# THE WISHBONE RIG

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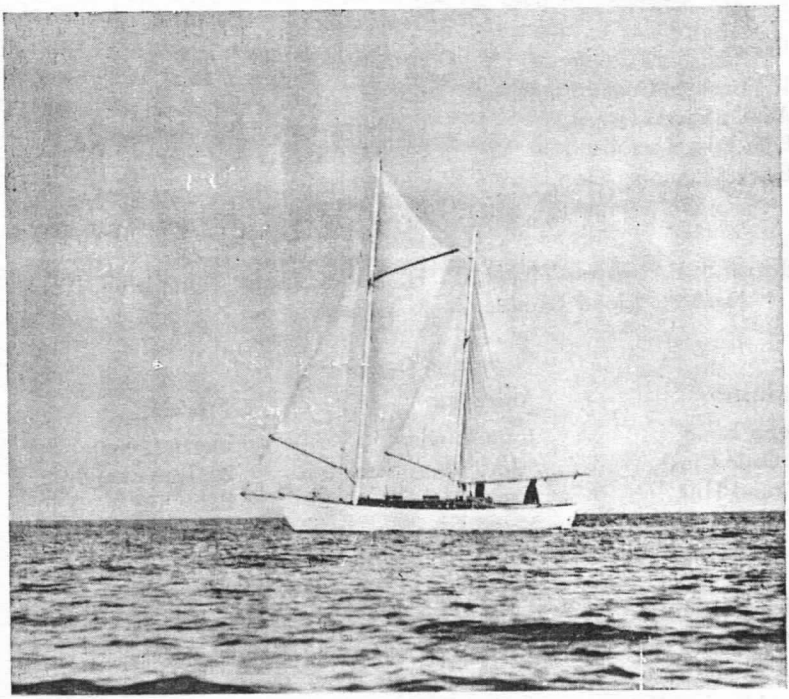

DIABLESSE

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## EDITORIAL

Some day, when I am really tired of my shore-bound existence, I swear I will get into the sailing boat of my dreams and set off on a cruise around the world. I am not sure what kind of hull will be beneath or around me. It may be a double hulled catamaran, an Indonesian type or perhaps a single hull with hydrofoil stabilizers. But of one thing I am sure and that is that the rig will be a wishbone ketch with a lowering wishbone. That is, unless some of the A.Y.R.S. members develop an even better rig, for the wishbone rig seems to me to be just what I want.

Here, therefore, is an account of that rig from material sent to me by Frederic Fenger who originated it and then developed it in its most practical form. A good deal of the material has come from an article written by the designer in the U.S. magazine *Rudder* though Frits Fenger has been most helpful in adding all the details which I felt were necessary to make the matter as clear as possible. He has read all the text at my request "*To make this the fullest possible account of the Rig, without being too technical*" and has corrected and added where necessary.

## THE WISHBONE RIG.

### ANCESTRY.

The gaff schooner may be said to be the traditional rig of the trading craft and larger yachts of the East Coast of North America.

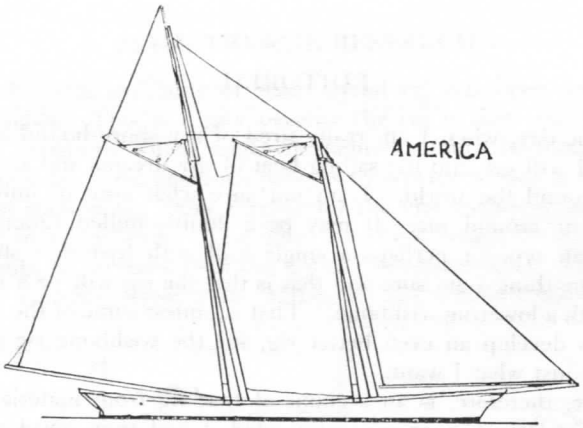



FIG. 1. *The Schooner* America

Famous examples of it were the schooner *America*, which won the "America's Cup" in 1851 and the Grand Banks fishermen from Nova Scotia and Gloucester, such as *Bluenose* and *Gertrude Thebaud*.

When the superiority of the Bermudian or jib-headed sail was realised in the 1920's and many yachts were being altered to the new rig, numerous schooners adopted the new sail for their mainsails with an improvement in performance. But the gaff sail on the foremast could not so easily be changed because there would have been a great loss of sail area and it would have been difficult to make such a sail sit well, so the gaff foresail was kept.

In 1925, however, John S. Lawrence, of Boston, rigged his schooner *Advance* with a Bermudian mainsail on the mainmast and the normal sails in the fore triangle but, between the masts he set

three small sails instead of the ususal gaff sail. The first of these was a sail shaped like a jib whose luff was put on slides on a track on the

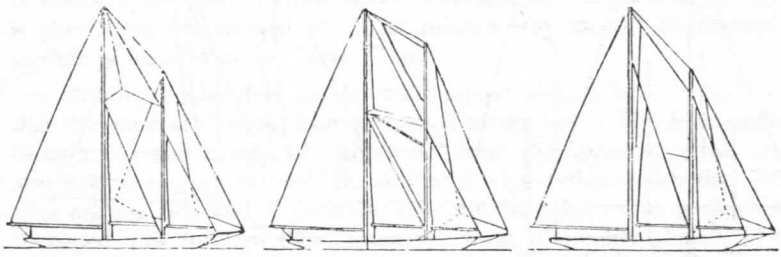


FIG. 2. Advance Mary Rose *Staysail Schooner*

after side of the foremast. The second was a staysail set on a stay from the mainmast to the base of the foremast and the third was a small jib set flying from the mainmast head to near the foremast head.

The *Advance* staysail was quite successful but the space between the masts was neither very completely nor effectively filled by these sails. This seemed to be a problem on which several designers were working because Herreshoff in *Mary Rose* produced a rig wherein all the space between the masts was completely filled by four sails, two staysails and two sails running in a track on the foremast. Ultimately this line of development took its final shape in the staysail schooner where a fisherman's staysail was set above a staysail set to the mainmast. *Nina*, who won the Transatlantic and Fastnet races in 1928 showed how useful a rig this was. Even *Advance* herself adopted it in her later years.

