and attentive helmsman. Cruising helmsmen, on the other hand, while usually quite skilled, do not devote the same attention to their task. As a result, cruising sails should be built with rather rounded leading edges (see Figure 1). This will widen the "groove" within which the boat will sail fast. It increases the angle of incidence at which the sail will stall. The peak performance of the sail will be inferior to that of a racing sail, but its "good" performance range will be broader and, thus, total day's runs will be higher.

The same sort of consideration affects the other three parameters of sail shape: the extent of draft, its placement in the sail, and the aspect ratio of the sail. Given two similar boats, one intended for racing and one for cruising, the sails for the latter should be rather full with their draft relatively far aft and they should be low in aspect ratio whenever possible. All of these characteristics maximize reaching and running ability at the cost of windward performance (see Table I). Since cruising entails more reaching and running than racing, this is, again, a maximization of cruising performance.

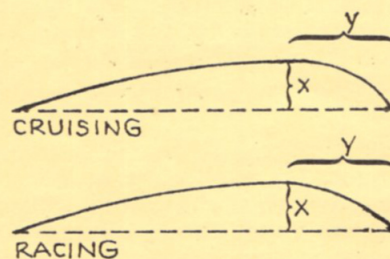


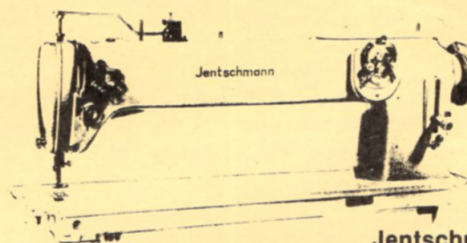
Figure 1: Entry Curve Optimization
Racing and Cruising

Industrial Sewing Machines for the Sailmaker

Continued from page 3

our Sailmaker) practically eliminates the need for pullers with its extra-large feed dog.

The Jentschmann machines from Switzerland are the only ones considered here that are especially designed for sailmakers (with the exception of the Porter Singer modifications). They produce a whole series of machines (many are also out of production Singer modifications), but the 98-2-8-650 will serve to indicate the basic characteristics of all that they offer. The arm is very long. The 650 has a 26-inch under arm length, and there are other machines in the line with much longer arms. Speed is relatively slow, 1600 s.p.m. for the 650. But speed is not usually a prime requisite for sailmakers. Feed consistency is, and this is where the Jentschmann machines excel. Special feed options include a belt feeding unit inside the presser foot. There are also more common puller feed mechanisms available, but the belt in the presser foot provides excellent stitch quality without the inconvenience of a separate device mounted behind the needle. The one disadvantage here is the price. These machines are extremely expensive — worthwhile in an environment where peak



Jentschmann 98-2-8-650

production efficiency is required but questionable otherwise.

No discussion of sewing machines is complete without some mention of the Adler. These West German machines are noted for their construction quality. There are no better machines for heavy-duty applications. Unfortunately, their price is as high as you might think it should be. But, if you intend to do a good deal of work with material eight ounces and above, the Adler line is the proper place to start.

One more thing should be said before we end this discussion of sewing machines for sailmakers. It mat-

Continued on page 5

Sail?

TABLE I
Racing and Cruising
Sail Parameters

Racing		Cruising
Flat	Entry Curve	Full
Flat	Draft	Full
Forward	Draft Placement	Aft
High	Aspect Ratio	Low

Construction Techniques

The primary concerns in a cruising sail are, of course, strength and durability. Racing sails require these characteristics also, but the need for weight saving, speed in setting and striking, and sail shape adjustment impinge upon those cruising needs. No racer would insist upon triple-stitched seams — it adds weight to the sail and it increases the roughness of the surface over which the wind flows. But triple-stitching makes good sense from the cruisers' point of view since seams are generally the first part of a sail to fail. The thread, after all, rests on top of the sail where it can be chafed away rather quickly. But note that the thread "knot" will generally lie on the bottom of a stitch. The thread will protrude much farther for this reason on the bottom, and it will chafe away there first. Thus, triple-seaming is not enough in itself — the stitches must be installed so that thread knots alternate from one side of the sail to the other.

The need for durability also leads many cruisers to eliminate battens in their mainsails. Battens are a maintenance problem — they constantly wear holes in the sail or they shake out or they break and often puncture the pocket. But battens are the means by which leech roaches are supported. This means that there can be no roach. Indeed, in order to keep the trailing edge of the sail from flapping, it is necessary to hollow it exten-

ters a good deal where you buy the machine. Quite apart from the engineering of the machine, dealer preparation can make a lot of difference. I have had many people familiar with sewing machines tell me that they have had little success with this or that machine. Generally the problems they have are not related to the machine but to the manner in which it is set up. We take great care in setting up our Sailmaker machines to be sure that they perform properly for sailmakers. Among other things, we change the presser foot; modify the upper tension to increase its range; change the flywheel; and add a two-speed drive to increase power. We also include with each machine or make available special presser feet that greatly simplify some tasks. When buying a machine, it will be very helpful if the dealer has some experience in your application. FF□

sively — usually to a depth of from 2% to 2½ % of the leech length.

Battens are seldom used in headsails anymore. Certainly they never should be in a cruising sail since they cause no end of trouble when they bang over the mast at every tack. So most racing headsails have hollowed leeches. But that hollow should be increased for cruisers in order to reduce the need to fine tune the adjustment of the sail. I like to see leech lines in cruising genoas, but I also like to build the sails so they are seldom used. All other cruising sails should be made so that leech lines are not ever needed. Again, this is best accomplished by making sure that there is sufficient leech hollow.

The foot edge of headsails should be somewhat rounded so that it "looks good." If the foot is hollowed, the sail will tend to look like it has been stretched out of shape. But that foot round should be kept to a minimum in a cruising sail. Any extra area gained by a large foot round will more than be offset by difficulty in keeping it from flapping in strong winds and by the frequent need of repair caused by its rubbing against the deck or lifelines.

Patches of leather or Dacron should be used anywhere chafe is likely to be a problem. These patches simply sandwich the sail to protect it. They do not add any structural integrity. The most common places to use them is at the ends of spreaders in a genoa, in the way of the bow pulpit on all headsails, and along the spreaders on each side of the main to protect it when running.

There are some "go fast" construction techniques that should be avoided because they are not seaman-like. One of these is the shelf foot in the mainsail. It helps carry draft right down to the boom, but only at the cost of making the flattening of the sail more difficult. It also places more strain on the clew of the sail instead of distributing it along the boom — this can lead to premature stretch in the fabric along the leech. A good cruising mainsail will be securely attached to the boom all along the foot and draft will decrease gradually and smoothly in the bottom third of the sail.

By the same token, "bendy" spars should be avoided. They may give somewhat more control over sail shape, but they do so at the cost of adding many times more stress to the spar. Cruising boats should strive to keep their spars as straight as possible at all times. This keeps all loads in column and maximizes the strength of the rig.

It hardly need be said that sailmakers should not cut corners when it comes to the weight of hardware on cruising sails. The extra weight is not a flaw if it keeps the sail useful over a broader range of wind velocities or for a longer period of time. But I want to warn of excess here. Modern stainless hardware is very strong and resistant to corrosion so excess is not necessary — I warn only against a trend that has appeared in some racing and OEM sails toward rather skimpy hardware. At the Long Beach Show this year we were surprised by the number of sailmakers who have given up luff reinforcement (except for one or two layers of tape). And more and more sailmakers are depending too much on the new pressed grommets. Good cruising sails can be made with these grommets, but it is wise to reinforce them with webbing straps well sewn into the sail. And

Continued on page 6

????????????????????!

Tina Maloney of Harwich, Massachusetts, asks: "Should I change the curve of a mainsail along its foot when I move draft forward or aft?"

No. The round along the foot of a mainsail should roughly fit the curve of the sail, but it is not practical to precisely fit it. There is ample stretch in the fabric to make up for radical disparity between the two shapes. So go ahead and experiment freely with the sail's shape and leave the foot curve as it is.

Many ask me what capital expenditure to expect in setting up a loft.

I can quote the cost of materials and instruction that are part of the Sailmaker's Series, but this leaves many still wondering how much it will take to set up shop and

Continued from page 5

what ever happened to the grommet assemblies that used to be so popular in cruising sails — several small grommets will distribute strain over a much wider surface area than one large grommet.

