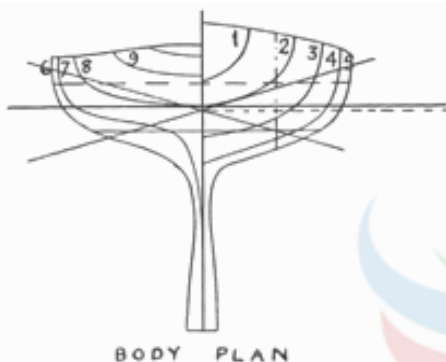


FALLACY OF GAIN IN SAILING LENGTH

By W. P. STEPHENS

SECOND only to the schooner *America* in her influence on racing types, the 46-footer *Gloriana* presented many interesting problems to the student of naval architecture. A departure in many ways from the yachts of the day and those which had preceded them, her continued victories



throughout her first season, 1891, called for comment and explanation on the part of yachting writers. With a singular unanimity, one of her prominent but purely external characteristics was seized on and exploited as the prime cause of her speed; the vital points of her design being entirely overlooked. Disregarding the marked departure in her under-water body, her light construction and the many novel details of hull and rig, column after column was written about her great length on deck and her overhangs above water, especially the forward one.

Since then many really abstruse problems have been laid before the yachting world by clever designers, most of them involving more or less the principles of the modern racing scow; not the least of these being involved in the great single-stick racing machine which has just defended the America Cup. As in the case of *Gloriana*, the success of *Reliance* is commonly attributed above all else to her excessive overhangs, no less than 37 per cent. of her over-all length and 60 per cent. of her measured water-line. Her over-all length being 144 feet and her water-line four inches under the official limit of ninety feet, the statement has been repeatedly made during the summer that when heeled to her ordinary sailing angle she actually realized an effective sailing length, through the immersion of her overhangs, of 140 feet; as compared with but little over ninety feet in the case of her rival, *Shamrock III*.

In spite of the great increase in over-all length of *Reliance* over *Gloriana*, this statement of the enormous gain through the supposed immersion of the long ends is practically as false in one case as the other,

and its continued circulation can only do harm in blinding yachtsmen to the study of the real points of advantage in the design of the new boat. There are yachts—if indeed they can be called such—in the smaller classes, in which such a gain of effective length is possible through a distorted form and an extreme angle of heel, due to the shifting of the crew to leeward; but *Reliance* owes her speed mainly to other features than excessive over-all length and extreme angle of heel. As a matter of fact, the official figures show her to be just 9 feet $\frac{3}{4}$ inches longer over all than *Shamrock III*, and those who witnessed the races will remember that the difference in average angle of heel was so slight as to be a matter of personal opinion among the spectators.

When under way in a good breeze, especially outside Sandy Hook, where the water is seldom really smooth, every 90-footer gives the idea of an excessive immersion of the overhangs, a tumble of water and foam is rolled up by the modern full bow, and the quarter wave follows almost to the end of the long after overhang. How much of this "fuss" is merely superficial, if not detrimental, and how much is really adding to the speed, are questions best answered by a consideration of the yacht when heeled to her average sailing angle in smooth water.

The lines of *Reliance* are of course not available for direct study—no lines of a Herreshoff yacht are allowed to be published—but the accompanying sketch shows a yacht of as nearly as possible identical dimensions with *Reliance* and about as extreme in type, so that the deductions drawn from it will apply with equal force to the real yacht. It will be noticed that the hull proper, apart from the fin, is very wide and shoal, the stern and the center line of the counter cut the load water-line at very small angles; partly as a consequence of this limited depth of body, the load water-line, though not angular like that of a scow, is very full and of an elongated egg section, and the overhangs are excessively long. The transverse sections of the bow and counter, as shown in the body plan, are also very round and full, like the midship section.