At about this time, Frits Fenger, of Massachusetts, was developing a type of hull in which the contour of the underbody would, more or less, resemble the *profile* of the gaff headed ketch rig, which he placed above it. Fig. 3 shows how the underwater contour was arrived at. Simply by drawing the reflections of the sails in the water at a reduced depth and by moving the foresail and mizzen towards the middle, the profile appears. This is an interesting concept in itself but it only concerns us in so far as the contour is deepest well forward of amidships and, from this "toe," the keel has a reverse drag, or upward

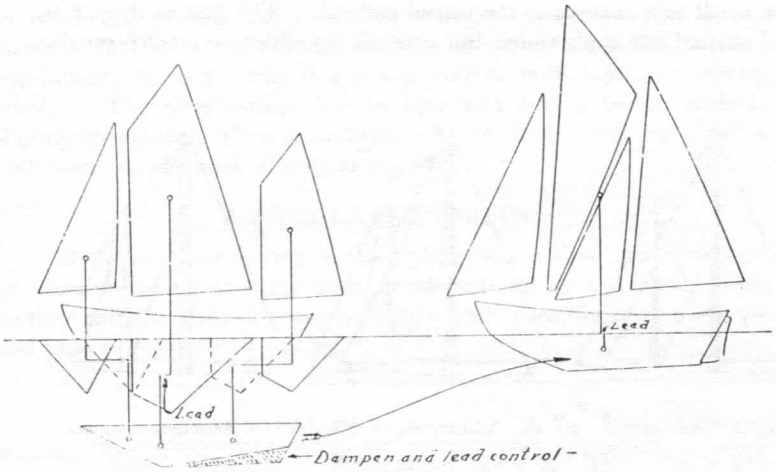



FIG. 3

slope aftward, toward the rudder. Frits called this new hull-form the *Dhow* hull, though he tells me that it resembles the Patamar (another Arab vessel), more closely. It then occurred to Frits Fenger that the sail plan above the hull might be shaped to a more similar, but opposite contour, to that of the hull. In this outline, the jib was retained, as before, and the mizzen was changed from gaff to Bermudian form. There remained the space between the masts, and, after a mizzen-staysail had been drawn in, the upside down sail on the mainmast suggested itself and was named the "Main Trysail"—now generally referred to as the "Wishbone sail." This sail plan was sketched in during the early Spring of 1924, about a year before the *Advance* rig appeared, but was left in abeyance while the design work was carried on for the new hull development. In short, this sail plan as well as the new hull form were worked up quite apart from what was being done elsewhere. It was only when the various staysail arrangements between the main and foremasts of the larger schooners began to approach Frits' concept, that he hastened to establish his priority on this particular sail.

The first article by Frits Fenger on this idea appeared in *Yachting* of August, 1926. The sail which was to become the wishbone sail was then loose-footed. His actual words in the article were : "Frankly the chief 'out' would arise when laying a course before

the wind. For here, without some means of booming out the main-trysail—and no sane solution has yet come to mind—this sail would be rendered useless, or practically so."

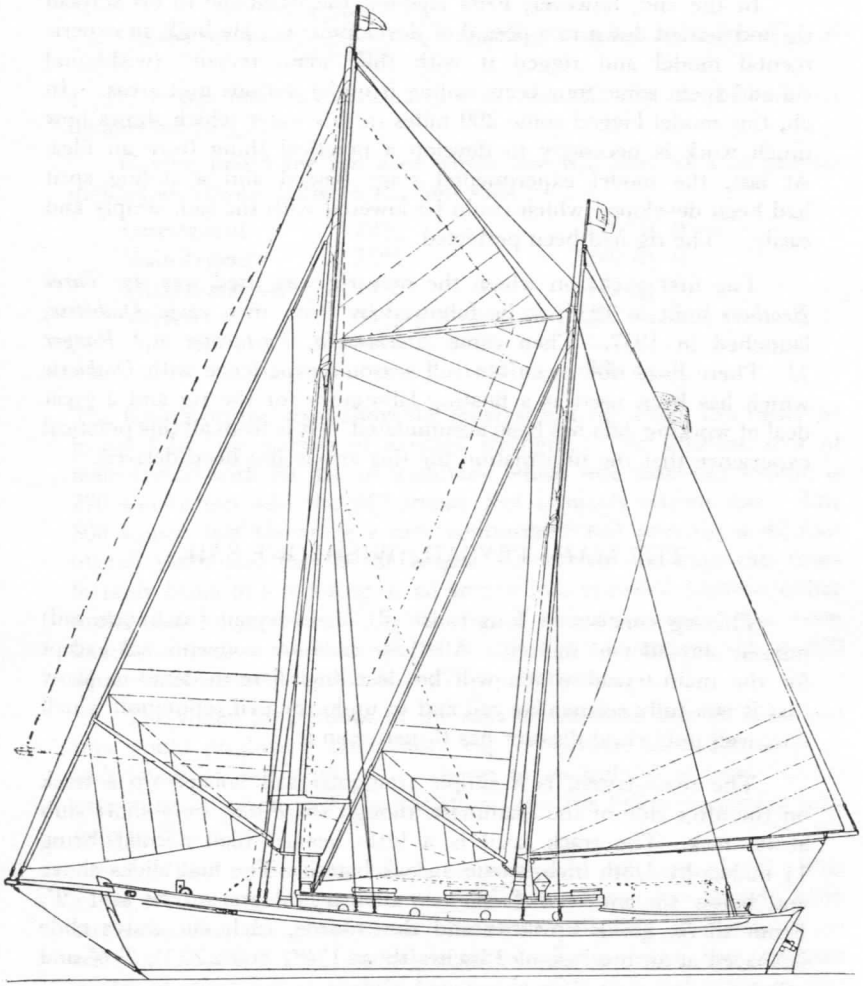


FIG. 4. *Sail Plan of* Diablesse

The wishbone or "split sprit" was first used in a few New Haven sharpies nearly sixty years ago, its inventor being thought to

be Nathaniel Herreshoff. Frits knew of this spar at the time when he designed his staysail rig, but he did not relish the idea of keeping it aloft and so did not at first suggest its use.

In the end, however, Frits adapted the wishbone to his staysail rig and settled down to a period of development. He built an experimental model and rigged it with the "main trysail" (wishbone) rig and spent some four years sailing it under various unit areas. In all, this model logged some 200 miles in salt water which shows how much work is necessary to develop a practical thing from an idea. At last, the model experimental stage passed and a sliding sprit had been developed which could be lowered with the sail, simply and easily. The rig had been perfected.

The first yacht on which the new rig was tried was the *Three Brothers* built in 1935, to be followed by Frits' own yacht *Diablesse*, launched in 1937. Then came *Stormsvala*, *Pustacaun* and *Ranger II*. There have now been ten full season's experience with *Diablesse* which has been used as a floating laboratory for the rig and a great deal of working data has been accumulated. It is from all this practical experience that the information for this article has been derived.

## THE MAIN-TRYSAIL (WISHBONE SAIL).

The rig consists of four sails: jib, main-trysail (wishbone sail) mizzen staysail and mizzen. All these sails are conventional except for the main-trysail which will be described here in detail to show that it is a fully seamanlike sail and to undo the evil reputation which one, well publicised disaster has thrust upon it.

The main-trysail is a simple triangular sail hoisted up a track on the after side of the mainmast, though there may be a short club at its tack. The track used is a little heavier than normal, being $1\frac{1}{4}$ inches by 1/8th inch, set on an oak batten. The first slides above and below the mitre of *Diablesse's* main-trysail are spaced at 1′ 9″. From there, going upwards and downwards, each successive slide is spaced at an increase of 3 inches thus: 1′ 9″, 2′ 0″, 2′ 3″, 2′ 6″ and so on.

The wishbone, or split-sprit, is a double spar made of two curved parts attached to each other fore and aft. Each side is curved to a parabolic arch to come to a sliding bronze fitting at the fore end which allows lateral and vertical movement but no twisting.