Fabric Choices

The most durable fabric will have a relatively soft finish. Yet it cannot be so soft in a cruising application that constant adjustment is required. All sailcloth manufacturers have developed a "relatively" soft material that they recommend for cruisers. Choice among them is mainly a matter of personal preference.

But cloth weight is not so easily decided upon. Most cruisers tend to use sailcloth that is, in my opinion, too heavy. Keep in mind that there are disadvantages in using a heavier fabric than normal. Sails are harder to store, they take up more room on the boat, and they are heavier and, thus, more difficult to move on the boat. For these reasons, I often find myself recommending a lighter weight fabric for cruisers than I do for racers. There will be more stretch in such cloth and that will inhibit performance to windward, but durability will be very little affected. The truth is that Dacron sailcloth almost never fails unless it has been subjected to chafe, decayed from exposure to ultraviolet, or pierced by a sharp edge. Extra fabric weight does little to protect against these dangers.

By the way, while on the subject of ultraviolet decay, let me repeat my concern that ultraviolet protection on sailcloth has been very much oversold (see **Fabric Foils**, Volume I, Number 2). To this point it is nothing more than a coating that adds almost an ounce to each yard of cloth. It tends to flake and peel from the fabric and, of course, it offers no protection when that happens. I am convinced that the lab tests that show it much more durable than unprotected cloth are not an accurate reflection of what happens in the real world.

This article should serve to introduce everyone to the subject of cruising sails. I promise to spend more time thinking about it and you will see evidence of that in future **Fabric Foils** issues.

FF□

Ask Jim Grant

survive the first year. I want to list here the basic startup requirements for sailmaking. More can be spent, but less is not likely to lead to success.

Equipment

Sewing Machine	\$1000.00
Sailmaker's Kit (includes tools)	271.62
Office Equipment (calculator, files, etc.)	600.00
	\$1871.62

Capital

For Basic Inventory	\$1000.00
For Three Months' Rent	1000.00
For Three Months' Utilities	300.00
	\$2300.00

Total Financial Requirement **\$4171.62**

Keep in mind that this assumes a full-time commitment to sailmaking and minimum expenditures for a one-person shop. Inventory can be kept at this level only by buying cut yardage as needed.

Rent and utilities will vary a good deal, but these are good starting figures. Dick and Barbara Orpin, who started their loft in Osterville, Massachusetts, in 1982 (see the lead article in the January 1983 **Fabric Foils**), report that they have an L-shaped work area of 850 square feet, an office space of 72 square feet, and a combined sales and storage area of 108 square feet. The total rent for the 1030 square feet is \$245 per month or 24 cents per square foot per month.

Average gross receipts during the Orpin's first season were \$1800 per month. During their loft's second season, they grossed nearly \$3,000 each month. They now have three machines and three part-time employees. And more growth is necessary before it can be said they have "arrived." I rather arbitrarily set the minimum threshold gross for an established loft at \$10,000. But, once the \$3000 level is reached, the loft can usually generate sufficient funds to finance its own growth. Prior to that point, it will be necessary to pump money into the fledgling business.

Malcolm Smith of Truro, Massachusetts, sends a sample of a cover fabric that he has found in many boat tops and side curtains. It is a supple fabric with a denim "look" on the underside and a vinyl laminate on the top. He wonders what it is and why we don't list it in the **Sailmaker's Catalogue**.

The material is available from a number of sources and has as many names. It is a cotton or a cotton and polyester "sateen" fabric with an embossed vinyl laminated to its upper surface. The Astrup Company calls its all-cotton version "Super Top." Astrup also has two 75% polyester and 25% cotton constructions called "Navatex" and "Sportex." They have very good body, and yet they are soft enough that they are actually a joy to work and sew.

The disadvantages of this type of cloth include shrinking slightly in both the warp and the fill directions. It also will support mildew on its under surface. And its initial strength, which is excellent, will tend to degrade somewhat faster than the acrylic and 100% polyester cover cloth that we feature.

FF□

GEOMETRY OF SAILMAKING

by
Ted Andresen

Ted Andresen is a computer programmer from St. Petersburg, Florida. He has been working for nearly 10 years on the problem of computer sail design. The fruit of that work is a rather sophisticated program that works on Prime mainframe computers. Ted leases that program to sailmakers.

The following article is part of a paper presented at the Chesapeake Sailing Yacht Symposium in Annapolis, Maryland, on January 17, 1981. This work contains much of the mathematical basis for the program that Ted has written.

FINDING BROADSEAMS MATHEMATICALLY

To find the broadseams, a sophisticated model of the sail surface is employed. This is the drafted twisted model which includes the sail twist, the leech and foot sags along with any roach or hollow along the leech.

To simplify the analysis, the luff for the model is assumed to be straight at the start. Later a luff round will be cut in the sail to match the headstay sag or mast bend. The curve for the leech is generated from the sail twist or a combination of four factors: the leech length, the head-to-clew distance, the leech sag, and the sag position. A similar curve is generated for the foot. Using the luff, the head-to-clew and the tack-to-clew distances, a tentative triangle representing the sail is assembled as shown in Figure 2. For high-cut headsails, the foretriangle I and J, the sheeting angle, and the heel are used to rotate the tentative triangle to its operational position. Mainsails and low-cut genoas are simply rotated until their foots are horizontal. Using the draft profile and the leech roach or hollow, an expression for the chord as a function of elevation is constructed. This function is combined with the tentative triangle and the draft ratio to complete the drafted twisted sail surface.

Once the model parameters for a sail have been selected, the model may be used to compute the broadseams by one of the following methods:

The Geodesic Method

In theory it is possible to approximate any surface by joining together a number of carefully shaped flat panels. Typical examples of this technique are found in the design of skins for footballs and inflatable spheres. In some cases, the flat panels are tapered so the seams will form geodesics on the final three-dimensional surface. Another example of such a surface is the sail. By finding the geodesics on this surface, the required panel taper and hence the broadseams can also be found.

In the geodesic method, the seams are tracked by using Frenet's constraint that the acceleration of a geodesic in a tangent plane is zero at the point of contact. Beginning at the leech intercept for a seam, a sec-

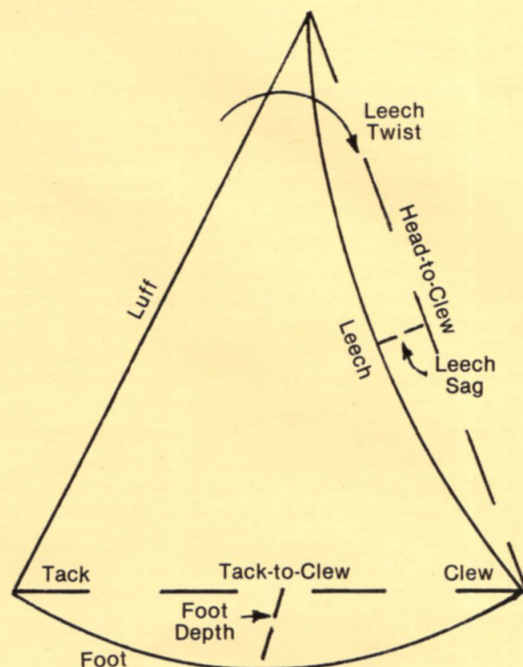


Figure 2: Drafted Twisted Model Sail

ond point, a small distance away in the approximate direction of the luff intercept is acceptable. A set of points which approximate the geodesic path through these points is then constructed. At each point the tangent plane along with the tangent, normal and binormal vectors are found. Using the information from the preceding point, the normal curvatures and the torsion are computed and used to advance the project of the geodesic another step in the tangent plane. The new point in the plane is then projected back onto the surface and the process is repeated until the seam intersects the luff. If the geodesic seam fails to intersect the luff at the correct elevation, the computation is repeated again, starting at another direction from the leech. The successful tracking of one seam from the leech to the luff will take a minimum of three iterations. As the computer steps along each seam it stores the coordinates of a set of equally spaced control points beginning at the leech. After all the seams have been traversed, the width of the individual panels between the control points is calculated along with the corresponding broadseams.