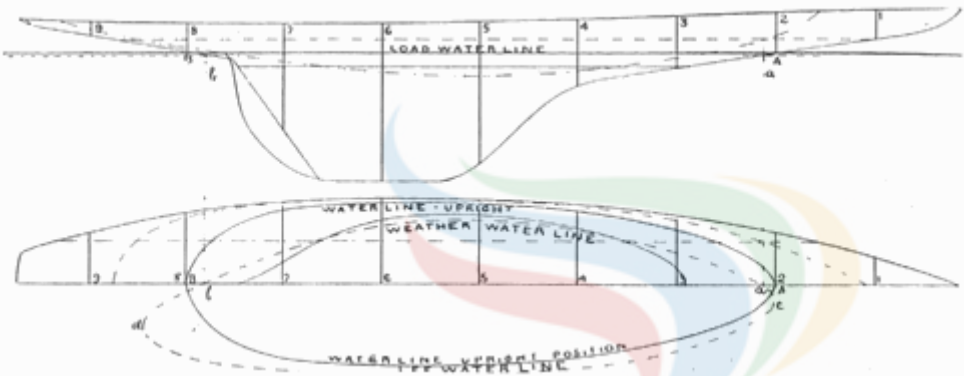
When measured for her official water-line, in an inclosed basin with the water as near as possible to absolute smoothness, the fore and after ends of the load water-line are marked—the points *A*, *B*, in the diagram—a strip of pine is floated on the water until it barely touches *A*, and the position of a plumb line dropped from the stem head is marked on it, giving the length of the fore overhang—which is then transferred to the deck, giving a point immediately above *A*; a similar point on deck above *B* is located, and the distance be-

tween the two is measured, giving the water-line length.

This imaginary straight line between *A* and *B* may be called the axis of the yacht, lying at the level of the water as long as she is upright. As she begins to heel, the first thing which happens is that, through the increased displacement of the lee bilge, this axis actually *lifts out of the water* a distance of several inches, so that the new water-line, now *a, b*, is materially shorter than the old—in the case of *Reliance* this shortening may be as much as two feet at the fore and three at the after end—so that the true central water-line when heeled

is grees by the weight and agility of her crew, the actual effective length for sailing may be double the measured water-line.

Nothing approaching this increase is possible in a yacht of the size and type of *Reliance*; the limit of lengthening of the inclined load-water plane is that shown from *c* to *d*, or about ninety-six feet in place of the original ninety feet. At times she will heel much further in a heavy puff, the water-line lengthening rapidly for the moment, but she will never be deliberately sailed for any length of time with her deck under water. In order to realize the effective length of from 130 to 140 feet popularly



Sketch of Typical 90-footer.

Length over all 144 feet; load water-line measurement, 90 feet; breadth, 26 feet; draft, 19 feet 6 inches. Fore overhang, 28 feet; overband, 26 feet. Water-line plane in upright position shown by solid lines; points of measurement marked *A, B*; lee and weather sides of inclined water-line plane at angles of 15 degrees shown by broken lines.

is probably less than eighty-five feet in place of the original ninety feet. In yachts of less extreme type, even those of fuller water-line plane than *Gloriana*, this central water-line shortens very rapidly forward, and there is no corresponding lengthening; but in *Reliance* as she rolls down the very round section marked 2 is immersed at some little distance out to leeward from the center line, thus lengthening the water-line to the point marked *c*.

In all yachts with the cutter counter, even of moderate length, there is an appreciable lengthening of the after end of the water-line as the vessel heels; the central water-line is shortened, from *B* to *b*, but the flat sections of the counter are partly immersed, extending the after end of the inclined water-line plane in a loop, *d*. In the old type of centerboard sloop, in particular such craft as David Kirby's *Arrow* though the after overhangs were very short there was a great gain of length aft as the wide flat quarter was immersed. In all yachts built more than eight years ago the inclined water-line shortened more rapidly forward than it lengthened aft, so that the longest possible water-line was that measured when upright. In the extreme flat scow of the small classes the water-line continues to lengthen regularly as the yacht is heeled until, when she is balanced on edge at an angle of some twenty de-

grees, she would have to heel until the two sections 1 and 9 in the body plan were not merely touching the water, but fully immersed; which is impossible.

Except for short intervals of heavy heel, the effective lengthening at the bow can never be more than as shown at *c*; in all well-designed yachts there is a certain gain of effective length aft by the submersion of the counter in the quarter wave somewhat beyond the theoretical point *d*; but in many yachts this submersion of the counter is carried to a point where water is dragged, to the detriment of speed.

Though materially finer than *Reliance*, *Shamrock III* is, at the same time, full enough in form to show a similar gain in length aft, though not forward; it is plain, however, that the difference in effective length when heeled is almost a matter of inches rather than of forty to fifty feet, as commonly stated.

The question of overhangs appeals to the designer in two lights. The base line of *Reliance*'s sail plan measures 201.76 feet, over a water-line of ninety feet; the long overhangs aid materially in a mechanical way in carrying this enormous rig, and give deck room for working both headsails and main sheet. On the other hand, this enormous extra length involves a great increase of weight of hull, a very serious disadvantage.