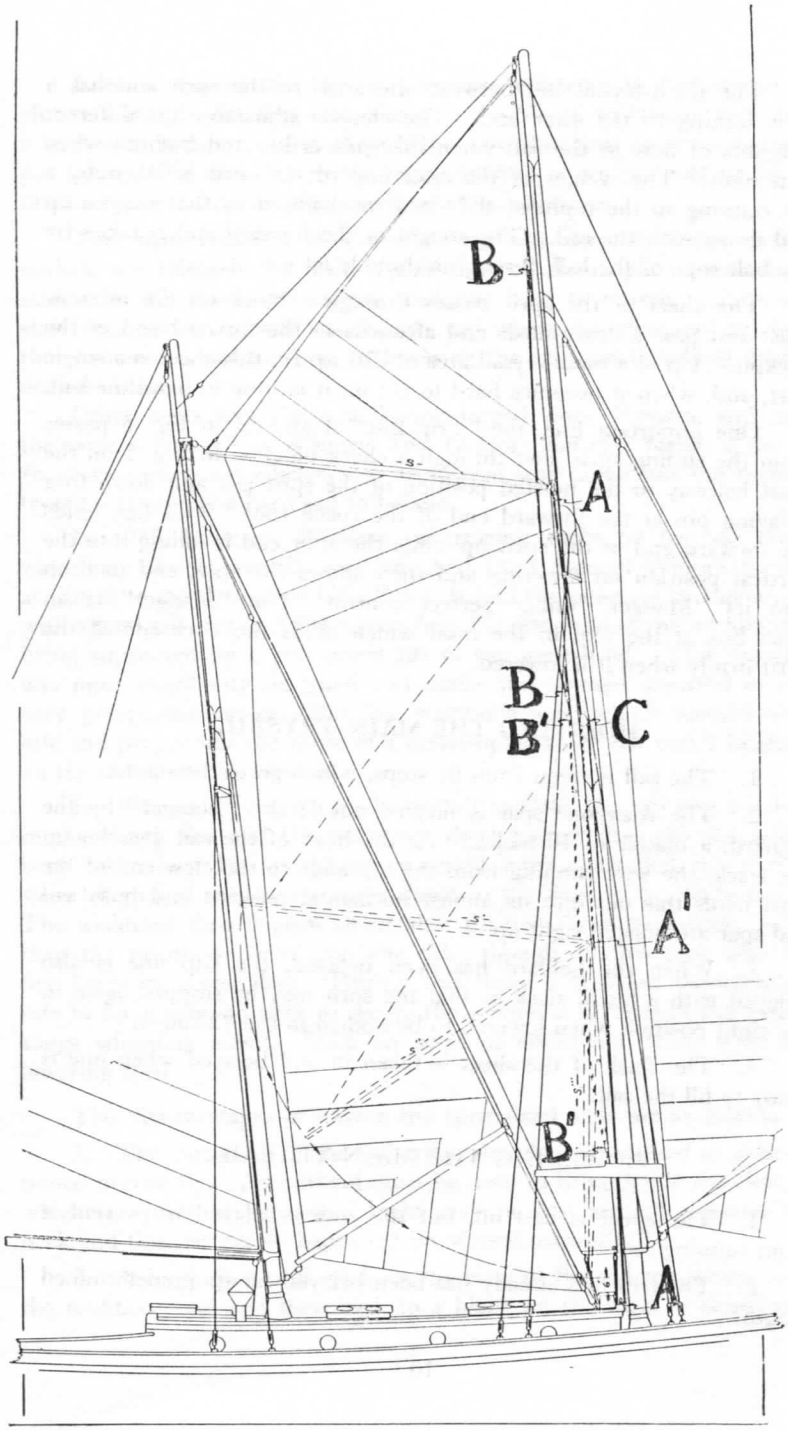



FIG. 5. *The main-trysail*

The main-trysail lies between the arms of the sprit and has a clew lashing to the after end. The clew is adjustable for different amounts of flow in the sail when the sprit is lowered but not when it is aloft. The weight of the after end of the sprit is taken by a lift running to the topmost slide and the halliard so that it goes up and down with the sail. The weight of the forward end is taken by the bolt rope of the luff, through a thimble let into it.

The sheet of the sprit passes through a block on the mizzen-mast and passes downwards and aftwards to the forward end of the cockpit. Up to a main-trysail area of 270 sq. ft., this sheet is a single part, and, when it becomes hard to get in, it is time to hand the sail.

One important line, the "Trip line" A and A′ in Fig. 5 passes from the sliding sprit jaws through a cheek block C in Fig. 5 on the mast halfway to the hoisted position of the sprit jaw and down to a belaying pin at the forward end of the coach roof. This line holds the forward end of the sprit up while the after end is falling into the vertical position on lowering and then allows the sprit end to drop into its "Manger" under perfect control. The "Manger" is an open box at the foot of the mast which holds the after end of the sprit firmly when it is lowered.

## HOISTING THE MAIN-TRYSAIL.

1. The sail is freed from its stops, which go to the mast.

2. The wishbone spar is hoisted out of the "Manger" by the halliard, a matter of 10 inches. As the head of the sail goes on up the track, the wire running from the top slide to the clew end of the sprit hauls this out into its almost horizontal position and both sail and spar are hoisted right up.

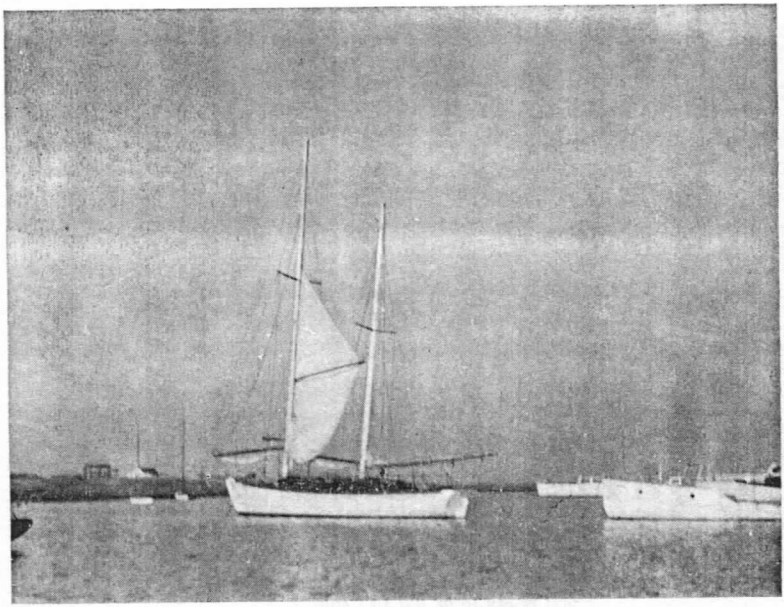
3. When the halliard has been belayed, the trip line is also belayed with a bit of slack so that the sprit may be stopped again in the right position when lowered to be homed in the "Manger."