Since this method yields the seam-by-seam broadseaming, it allows the sailmaker to exercise control over the cross-sectional shape at different elevations. Unfortunately, because of the iterative nature of the calculation, the cost is high in terms of computer time. Also, since the geodesic method requires a surface which is analytic, the tracking is unpredictable whenever the surface becomes discontinuous.

Such discontinuities are found when there is an abrupt change in the chord function as occurs at the elevation of the batten tips or at the clew elevation on high-cut working jibs. To avoid some of these problems, a method which is less dependent on surface continuity has been developed.

Continued on page 8

GEOMETRY OF SAILMAKING

The Integral Method

In the integral method the path integrals along a number of control paths on the surface are determined. From these integrals, the total broadseaming is computed and distributed over all the seams in the path.

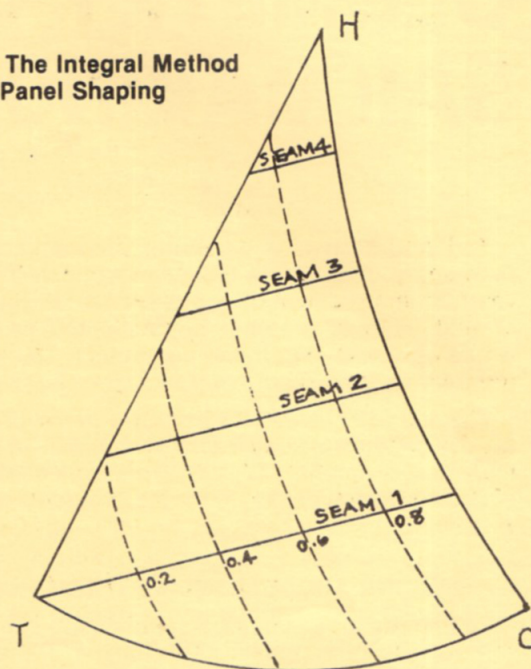
Here the computer is used to evaluate a group of path lengths as shown in Figure 3. These paths are equidistant from one another and parallel to the leech. The integrals are then compared with the value they would have if the surface were geometrically flat and had zero Gaussian curvature. The differences between the path lengths on the model from those on the flat surface give the total broadseaming that would be necessary to build the model from flat panels. The total broadseaming is then distributed equally over all the seams in each control patch. Since the broadseam adjustments along each control patch are equal, the panels can be stacked together and cut simultaneously with the same broadseam pattern. When the panels are joined together, the result sail should have the desired cross-sectional shape.

Although this technique does offer the time-saving possibility of cutting all the seams simultaneously, it has one limitation. Because all the seams are weighted equally in the final distribution, it does not offer the possibility of building sails with cross-sectional shapes that change with elevation. Until a more sophisticated method for distributing the total broadseams is developed, the integral method may only be applied to sails with limited stretch characteristics and with constant cross-sectional shapes from tack to head.

Testing the Integral Method

In an effort to test the integral method, a three-quarter paper model based on the Penguin mainsail was constructed. This mainsail is loose-footed and is attached to a bendy mast. Values for the leech sag were taken

Figure 3: The Integral Method of Panel Shaping

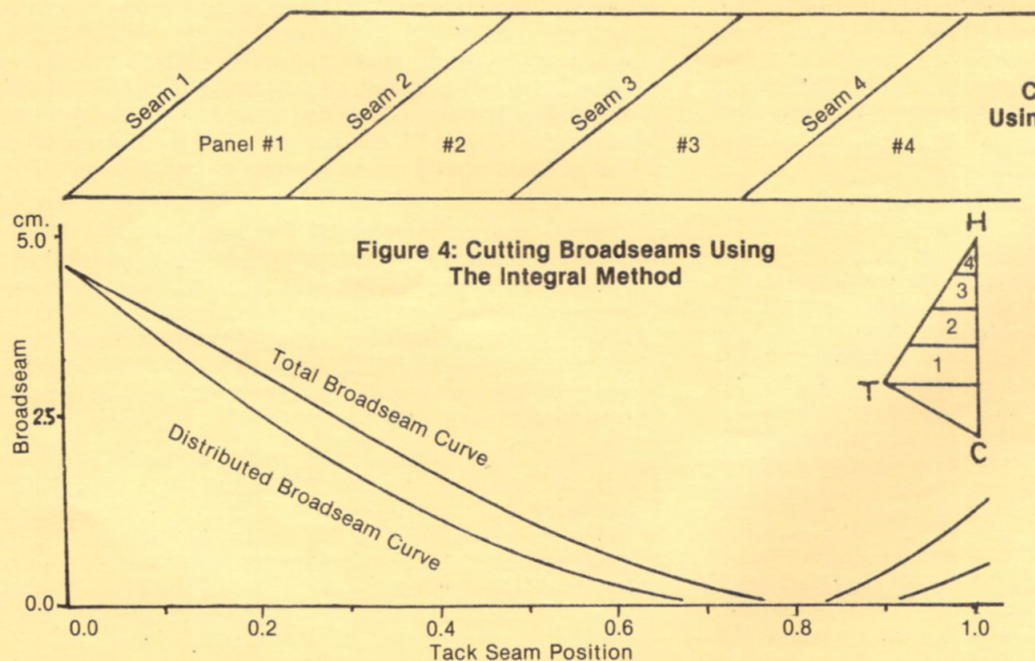


from photographs while the draft ratio was obtained by direct measurements of several sails. The calculation was performed using an interactive computer program especially written for calculating broadseams by the integral method.

Initially the panels were cut, trimmed, stacked, and marked with the broadseam curve as shown in Figure 4. Finally the sail was assembled and suspended above the ground.

Since the main is loose-footed and the intended draft ratio was 0.15, the draft ratio of the foot was set to this value.

Figure 4: Cutting Broadseams Using the Integral Method



Results and Discussions

The cross-sections were measured along with the estimated errors as shown in Figure 5.

Ideally the draft ratio of all the cross-sections should have been 0.150. Instead the measured draft ratio first climbs to 0.155 before it exhibits an almost linear decline to 0.140 at the $\frac{3}{4}$ -elevation.

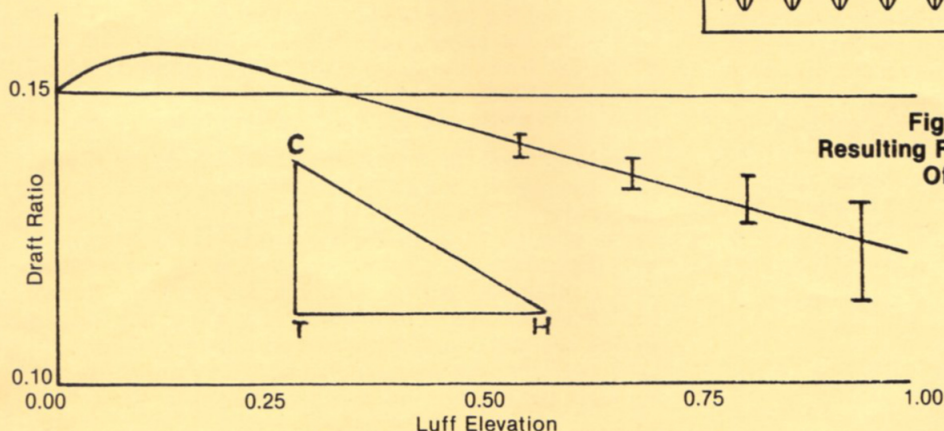
It is believed that the initial rise in the draft ratio is attributable to the heavy broadseaming which was applied to the leading portion of panel #1. If the sail had been made of narrower panels, the broadseaming near the tack would have been distributed over a larger number of seams, instead of just one seam. The flattening at the upper arcs may be explained partly by the rigidity of the fabric. But, even more important, is the sensitivity of the upper arcs to any deviation of the actual leech sag curve from the one used in the model.

Indeed, the practice of equally distributing the total broadseaming among all the seams in the control path may be incorrect. Based on this experimental model, it may be better to weight the upper seams more heavily in the total broadseam pattern. Unfortunately there is little theoretical evidence for such a distribution or even for the uniform distribution selected for this experiment.

Final Statements

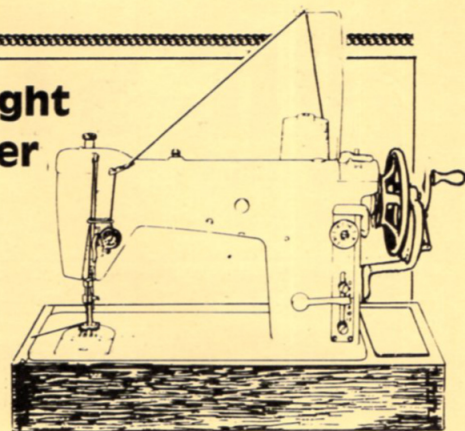
Any attempt to use mathematical techniques to design sails will be limited by its simplifying assumptions. Here the assumed horizontal flow and fixed luff geometry do not limit this approach as severely as does the assumption of minimal fabric stretch. In the future these models and methods can be modified to include new techniques for computing the fabric strain. For the present it may be useful to develop a strain index which might include the sail area, the wind speed and the stretch modulus. Such an index would guide the sailmaker in deciding if it is legitimate to use low-stretch analysis for a particular sail design.

Of course, any research program must go hand-in-hand with the creation of a more concise measurement technique. Any new method must necessarily provide reliable measurements of the draft position ratio along with the entry and exit curvatures. FF ☐



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Figure 5: Sail Shape
Resulting From the Integral Method
Of Broadseaming

VIC'S LOFT

Vic Kaminsky

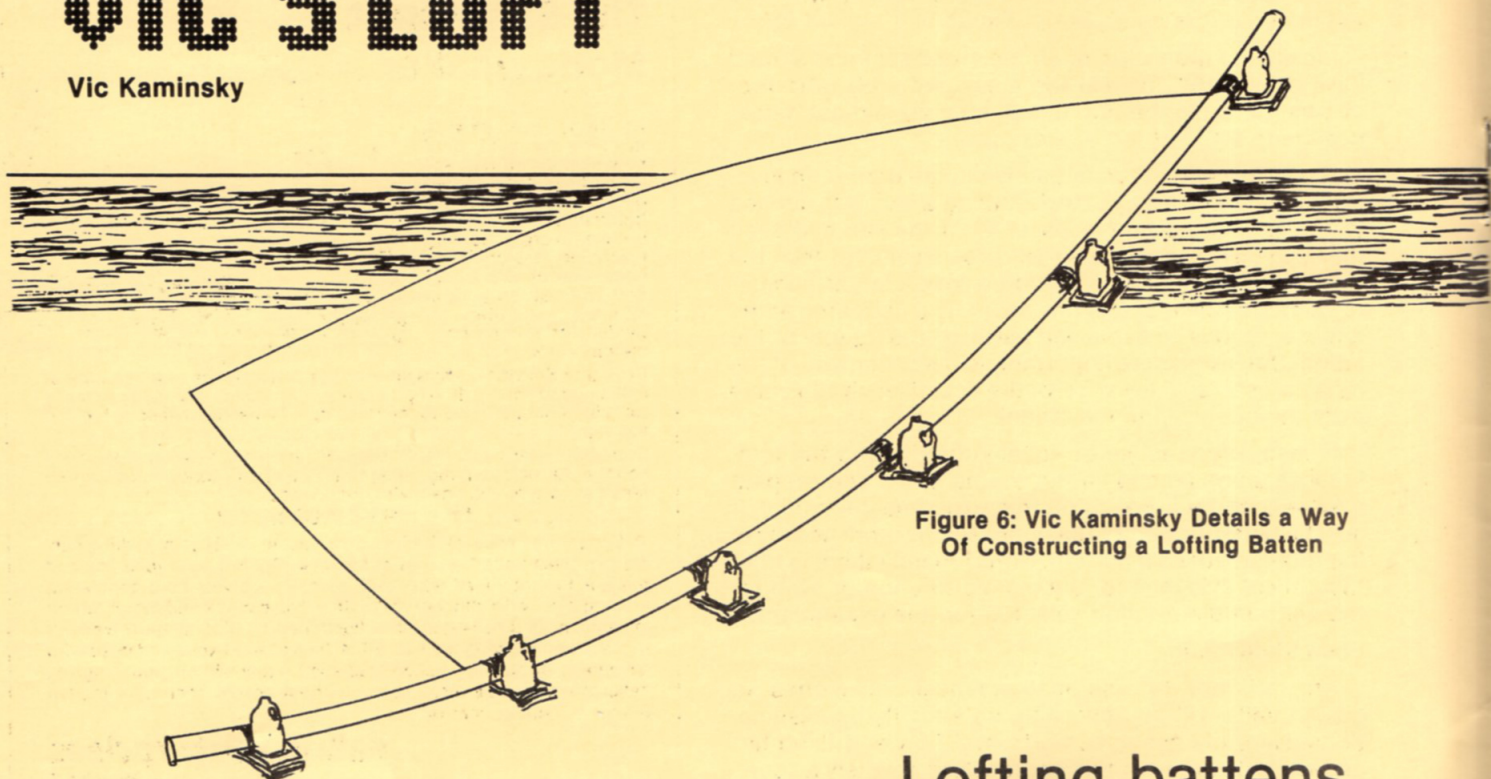


Figure 6: Vic Kaminsky Details a Way Of Constructing a Lofting Batten

Lofting battens and a way to hold them in place

Smooth curves are an absolute necessity in sailmaking. Some use masking tape to mark the edges of the sail, but it is usually necessary to fuss with the curve thus "lofted" and that takes time. As a result, most lofts use "lofting battens." These can be wood or fiberglass splines from ten to thirty feet or more long. Unfortunately, there are problems with both materials. Wood is seldom consistent in the way it bends, it cannot be separated to shorter lengths for storage or for more flexible use, and it eventually cracks or breaks. Fiberglass is more consistent and durable, but it is very expensive—twenty foot battens will cost \$80 each when shipping costs are considered. In addition, holding battens in place can be a problem. Most sailmakers use awls driven into the floor to accomplish this. But that obviously damages the floor which can be a problem for those who rent or build only a few sails in their own home. An alternative would be the lead "ducks" used by boat builders to hold their lofting battens in place. But they are rather expensive and they can damage finely finished floors.

My objective here is to describe a lofting batten (Figure 6) that is easily built from readily available and inexpensive materials, can be broken down for storage, and can be held in place without damaging a working surface. The last objective is accomplished with a rather unique "duck" designed just for the battens.

The batten is detailed in Figure 7. It is made of 10-foot sections of Schedule 40 or heavier CPVC plastic water pipe. This material is available in most hardware or building supply stores.

Note that the pipe sections can be plugged and filled with sand. The sand gives the batten a better "feel" and it provides a more uniform curve. Fill the pipe with sand a little at a time—stand it on end and gently tap it on the floor to fill voids and pack the sand in place.