4. The slack of the sheet is taken in and belayed when one is ready to fill the sail.

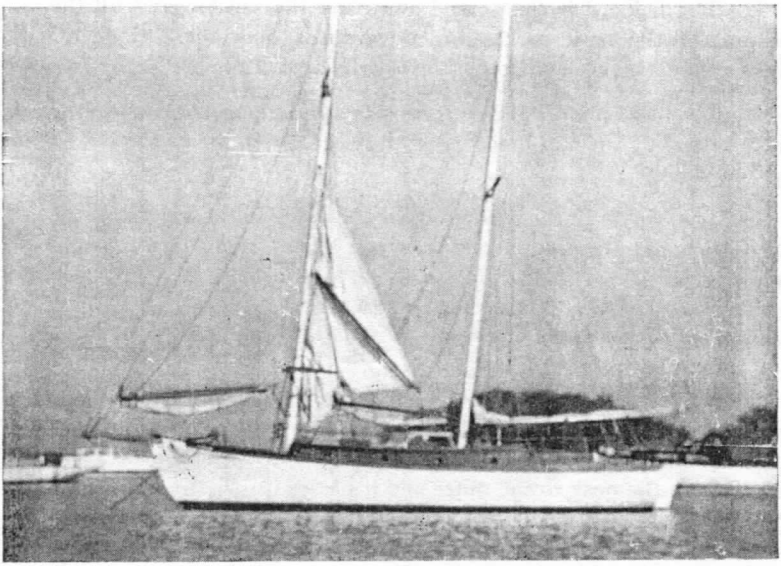
## LOWERING THE MAIN-TRYSAIL.

1. The sheet is cast off, but the end is belayed to prevent it rom running out.

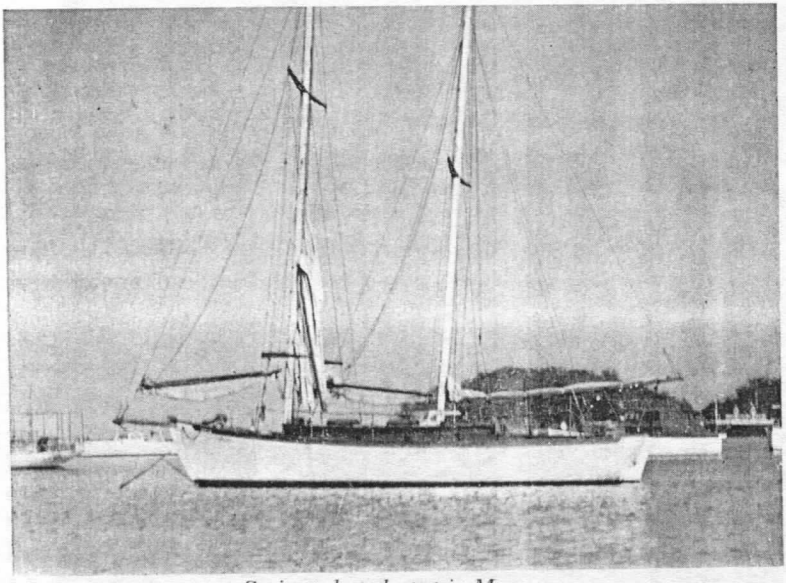
2. The trip line already has been belayed for its predetermined length.



*Fore end of sprit caught by trip line*



*Aft end of sprit swings down*



*Sprit ready to be put in Manger*

3. The halliard is then eased away and the sail lowered till the after end of the sprit is hanging downwards over the "Manger," its forward end being held up by the trip line.

4. The trip line is then eased away and the clew end of the sprit is aimed at the "Manger" and the spar is housed vertically by dropping it into the manger.

5. The sheet is then belayed so that the slack will clear the mizzen stay and the sail is put in stops. Frits now uses stops of shock cord with hooks and eyes on either side of the mainmast. He also uses this kind of stop for the mizzen but with that sail they, of course, go round the boom.

Sometimes, when the track becomes sticky through neglect, the upper triangle of the sail may not collapse readily to allow the clew end of the sprit to swing down. For this contingency, a down-haul (B and B′ in Fig. 5) is worked into the luff of the sail at about half way from the peak to the mitre and it passes inside the sprit arms to be again worked into the luff lower down. When the sail hangs, this line can be reached from the deck and a light pull on it will collapse the sail and allow the sprit to swing down.

This lowering, housing and furling takes 6 minutes, for one man. When the main-trysail is unbent and bagged, two more minutes are needed. All this is shorter than tying in reefs but longer than taking some turns with a roller reefing gear. The speed in unbending the sail is due to the use of pigtail hanks which allow the sail to be taken off each slide with a twist of the wrist.

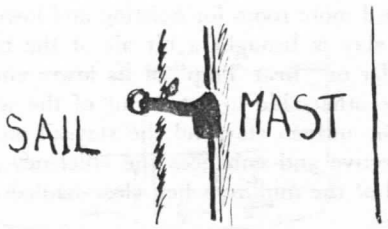
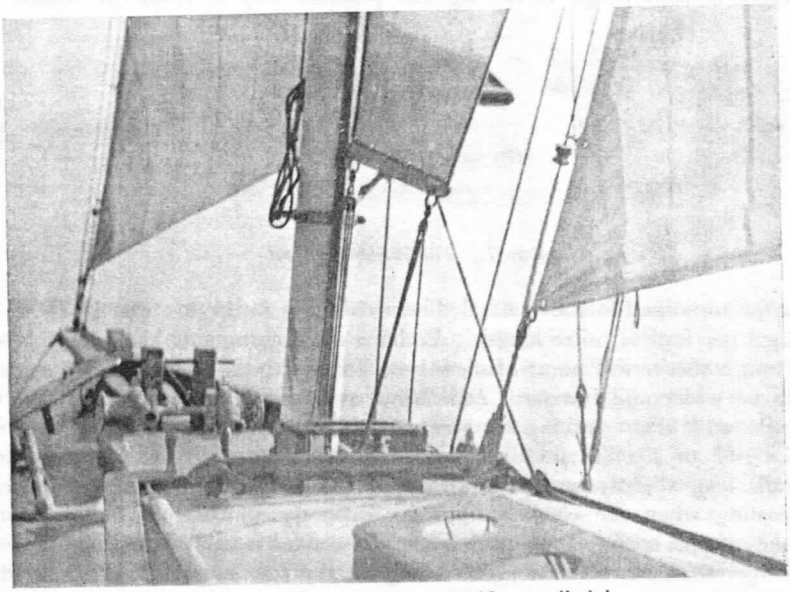



FIG. 6. *Pigtail Hank*

It is a matter of common sense to avoid fouling or rubbing against the mizzen stay when hoisting or lowering the main-trysail. When hoisting to sail away from an anchor or mooring, one can decide upon which tack one will go. The mizzen is then hoisted and, with



*Manger, "Bear trap" and Wishbone sail club*

a short tackle, is held to one side, for example to starboard for a port tack. The vessel will then be held with her stern slightly to weather and the main-trysail will clear the mizzen stay on hoisting. At sea under the three lowers, the vessel will maintain her course on her own when close hauled or with the sheets started and the sail will go up or come down without interference.

In order to afford more room for hoisting and lowering the main-trysail, the mizzen stay is brought a bit aft of the mainmast to an arthwartships traveller or "Bear Trap" at its lower end which allows it to slide to one or other side to get it out of the way. However, this movement of the mizzen stay and the staysail on it permits the sail to be more effective and enhances the efficiency of the mizzen. It stands to leeward of the midline when close-hauled and to weather when the wind is free.

## THE WISHBONE SPAR.

This double spar is 12 feet 4 inches long in *Diablesse*. It weighs 30 lbs. complete with its sliding bronze fitting. Each arm is of a T cross section which is the lightest possible way to make it. Both


FIG. 7. *The Wishbone Sprit*

arms are joined fore and aft. The archings is 1 : 11 or about 11/16th inch per foot of mitre length. Perhaps the arching should be greater from a theoretical point of view but, if it were, the sprit would have to be wider and heavier. *Diablesse* also has wishbones on her stay-sails and their arching is greater than on the main-trysail, being 1 : 10.5 or 1 1/8th inch per foot of mitre length. In all sprits, the sails lean slightly against the flats of the arms. There is not any chafing when the clew lashings are properly spread over the after end of the sprit. It is probable that wooden sprits should not be longer than 18′ 6″. At greater lengths, the spar should be made of light alloy.

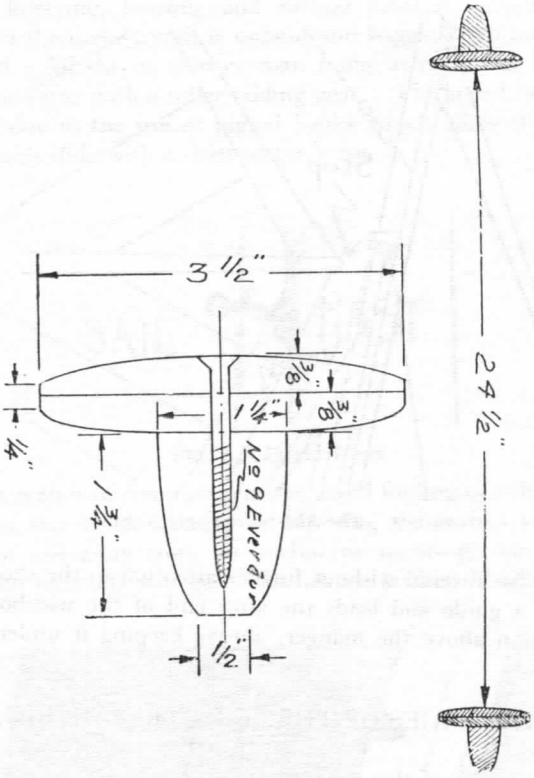



FIG. 8. *Details of wishbone spar*

## VANGS.

Vangs are only used on *Diablesse* in light winds to prevent the wishbone from slamming in a sea with little wind. However, a handy vang may be used by running the main-trysail sheet through a hole or eye in the wishbone end and then running it down to the foot of the mainmast. A stop is worked into the sheet on the mizzen mast side of the eye and does not interfere with the sheet's working but, when one wishes to use the vang, its lower end is unclipped from its eyebolt and taken to a pendant on the rail, either abreast of the mast or somewhat forward when sailing down wind. When lowering the sail with this type of vang, it is necessary that the vang shall be in the midships position. The sheet is eased off a foot or so and the

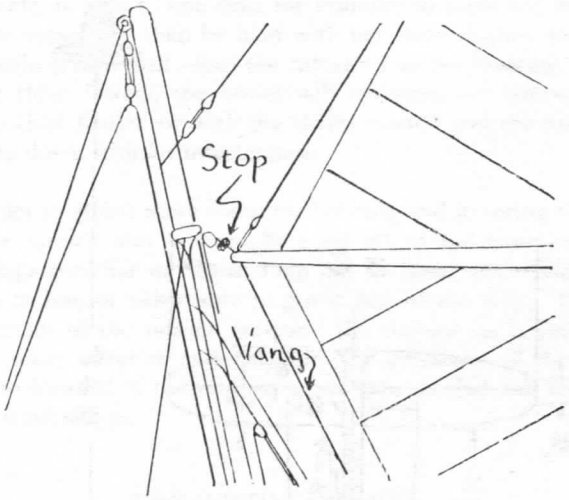



FIG. 9. *The Sheet-Vang and stop*

sail can then be lowered without further attention to the sheet. The vang acts as a guide and leads the after end of the wishbone to its vertical position above the manger, always keeping it under control.

## ADVANTAGES OF THE MAIN-TRYSAIL RIG.

The advantages of this rig are :—

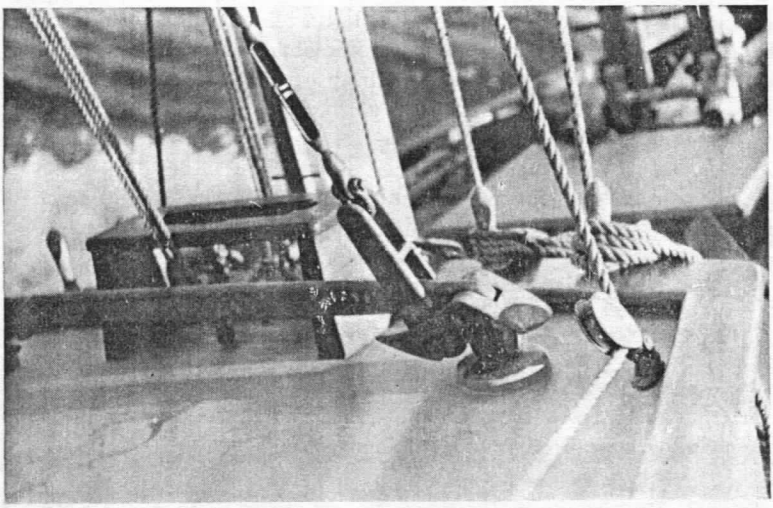
1. The sail area is split up into exceptionally easily handled units. D. Phillips-Birt says that with no other rig may a yacht of 60 tons displacement be efficiently powered and yet have no sail more than 600 square feet. Nor may the 800 square feet of canvas, which is the sail area needed to drive the largest reasonable single-handed yacht, be so easily handled by one man.

2. The small sails make them very long lasting. *Diablesse's* main-trysail has kept its shape for 14 seasons and is still good for a season or two. The three lowers lasted 9 seasons and still had their original drafts when replaced. The long life is attributed to: (a) A good sailmaker. (b) Large head angles. (c) Small units with small stresses per unit sail area.

3. Splitting up the sails increases the efficiency of the rig, especially to windward and the rig is almost as close winded as a Bermudian sloop. It is 15% more efficient than the Bermudian

ketch. This increase in efficiency is due to the fact that all the sails sit perfectly; they keep their shape and perhaps what is most important, the upper sail, the main-trysail, is trimmed to the wind direction high up while the mizzen staysail is trimmed to the wind direction low down. With but one sail between the masts—a Bermudian mainsail—the boom flattens the foot of the sail and the whole sail twists so that it is badly trimmed to the wind. In A.Y.R.S. publication No. 3, *Sail Evolution*, will be found an account of Captain Illingworth's development of the fore triangle where two sails of very similar shape to the main-trysail and mizzen staysail are put before the mast of a cutter and increase the performance.