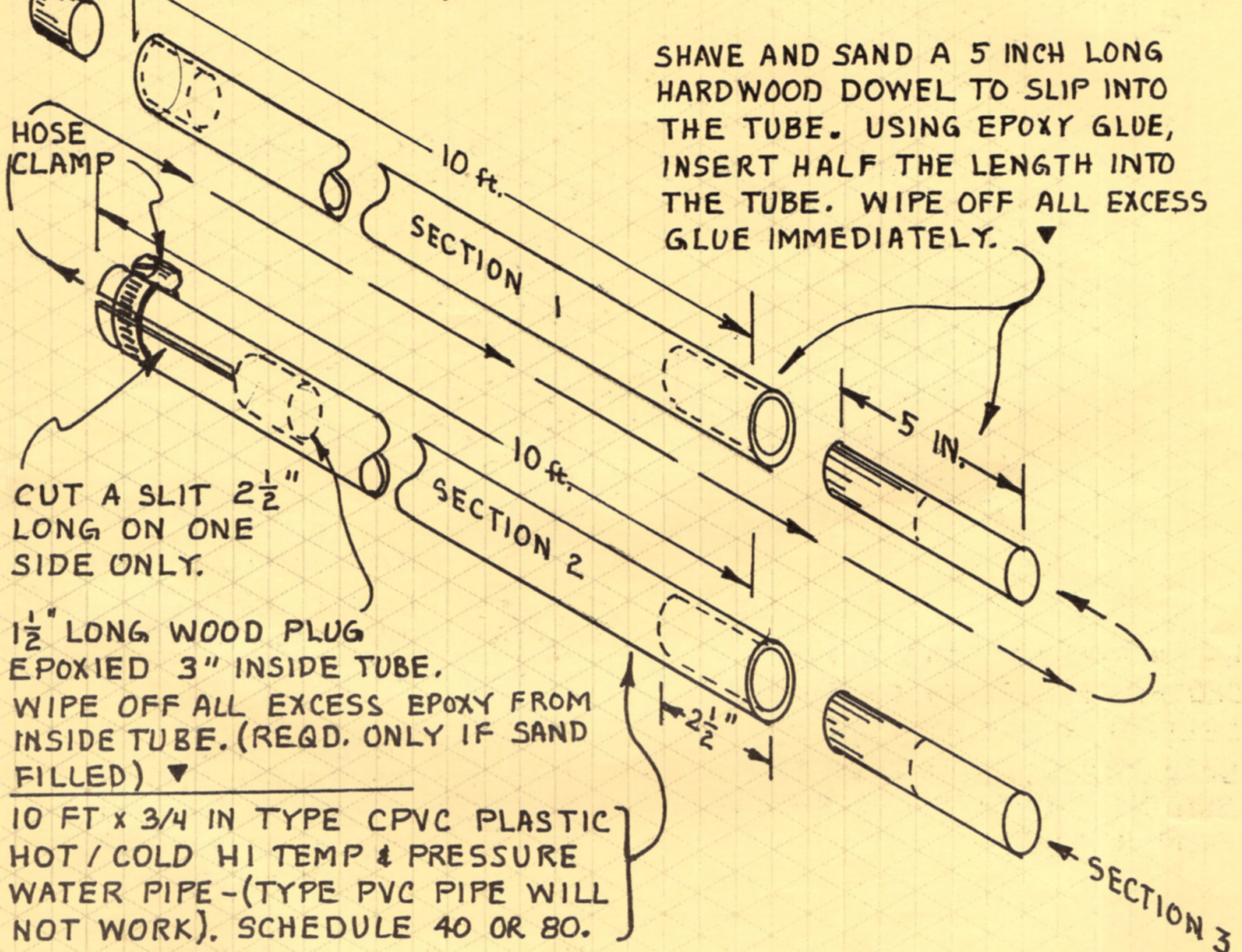
You will need three or four "ducks" for every 10 feet of batten (see Figure 8). Note that the non-skid vinyl or rubber pad at the rear of the wooden base should be dense enough to keep the base from making contact with the floor. The pipe clamp should be the shallow type. It must have a vinyl or rubber pad inside its throat. The idea is to distribute the weight of either a 10-pound barbell weight or a plastic gallon milk jug filled with sand or water over the base pad and the batten. The cup hooks at the back of the ducks are handy for stretching a line to provide for sail base lines.

FF□

Figure 7: LOFTING BATTEN

1 1/2 IN. LONG HARDWOOD DOWEL
EPOXIED IN PLACE. SHAVE &
SAND TO FIT SNUG. ▼
(REQUIRED ONLY IF
SAND FILLED)

Additional illustration
on following page

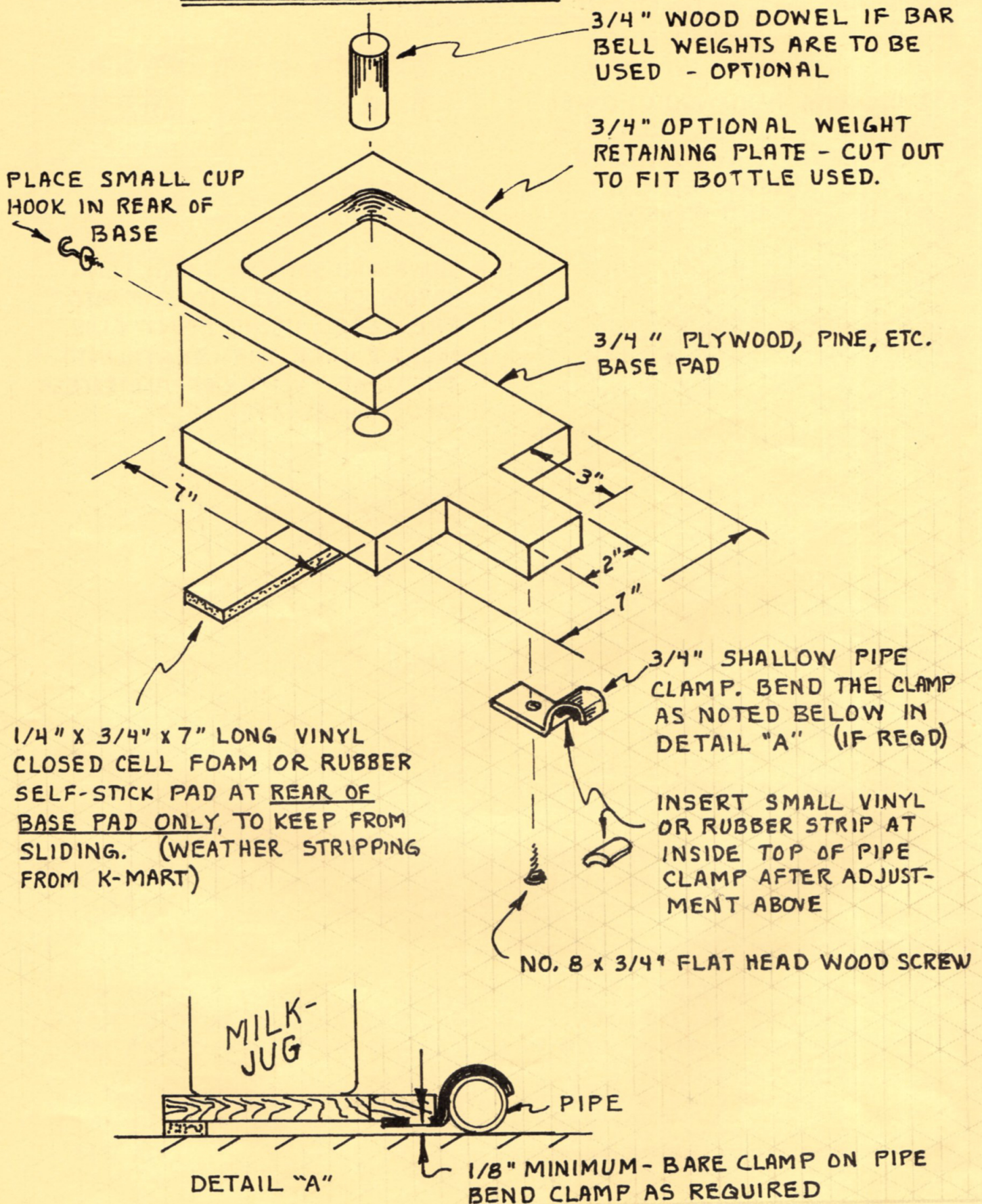


NOTE: BUILD A THIRD SECTION IDENTICAL TO SECTION 2. THIS WILL PROVIDE A 30 FT BATTEN. IF DISASSEMBLY IS NOT DESIRED, DELETE SLITTING AND HOSE CLAMPS AND EPOXY SECTIONS TOGETHER.

▼ TO EPOXY GLUE DOWELS, APPLY EPOXY INSIDE THE TUBE AND ON DOWELS, SLIP TOGETHER AND ROTATE 1/2 TURN. I USED THE QUICK SET TYPE EPOXY.

VJK 12-83

Figure 8: BATTEN CLAMPING PAD



Carole and Bruce Bates of Bonnie Lee Sails in Golden, Colorado, dominated this column in the last issue. Even so, they brought many good ideas that I did not have room for at that time. I will be using them in future issues. Here is one labor-saving technique.

Tips worth passing on...

REEF PATCHES

There is a good deal more labor in a row of reef points than might be thought. Much of this labor is required for cutting the patches. There is a simple shortcut that most lofts employ. They use a mylar sheet the same shape as the largest patch for a "normal" reef. This will usually be about 20 inches along the sail edge, and it will extend into the sail about nine inches. I like to cut the patch as a simple triangle of roughly the shape shown in Figure 9 (right).

Bruce and Carole make this pattern do triple duty by cutting dashed lines into it with a razor blade to indicate the shape of smaller patches as well. This saves all the "lofting" that is usually involved.

Even though the patches will be slanted along the leech, the look is not displeasing. And, with a little care, the cloth can be cut to keep the threadline of the patches in line with that of the sail. But it should be noted that the Bateses report they pay no attention to threadline when they cut reef patches. They find it is less wasteful of cloth and more impressive to the customer if they simply build the patch assemblies so thick that stress lines never appear even with bias patch orientation.

Mylar, by the way, is a handy material for sailmakers. It is extremely stable so any patterns made with it can be used again and again with confidence that each cut will be the same. You can specify a matte surface so that it can be written upon with a pen or pencil. Indeed, a good source for the material is the local technical art store — engineers use a good deal of it. Aside from its use as pattern material, many sailmakers use layers of mylar in the corners of their sails to stiffen them. Most J-24 headboards are simply five or six layers of mylar. This provides adequate stiffness with much less weight than aluminum. And mylar patches (one or two layers) in the head of a spinnaker are flexible enough to get by most measurers while stiff enough to open the head of the sail nicely, even in very light air.

Luff Reef Cringle Placement

John Shugar of Windward Sails in Port Clinton, Ohio, sends the following note on placing the luff cringle in a reefing system (Figure 11). When the sail is secured to the mast with slides or slugs, there is usually a stop at the bottom of the track or groove to keep them from coming away from the mast as the sail is lowered. This means that they will stack up above the boom. The reef cringle must be installed to provide for this.

John suggests the following rule. The cringle must be at least as far above the slide below it as the height of the stacked slides when the sail is reefed. And the slide above the cringle must also be that distance. Add at least an inch or so to each of these dimensions so there will be no strain on the fabric.

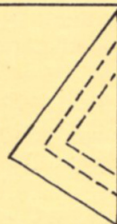


Figure 9: Universal Reef Patch Pattern

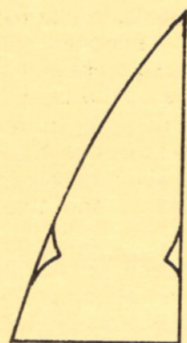


Figure 10: Reef Patches In Place

Figure 11: Luff Cringle Reefing System

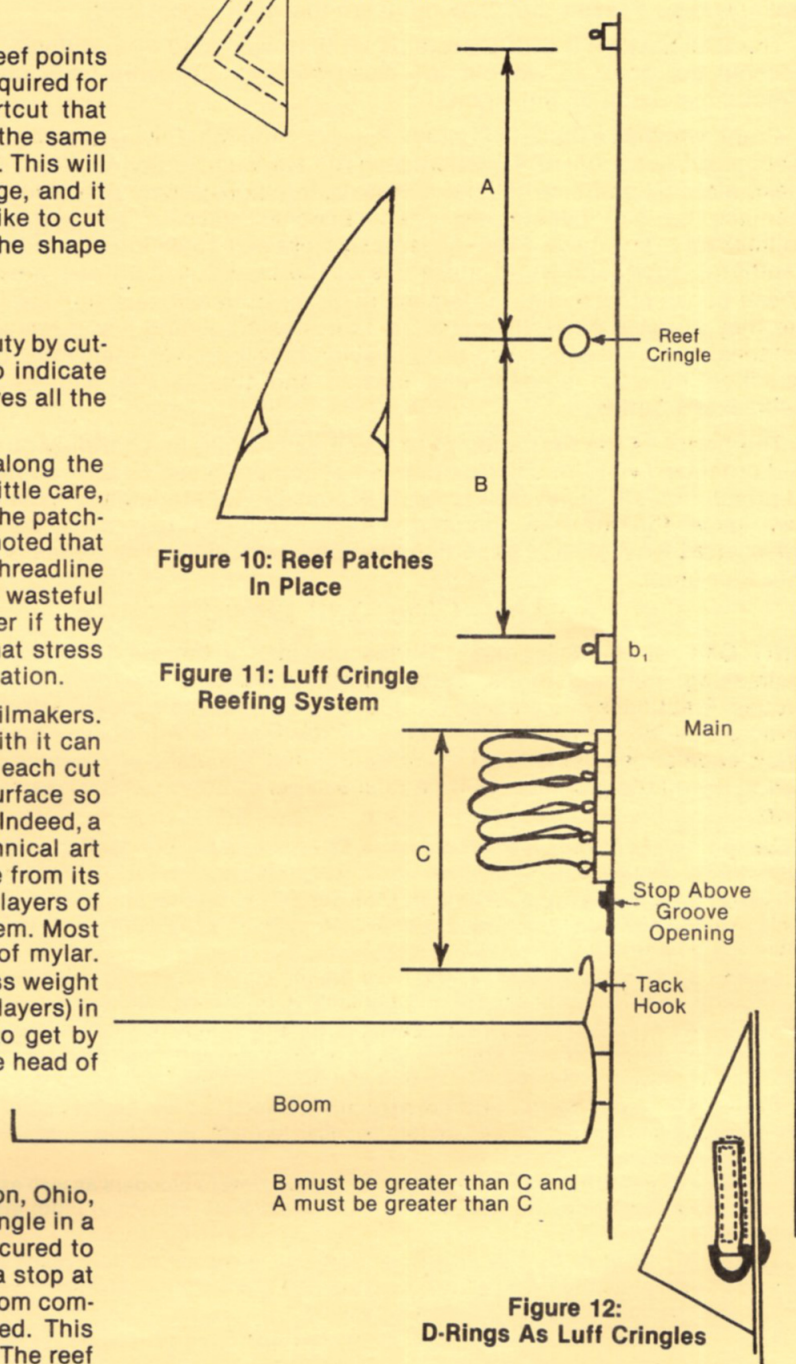


Figure 12: D-Rings As Luff Cringles

John also adds a suggestion that he picked up from a lecture by Rod Stephens concerning the luff cringle itself. Use a D-ring (Figure 12) on each side of the sail secured with webbing instead of a grommet. If your tack has a hook for reefing, the D-rings will be much easier to secure that twisting the entire luff with a grommet sewn into it.

Learn Sailmaking at Home

Sailmaking has always been taught through apprenticeship. It is an art, and the teaching of any art requires personal interaction which apprenticeship makes possible. Traditional apprenticeship has some real disadvantages. It requires a full-time commitment over an extended period. Apprentices often complain that they are trained in particular tasks and left to perform just those tasks, and as a result they may not learn the work completely.

The **SAILMAKER'S SERIES** retains all that was good in traditional apprenticeship but does so without the disadvantages. Students work under the direct supervision of Jim Grant.

Grant, who has a Ph.D. in Political Science from the University of Chicago, is recognized as Master of the Sailmaking Art. He founded Sailrite Kits in 1970 to make material and instructions in sailmaking more widely available. His five manuals on sail construction have become classics and are used by sailmakers everywhere. Even the largest, most respected lofts like Ratsey and Lapthorn, Hood, and North make use of the books to train new employees. These books are excellent reference texts for professionals working in a loft yet they are also perfectly suited for individuals building just a few sails for personal use. To teach the art of sailmaking fully, however, there must be an interaction between student and master...and this is the purpose of the **Sailmaker's Series**.

The Series is the first attempt to teach sailmaking in a carefully structured and organized way. This instruction is not compromised by any requirements of production efficiency. Moreover, it is possible for students to move at their own pace through the material. Indeed students can even decide for themselves what level of expertise they wish to achieve. The Series is divided into four units.

Unit One: Sail Design

UNIT ONE of the Sailmaker's Series provides a thorough introduction to sailmaking, defining terms, setting forth principles, and developing techniques. Practical skills are also introduced—several scale model sails are constructed during the work. This series of ten lessons will convey a complete knowledge of sail design and construction that will make any skipper a better sailor, laying the groundwork for actual sail construction which begins in Unit Two.

Lesson 1 / The Words and Measures of Sailmaking: An introduction to the unique terminology employed by sailmakers. Organized to make a useful reference tool.