4. The mizzen staysail is very useful, in spite of its small size, because the "Bear Trap" allows the luff of the sail to go somewhat to leeward when close hauled and this movement augments the wind-flow under the lee of the mizzen and thus increases its efficiency. It can be taken to windward when the wind is free. This sail is also very useful for offshore sailing because a yacht will heave to under it alone and will still make to windward in a half-gale. In an out-and-out blow, however, one's vessel should not be allowed to fore reach and a proper storm trysail should be set on the mainmast to establish a square drift.



*Manger and Bear trap—Mizzen stay to weather*

5. With a permanent backstay, there are no runners to be set up on tacking. However, a permanent backstay should be adjusted for varying conditions and it is bad seamanship to allow a rig to depend on any one stay, so the mast should be independently stayed with large spreads and drifts to the shrouds which, in the mainmast become "swifters," similar to the drifted extra shrouds used in the old square riggers. With the large mizzen advocated by Frits Fenger and used in *Diablesse*, there is less need for a backstay because the mizzen sheet in a wind of 14 knots pulls downwards with a force of 320 lbs. As the sheets are eased, the masts tend to stray slightly forward, but the runners are only used when the sheets are well started in winds of 18 knots and upwards. There is not a standing backstay in *Diablesse*.

6. With the large mizzen recommended, it is possible to jog about in a harbour with that sail alone. With a well balanced yacht, she will tack, pay off and gybe, which is very convenient for the single handed or short handed-sailor. In the event of an engine failure, one can always fetch off to gain room. The mizzen is the last sail to be handed and it can be furled under power with the wheel within hand or foot reach. Under the two end sails, fore staysail and mizzen, a watch tackle will let one go astern for a short distance in a crowded anchorage to clear another vessel (an old schooner practice). It is also a great convenience to start under these easily handled units and then hoist the middle sails according to the wind met outside. This avoids any doubts as to whether or not to reef. The mizzen is 49.5% greater in area than the fore staysail and has a higher centre of effort. Under the end sails, she will therefore come about better than with a small mizzen. *Diablesse* puts about with an easy helm and with very little loss of way. Uffa Fox states that a ketch under her two end sails will not come about when there is a strong gale and heavy seas but *Diablesse* has never failed to come about even under the most extreme conditions and this has probably been due to her large mizzen as well as her deep fore-foot and diminishing lateral area aft.

## OTHER WISHBONE DESIGNS.

The Fenger-rigged *Three Brothers* was launched in 1935, but two years earlier, the famous *Vamarie* was built to the designs of Cox and Stevens with a wishbone rig. In this vessel, the wishbone was kept aloft all the time, its fore end being secured to the mast and the after end being supported by a permanent mast-head lift. With the large size of the spar, this allowed the sail to be hoisted with greater ease because the weight of the sprit did not need to be carried by the halliard.

*Vamarie* showed that the rig possessed efficiency in a most conclusive way. In her first year, she won the Miami to Nassau race in a hard wet drive to windward with the wind blowing up to 50 miles per hour. She was also pretty regularly first home in most of her races but she didn't win many owing to her handicap.

The main criticism of *Vamarie's* rig was that when the clew outhaul was released, the main-trysail thrashed about, put enourmous strains on the masts and rigging and was hard to muzzle. Such a state does not occur with the Fenger sail where the clew outhaul to the wishbone is not touched on lowering the sail and thrashing does not take place.

Other boats have been wishbone rigged since *Vamarie* and in the same way, such as *Winsome Too*, *Golden Lion* and *Jeanne d'Arc*. In every case, great efficiency to windward was noted but the main trysail was usually a hard sail to handle.

In 1935, however, *Wishbone*, a cruising yacht 60 feet on the waterline, 83 feet overall, was launched from Samuel White's yard at Cowes to the designs of Uffa Fox. It had the same rig as *Vamarie* with a total sail area of 2,794 square feet, the after end of the wishbone being supported by a permanent lift to the mast-head. This vessel was most excellently designed and made and seemed assurred of a very prosperous career. But her wishbone spar which seemed so safe and proper was the cause of a catastrophe which has cast a blight on the use of the rig ever since.

In 1936, on a voyage from Lowestoft to Oslo, she ran into a gale in the North Sea and the wishbone sheet parted after the sail had been taken in. The vangs which could have controlled the sprit were let go and they never came down to the deck to be made fast. The wishbone then flogged about aloft till first the mizzen-mast and then the mainmast went over the side, though all this took nearly five hours to accomplish. During this time, it was not considered safe to let anyone go aloft to secure the wishbone because of the wire vangs whipping about. Such an accident could not occur with a lowering sprit.

The disadvantages of having the sprit fixed aloft are as follows:

1. The thrashing of the sail when the clew is released as mentioned previously. An outhaul must be used to bring home the clew, which is a menace because a bight may be cast around someone's neck and this has nearly happened on several occasions.

2. A single-part outhaul from the clew of the sail to a block on the wishbone end and then back to a block on the mast is handiest

but doubles the stress on the wishbone. A 2 or 3 part outhaul produces a lot of tail when the sail is up and still increases the spar stress.

3. Since the arms of a sprit fixed aloft must be hinged at their ends these members are in effect what are known as "Pin end" columns and must be considerably stronger than with the secured ends as in the sliding sprit.

4. For these reasons, the weight of a fixed spar must be twice that of one arranged to lower.

5. In strong winds, the weight of the wishbone spar aloft considerably increases the top hamper and also causes windage.

## ALLEGED FAULTS OF THE RIG.

1. *There is undue stress on the mizzen-mast head.* This is less than one would suppose. The leech stress is taken by the wishbone. The strain on the mizzen-mast is then only *part* of the *lateral* force of the sail because most of the sail force comes on the mainmast. In *Diablesse*, a 14-knot breeze only caused a measured pull of 70 lbs. on the main-trysail sheet from the 262 square feet of sail area. Since the mizzen-mast has such an ample spread for its shrouds, this load is only a minor factor in its design. Recently, the mizzen spreaders have been abolished and the upper shrouds have been simply homed just below the Mizzen stay.

2. *When the main-trysail is handed, the sail reduction is too drastic.* This objection does not appear in a practical form when cruising. But for racing, a No. 2 main-trysail can be used. It will take only 7 minutes to get off No. 1 and another 7 minutes to get No. 2 in its place, with 1 minute to bag No. 1 afterwards. It does not appear really necessary to go to this trouble, however, because in a practical test with *Diablesse*, she was heeled to an angle of 32° with her main-trysail set. When the sail was handed, she came up to 20° of heel *and the speed as measured by the log was no different. Dablesse's* main-trysail is only 30% of her sail area, so the loss of drive by handling the sail is not great. However, due to its height it probably contributes about 37% of the heeling moment. The effect of taking in this sail is greater in yachts carrying a smaller mizzen than *Diablesse*.

## DESIGNING A MAIN-TRYSAIL RIG.

In designing any rig, one must be guided by what has already been found to work well. Let us therefore start with the Bermudian or jib-headed ketch rig. For any hull, tables can be consulted which give the sail area it will carry, if of normal design. If the sail area

thus discovered is reduced by 15%, one will have then the sail area to use in the main-trysail rig. This smaller sail area will produce the same heeling moment as the Bermudian ketch and will still be slightly faster.

On the formula $\frac{\text{Luff}^2}{\text{Sail area}} \times \frac{3}{2}$ *Diablesse's* rig has an aspect ratio of 4 : 1. If this ratio is increased to 6 : 1, the sail area can be reduced by another 15%.

Having found the sail area which one will use, its area can be divided as follows, between the four sails :—

| | | |
|---|---|---|
| Forestaysail | 22% | 176 sq. ft. |
| Main-trysail | 30% | 240 sq. ft. |
| Mizzen-staysail | 14% | 112 sq. ft. |
| Mizzen | 34% | 272 sq. ft. |
| | Total: | 800 sq. ft. |

The figures on the right show the greatest sail rig which can easily be handled by one person of average strength. The greatest area of main-trysail with 30 lbs. of wishbone which one man can handle is 270 square feet and the 240 square feet is nicely within this. The 800 square feet shown is a nice comfortable sail area for a 42 foot overall yacht and that is the largest size which one man can comfortably bring to a mooring or an anchor in a crowded harbour either under sail or power. With this rig, if the main-trysail has been handed outside a harbour, there is still left an efficient rig of 560 square feet whose largest unit is 272 square feet.

The actual proportions of the sails of *Diablesse* may be used and this would produce a satisfactory rig. However, most people have individualities and want to do things in an individual way. Great care must be taken with the variations and the following guides may help in this matter:

1. The proportions of the sails should be maintained. The value of the large mizzen in many different ways has already been stressed. But the proportions of all the sails are so balanced by tests on *Diablesse* that, as sail is taken off the yacht, the resultant centre of effort moves slightly backwards with each reduction so that manoeuvrability is maintained, yet, when finally down to the mizzen-staysail, it is in the right position for jogging along in a ha'f-gale.

2. The aspect ratio of the whole rig may be altered without drastic effects. If, as a result of this, any sail becomes too narrow

to sit properly, that sail may be shortened in the hoist and lengthened in the fore and aft axis without loss. Frits Fenger likes the head angle in the main-trysail to be 41½°, but it seems to me that there is nothing mystic in this figure.

3. Little is lost by spreading out the sails fore and aft. By our formula, the aspect ratio will remain the same. There must be no attempt however, to crowd too much sail between the masts. It is both unseamanlike and a waste of canvas. The mizzen stay is now about 15 inches clear of the leech of the main-trysail in *Diablesse* and parallel with it.

4. The mast rakes may be altered. *Diablesse* uses 5° for the mainmast and 6° for the mizzen, the extra 1° being to make the masts appear parallel. She is also tuned so that she sails with the helm amidships, which makes for easier self-sailing for the short handed yacht, and not with a little weather helm as is usual. The lead of the C.E. before the C.L.R. is 4.5% of the L.W.L., though it can be adjusted by the mast rake.

## MAST STAYING.

Owing to the shorter masts and the nature of the sails between them, there can be more spread and drift to the shrouds than with a Bermudian ketch. The masts, especially the mainmast, are therefore exceptionally secure.

The clew force of the main-trysail is translated into thrust along the sprit to become a bending strain on the mast but this is taken up by the intermediate shrouds, or swifters, whose angle of drift is 8° to 11° and so is very well accounted for.

Thanks to the sprit, the load from the upper triangle of the main-trysail is not very great and upper shrouds are hardly needed. *Diablesse* has been sailed with her uppers quite slacked off in a rail down wind and her mast did not appear to be suffering. Because of the smaller area of the main-trysail as compared with a Bermudian mainsail and the absence of sheet strain, the compression load on the mainmast from the halliard and leech is reduced by some 46%.

Stirrups, which can fold out of the way, are fitted to the fore side of the mainmast for use in putting stops on the main-trysail. Above these stirrups, athwartships ratlines are fitted to the shrouds so it is possible to climb right up to the mast head.

## SAIL TRIMMING.

*Close hauled.* The main-trysail should be sheeted much more broadly than seems to be natural. In effect, one is sheeting what

would be the upper leech of an ordinary sail and not the boom at its foot. The spirit should be at an angle of 14° or even 16° from the axis of the vessel. This looks wrong and the instinct is to pull in the sail, which will kill the vessel's speed. The wishbone staysails of *Diablesse* are sheeted at 12° and the mizzen with an ordinary boom is sheeted at the normal 6°. The mizzen stay should be allowed to slide to leeward in the "Bear Trap."

*Running.* The flow in the main-trysail should be reversed so that the wind is blowing from the leech to the luff. The best angle to trim this sail seems to be about 67° from the apparent wind. It also is best to pair the sails in wing and wing fashion with the end sails on one side and the middle sails on the other, thus giving an S-shaped flow through them when the wind is directly abaft. The mizzen-staysail should be stood to weather in the "Bear Trap."

In light winds, increased draught may be got in the main-trysail by slackening off the tack tackle a bit to let the luff creep up.

## COST.

The cost of the wishbone or main-trysail rig is comparable to that of a Bermudian ketch. The extra cost of the wishbone spar and the "Bear Trap" are about balanced by the smaller sail area and shorter masts.

## SHORT HANDED CRUISES.

By consulting Richard Gordon McCloskey of the *Slocum* society, I have learned that there has been only one ocean cruise in a small yacht using the wishbone rig.

Harry Scott, a 70-year old Australian, is now cruising around the world with his wife in his 43 foot wishbone ketch, rigged with a lowering sprit to the Fenger design. He has already been 30,000 miles in the last 8½ years. He is very enthusiastic about the rig. The Quincy Patriot Ledger quotes him as saying: "There's nothing like it and I have sailed shipmates with about every rig now used. It eliminates reefing. There's not a reef point aboard. In a matter of seconds, I can shorten down to storm canvas, single handed, even in heavy weather and you know what a job that is when you reef, and how long it takes when it's blowing hard and your craft is jumping about. If a bad squall makes up, I can snug her down quickly by letting the halliards run without getting my wife on deck." Once, caught in a bad blow, Scott's yacht *New Silver Gull* worked 90 miles

to windward in two and a half days under mizzen staysail alone. In the 30,000 miles, she has been in three all-out gales and has behaved handsomely in each. She is a self-steerer in both light and strong winds. The tiller swings free in light airs and is loosely lashed, slightly to weather, when it freshens. At no time in the eight and a half years has she been in serious trouble.

## ARTICULATED SPRITS.

All the previous writing in this publication is about the wishbone or main-trysail rig as it has been developed and as it is now. This section and the following one will deal with possible improvements and lines of research on this rig.