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Lesson 3 / Sewing Techniques: Covers the principles of sewing machine usage in sailmaking, sewing machine repair and adjustment, as well as hand sewing techniques.

Lesson 4 / Mainsail Design and Construction: A complete study of the mainsail, moving from design considerations, such as aspect ratio and roach width, to construction details, such as boltrope attachment and broadseaming techniques.

Lesson 5 / Jib/sail Design and Construction: Structured like Lesson 4 but focused on headsails and the design parameters peculiar to them. Emphasis is on draft needs and draft placement in sails.

Lesson 6 / Spinnaker Design and Construction: Covers bloopers as well as horizontal cut, radial, spherical, star cut, and tri-radial spinnakers. Effects of cloth stretch are analyzed.

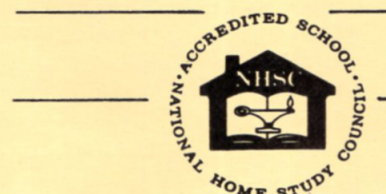
Lesson 7 / Staysail Design and Construction: Here the primary focus is on the theory of sail interaction. Design and construction of six distinct staysail types is considered in the light of this theoretical grounding.

Lesson 8 / Stormsail Design and Construction: Strength and seaworthiness in stormsails are the primary objectives emphasized in Lesson 8.

Lesson 9 / Sail Repair Work: The maintenance of sails from a sailmaker's point of view is presented here.

Lesson 10 / Canvas Work: Sail covers, boat covers, bags, awnings, dodgers, weather cloths, and many other projects, spelling out principles of construction.

Upon completion an Apprentice Sailmaker's
Certificate will be awarded.



The United State Department of Education has only one agency listed as a "nationally recognized accrediting agency" for home study schools — the Accrediting Commission of the National Home Study Council. The NHSC's Commission has accredited only one home study sailmaking school in the United States...our **Sailwright Academy**.

Enrollment Agreement for UNIT ONE of the Sailmaker's Series

Please enroll me in Unit One of the Sailmaker's Series. I understand that the entire tuition and materials fee is \$395.00. In addition to ten lesson books, supplies for the construction of model sails, ten assignment papers, and one final examination, this fee includes the following texts:

The Sailrite Sailmaker's Library	\$30.00
The Sailrite Sail Repair Kit	35.00
Marchaj's Sailing Theory and Practice	17.50
The Best of Sail Trim	14.95
The New Canvas Worker's Library	25.00

Students who own any of the texts listed above should deduct their value from the total cost of Unit One.

I am considering below the payment plan I prefer and will note it on the order form on **PAGE 17** of this issue:

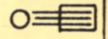
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☐ **PLAN B** / I enclose the entire tuition and material fee for Unit One of the Series or \$395.00. Of this amount, I understand that \$100 is a non-refundable enrollment fee.

You may charge the above to American Express, Master Charge, or VISA, by indicating your card number and its expiration date on the order form.



LETTERS



Dear Mr. Grant:

I must take exception to your "Ask Jim" column in the October issue of Fabric Foils, concerning the cleaning of sails using benzene (benzene) for the removal of number adhesive. Benzene is a very dangerous solvent which is absorbed into the body by breathing or through the skin. It tends to be stored in the body. Some reports have linked it to leukemia.

A safer solvent is **toluene** which has similar solvent properties but is excreted from the body. It is common practice in chemical laboratories to substitute toluene where benzene was used before. I would suggest instead "Varsol," which we have used with fair success (requires elbow grease) for the removal of number adhesive.

Yours truly,
D. T. Krajcarski
Nepean, Ontario

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

Dear Jim,

I have completed the main for our Starratt 45 — and a beauty it is. It's every bit up to the standard of the No. 3 genoa you evaluated. If need be, I will bring this one up, too, as I won't have pictures for a while.

I'm ready to begin Unit III of the Series. Enclosed is a check for enrollment and the plan for the first project — a storm foresail.

I would be glad to be used as a reference for the Sailmaker's Series as evidence of what can be done with the course. I have been able to utilize the course basically as written with very few questions or problems. And when I have had any of either, your ideas or help have been readily available.

In addition, although I have no idea how well the Reads sewing machine would perform (our original choice), I do know that your Sailwright Sailmaker has performed well. It has suffered through my learning curve and punched its way through 8-10 layers of 8.25-ounce cloth.

Thanks,
John Shugar
Windward Sails
Port Clinton, Ohio

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

It was only when I eagerly showed Fitch Williams the last issue of FABRIC FOILS at the Long Beach Show that I realized his article, "Thoughts on Stormsails," was printed without any mention of its author. Let all know that the man responsible for that excellent piece was Mr. Fitch Williams of Newbury Park, California!

Dear Jim,

I enjoyed talking with you at the recent Long Beach Boat Show...The show turned out good for us although down slightly from last year.

I am not sure I agree with your comments about boat shows (editorial in Volume II, No. 1 of **Fabric Foils**) although perhaps they will discourage any additional competition at the shows. There were 10 or more sailmakers at the Long Beach Boat Show.

I read your article on the HCS II and felt you were fair to Horizon while being objective.

Charlie Gautier
Winjammer Sails and
C & G Marine
San Diego, California

☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆☆

Jim and Connie,

Just reread your FF Oct. 1982 "Fine Tuning a Sewing Machine" and have a few comments to add.

On timing of hook to needle on a zigzag sewing machine, it is easier to time a wide-throw zigzag machine when the machine is set at maximum stitch width. When the needle is on the left side as viewed by the operator, the hook point should be less than $\frac{1}{2}$ above the bottom of the eye of the needle.

Your comment, "If the machine cannot sense the thickness of the material..." is very important. On many of the newer modern machines, thickness is sensed by the "stirrup" (the hook in Figure 10 which the words "take up spring" are cutting thru). This hook or "stirrup" is attached not to the face or body of the machine but is a separate metal finger that is attached directly to the presser foot shaft so that when it moves up the stirrup moves up and automatically compensates for fabric thickness.

Now for the WORD. "Oil Thy Hook" when sewing acrylics. These fabrics have a tendency to "powder" since they are made of spun fibers that are very short like wool or cotton. The resulting lint will absorb or dry up lubricants. Repairs on old, salty, sandy, dirty sails or covers also require lots of machine oiling to prevent rust and dirt accumulation.

Your article on Hildamatic (FF, July 1983 / Volume I, No. 4) was very good. We always like to take the air out of some sales!

Continued on page 16

Don't concur completely with Vic's Loft (FF, July 1983). The headboard drawing shows the slide below the headboard which is okay, just as done on Hong Kong sails! BUT...there should be a slide secured directly to the headboard. Also, on big boats it is a good idea to use two. This keeps the headboard aligned with the luff when fully hoisted and, when the sail is reefed, it keeps the leech firm and helps to prevent flutter.

Concerning Jim Hughes's suggestion in the Tips column (also July 1983), he's right! On some soft cloth and nylons, sewing through all layers at a corner with a short neck 107 can cause that corner to look like a product from Aunt May's quilting bee!

We used multi-step or serpentine zigzag machines for years in the construction of our trampolines and nets.

We hardly ever make a mistake and have to rip the seam apart (HA HA)! The low speed is a trade-off since we need only one pass down each seam on genoas, and there is no overcasting.

We had the Star Worlds here at Marina del Rey and we reworked about 12 jibs. Eight were vertical-cut Raudashals from Austria — they were made with the four-step zigzag. The rest were Norths — not remarkable except that all were made of very firm yarn-tempered cloth.

We are currently sewing with Teflon thread. No stretch — it is a bear to adjust machine tension. But the thread is not affected by UV or smog and chafe problems should be greatly reduced. We are running our tests now.

John Hjorth
Mare Co. Sails
Marina del Rey, California

ON THE WATERFRONT

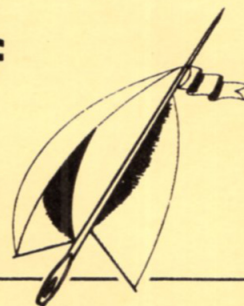
Ann Pencoff of San Bernardino, California, sends these photos of her **Flicka** all dressed up with new sail cover, cushions, winch covers, and tiller cover.

Ann has enrolled in **Unit I of the Sailmaker's Series**. We expect to see some new sails soon!

Dr. R. L. Booth of Middleburg, Virginia, sends this photo of his strip-planked number of the **Elver** class. The lines across the main over the sprit are trails and work beautifully for furling the main and mizzen. Booth writes that he took her to Newport to the Wooden Boat Show and, in addition to high spectator interest, he received a second in class of boats built by the skipper. "I had many folks aboard and spent most of the four days telling faint-hearted would-be builders that indeed they **could** build her!"



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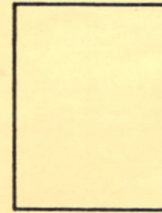
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The Raudashal Cut

The purpose of the cut is to minimize leech and luff stretch while eliminating the roughness caused by horizontal seams in small sails. It serves this purpose well, especially when a "warp-oriented" cloth like Bainbridge 2.2 or 3.3 ounce "genoa" fabric is used (note that all other Bainbridge cloth is "fill-oriented," i.e., more resistant to stretch across width than along length). This cut is also likely to save a bit of labor since seaming operations are reduced.

But it has definite limitations. First, it should not be used for large or low aspect ratio sails since bias stretch through the center of the sail would produce a wash-board effect if there were more than one seam.

Second, even though some broadseaming can be added in the center seam and in the lower "slits" at the leech, that broadseam must be a largely *ad hoc* thing. That is, it is not easy to develop a rule of thumb to be used for sails of different sizes using this design. That is why the cut has been limited to one design boats where a pattern can be developed through experimentation and then used again and again.

Third, because broadseaming is not likely to be extensive in such a sail, the luff round will be the dominant means of providing for shape. This has two consequences — the sails will tend to be rather flat and draft will tend to be farther forward than normal. These two characteristics are not undesirable in small, light, and fast boats, but they often are elsewhere.

If, after careful consideration, it is decided that these limitations do not apply in your case go ahead and use the Raudashal cut. I would suggest that the luff curve be cut normally with allowance for round and for sag which will create the characteristic "S" curve. The vertical wedge in the lower part of the sail should be cut so that the thread line of the fabric (either the warp or the fill) runs from the center of the narrow end to the point of the wedge (see Figure 20). This will reduce distortion caused by bias stretch to a minimum. The small wedge at the bottom of the luff panel should, as I mentioned earlier, be cut so that its thread line parallels the foot.

The slits in the leech panel should be placed in the lower half of the sail. Two will generally be sufficient since this cut does not lend itself to sails more than 25 feet or so in height. The slits are only for the sake of adding some broadseaming to the lower part of the sail. This broadseaming will tend to pull draft aft — without them the draft will be very far forward, especially in the lower third of the sail. The slit broadseams should flair gradually over the first third of their length (note that the broadseams "start" near the center of the sail). Then the seam should widen in a linear way to keep the run of the sail aft flat (see Figure 21).

The amount of broadseaming necessary should be determined by experimentation. Keep in mind that increasing the width of the leech seams (more broadseaming) will move draft aft in the sail and, of course, narrowing the seams will move it forward. FF□

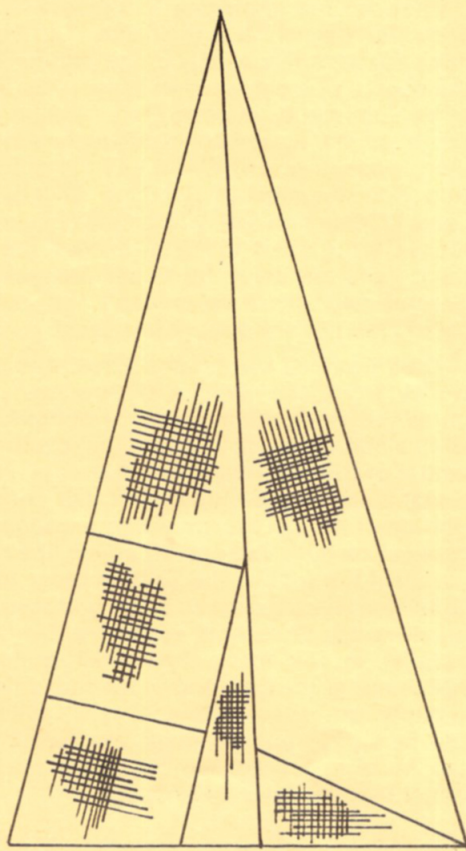


Figure 20: Threadlines in a Raudashal Cut Jibsail

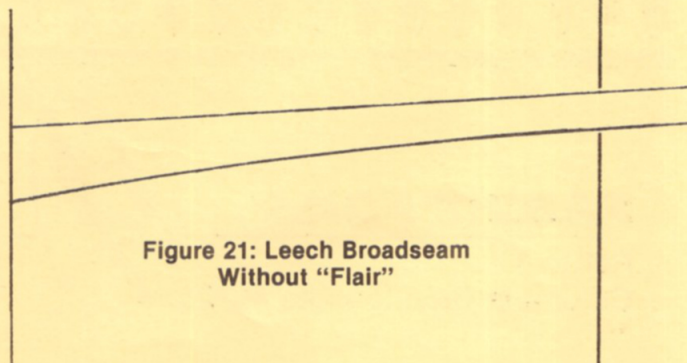


Figure 21: Leech Broadseam Without "Flair"

The Advertising Game

The Raudashal Cut

First, let me apologize to those who know how to spell "Raudashal." It is the name of an Austrian loft that does not advertise widely in the United States. Yet it is the source of a cut for high-aspect jibs that has gained some popularity among one design racers. John Hjorth's letter elsewhere in this issue notes the fact that there were several jibs with this cut at the Star Worlds. And Ron Johnson of Johnson Sailmakers in Moses Lake, Washington, has written me concerning its use on the G-Cat 5.7 Meter. In the latter case, the original equipment sails are made by Super Sailmakers of Florida. Several sailmakers have used the cut for Tornado catamaran jibs for quite a few years.

Let's examine the cut and attempt to discover why it works for these sails and how we can employ it ourselves. First, the cut must be defined. It aligns panel warp along the leech and luff. The resulting seam up the center of the sail entails two bias cuts (Figure 19). Additional cloth to make up proper sail chord in the lower portion of the sail is provided by a wedge of cloth that is bias cut on both fore and aft edges (the cloth threadline parallels the foot of the sail). In order to keep the foot from stretching too much at the bottom of the luff panel, small wedge of cloth is added there with its threadline parallel to the foot. This small wedge will not be necessary at the clew end of the foot unless the sail has a rather low aspect ratio and, as we will see, that would not be an appropriate shape for this cut. Finally, there are horizontal seams in the lower third of the leech panel that are used for shaping.

Continued on page 19

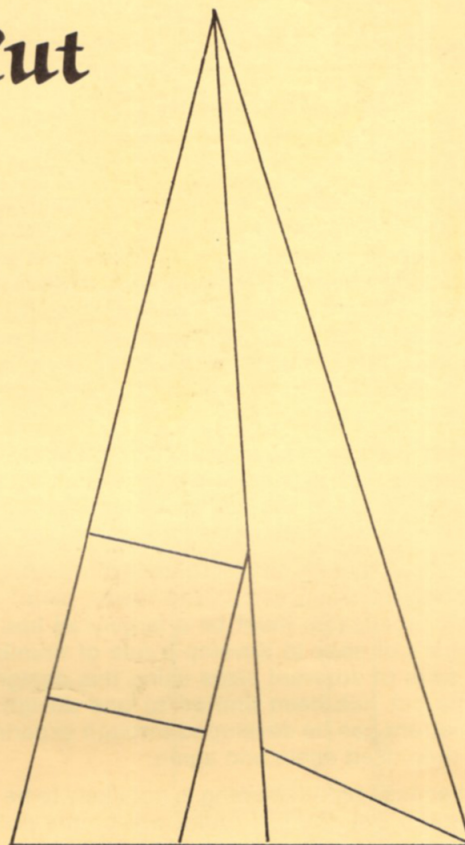


Figure 19: Seaming Lines
For a Raudashal Cut Jibsail

20 / January 1984 / FF



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