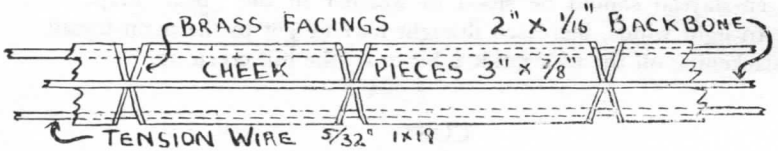
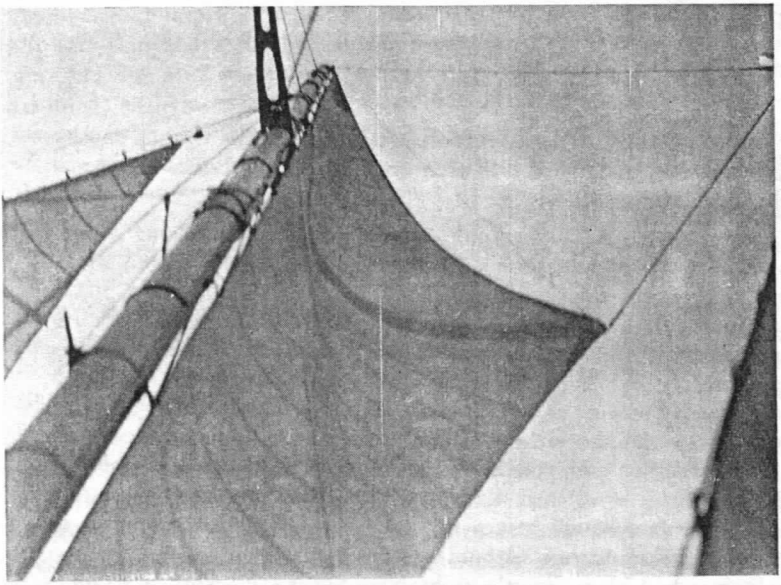



FIG. 10. *The Fenger articulated sprit*



*The articulated sprit failing*

The split-sprit, or wishbone spar is moderately heavy and must interfere with the wind flow on the main-trysail by its weather arm. It would therefore be an improvement to develop a sprit which could take up a parabolic curve on either tack. Frits Fenger has actually tried this out made to the section shown. The photograph shows how, in a wind of about 16 knots, it failed and took up an extreme curvature, still valiantly maintaining its parabolic shape. Before this happened, the sail set very well indeed with the spar fitting into a neat 6 inch pocket along the mitre of the sail. When he raised and lowered the sail, however, in a wind rising 16 knots, the flogging of both spar and sail was terrific, so much so that he feared the seams would go. Also, to be strong enough, this sprit weighed almost as much as the sliding split-sprit and it was not so easy to make a decent furl when the sail was handed. For all these reasons, Frits feels that the sliding spli-sprit will remain the best.

Frits Fenger's articulated spar was only $1\frac{3}{4}$ inches thick by 3 inches wide and yet was strong enough to bear his weight sitting on

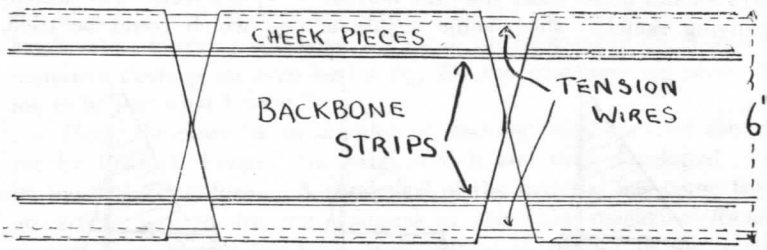



FIG. 11. *An articulated sprit*

it. Surely, by simply increasing the thickness of the spar, one would get enough strength and it could be made as in the sketch, for lightness. This leaves the problem of flogging and this can be dealt with by rod couplings from each articulated piece to the next but one. When this is done, the spar can take a curve on either tack or it can be straight, but it cannot assume an S bend and therefore cannot

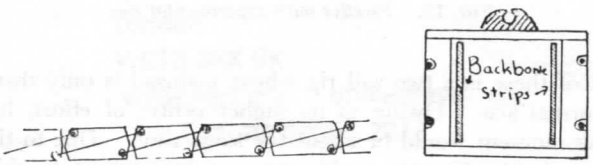



FIG. 12. *Rod couplings and section of sprit*

flog. In the Fenger articulated sprit, the backbone is clamped by bolts to each piece and this could put tension into the backbone instead of the tension wire. In this suggested sprit, the backbones are free in the slots so all the tension must come on the wires.

It is pointed out that this articulated sprit could well be used as a bending boom for use with an ordinary Bermudian mainsail where it would increase efficiency. The section drawing shows how the bolt rope groove could be fitted.

## MAIN-TRYSAIL RESEARCH.

So far, the wishbone or main-trysail rig has been confined to larger yachts. This is a pity because the rig is then expensive and trials of variations which might be failures cannot be made. What is needed is for some generous persons to provide weekly prize money in a class such as the Fairy Fireflys for the first wishbone rigged boat to come in every week. The only regulation would be that the sail area should be no more than the normal 90 square feet. The accompanying sketches show some wishbone rigs which could be tried.

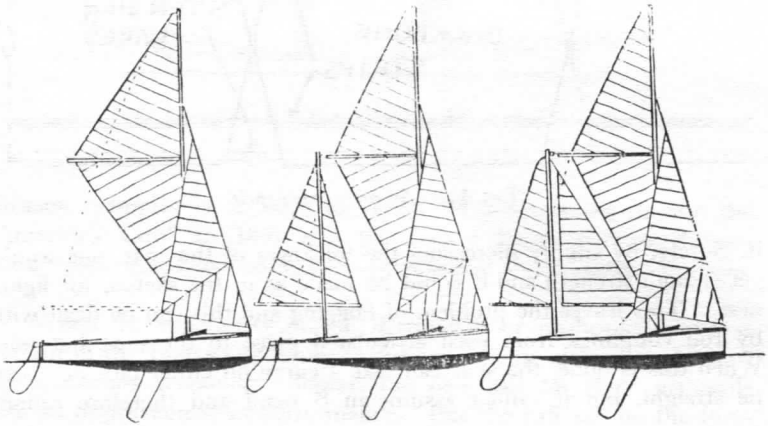


FIG. 13. *Fireflys with experimental rigs*

The first of these is a two sail rig whose mainsail is only three-fifths of the normal size. Owing to its higher centre of effort, however, its heeling moment would be about the same time. Due to the wind velocity gradient, this rig would have a better thrust to side force ratio than normal and be a faster rig for a catamaran than an ordinary

sloop. The second rig uses the whole amount of sail area, but splits the mainsail area into an upper main-trysail and a lower lugsail of one of the designs shown in No. 9, *Sails and Aerofoils*. This rig, with careful trimming of the sails, should also be faster than the normal sloop rig. The upper and lower sails can be accurately trimmed to the wind directions at each height of the rig and so there is less "Twist" than with the Bermudian mainsail. The third rig of four sails would be less efficient than No. 3 but its relative value would be of interest as being closer to the rig used in *Diablesse*. It will be noted that in all these rigs, the full mainmast of the Firefly is used and the aspect ratio would therefore be the same as normal when the full sail area was used. Also, both halves (upper and lower portions) of the wishbone sail are the same and the sprit is horizontal which is a departure from the usual main-trysail proportions.

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