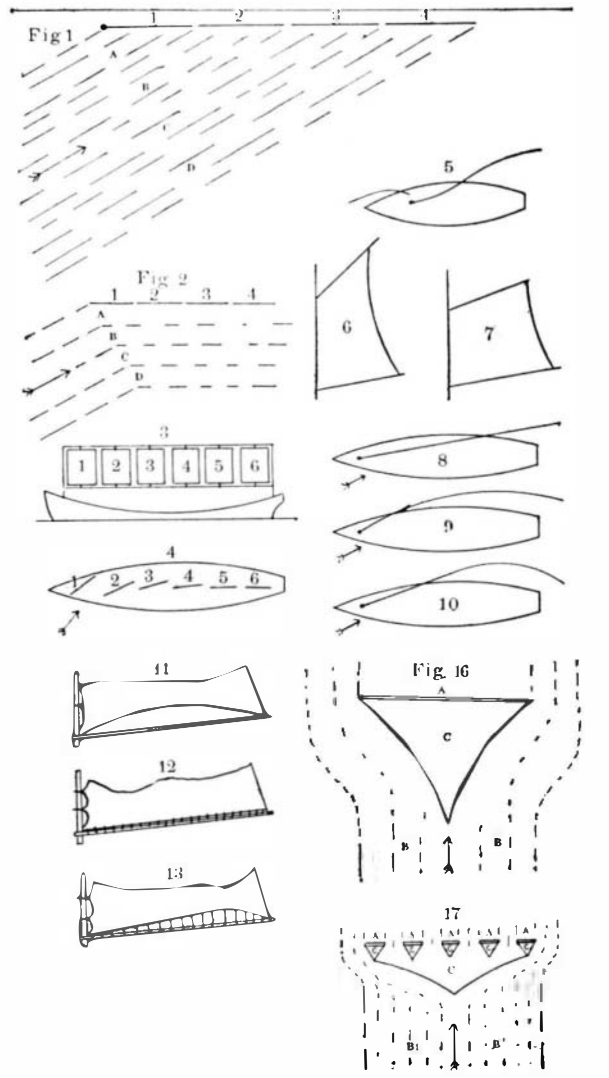
BOATS AND SAILS.

BY WALTER BURNHAM.

SAILS.

Supposing four playing cards be stood vertically in a row, with their edges touching, and the area thus made be regarded as a sail, as represented in Fig. 1. The wind which would pass through a line equivalent to the right hand edge of the fourth card and the left hand edge of the first card (that is the after-leech of a sail and the mast) may be regarded as a column of wind divided into four parts, *A*, *B*, *C*, *D*, moving in the direction shown by the arrow.

In Fig. 2, *A* is the column of air which strikes on the first card and is turned or deflected by the first card and passes aft over the three remaining cards. This column of wind does not lose its dimensions very much. A little is "spilled" over the top and bottom of the card but it turns in bulk. If it does not turn in bulk, that is to say, if the bulk of wind is materially affected, then its pressure must be materially increased or diminished, which is seen at once not to be the case, or the wind must be backed up.



ACTION OF WIND ON SAILS.

For many years I was under the impression and conducted my experiments under the belief that the wind did materially lessen in its bulk, but of late years I have become positive in the opinion that the deflection of wind which would have struck on the first card, or the section of the sail nearest the mast, remained about the same in size, density and velocity and passed aft over the sail. This is why I speak so positively.

Column of wind, *B*, is that column which would strike on card 2, but which never reaches the card because the deflected wind, *A*, from the first card is interposed between it and the sail. Similarly so in *C* and *D*. It will then be seen that on the first part of the sail there is a very good wind; on the second part of the sail a mixture between a dead-ahead wind and a favorable wind; on the third part of the sail two dead-ahead currents; on the fourth part, three.

In investigating this further, the following experiment was tried, shown by Figs. 3 and 4. On a boat a framework was put up that carried six smaller frames, covered with muslin, thus constituting sails. Each of these six sails was pivoted in the center so that they might take any angle. The first plate or sail was set at the angle shown by No, 1, Fig. 4, the course of the wind being shown by the arrow. No. 1 was fastened in this position. Then No, 2 was slowly moved until it was found to be set at the angle which received some wind, that is, "set so it would draw" and fastened. Nos. 3, 4, 5, and 6 were similarly and subsequently so set. When it was found that No. 5 was set almost fore and aft, the leech or after part of sail No. 6 was really to windward of the keel. This may seem, when so stated, astonishing, but it will readily be conceded when it is remembered how the jib will "back" the mainsail as shown in Fig. 5, or how much more inboard the boom of a mainsail must be drawn than that of the foresail, and numbers of other similar experiences.

Attention is also called to the fact that if some cotton be thoroughly saturated with tar and lighted, the smoke from it cannot be made to touch the sail unless held forward of the mast and quite in line with the wind. As you go to windward of the mast the distance the smoke will remain from the sail increases, going to show that the bulk of the wind as it is turned by the sail does not materially diminish.

For these reasons, attention is called to Figs. 6 and 7. Fig. 6 representing a tall and narrow sail, which is undoubtedly the speediest; Fig. 7 being a low and broad sail, which is undoubtedly the slowest.

The course of the deflected wind and its unaltered bulk, is without doubt the explanation of why a catboat can outpoint a sloop, and a sloop outpoint a schooner, and a schooner outpoint a ship.

Fig. 2 and the facts that are gathered from it, are also an explanation of why a perfectly flat sail, as shown in Fig. 8, is not good. It also shows why a bellied sail is better than a quite flat sail, as shown in Fig. 9, and it would also point to the proper curve in a sail being that shown in Fig. 10. In old times they used to fasten the sail free on the boom, as shown in Fig. 11, which represents a too much bellied sail for beating. The custom now is to lace the sail on the boom, as shown in Fig. 12, and I think that with the lacing of the sail it is very easy to secure a too flat sail, as shown in Fig. 8.

I have almost always been able to speed a boat up and increase her windward work materially by relacing it on the boom, as shown in Fig. 13.

Figs. 3 and 4 suggest an experiment in sails which I have very thoroughly tried, and of which illustrations are given later, but before I leave the sketches I wish to explain what I have found to be the case in a sail running before the wind, as illustrated by sketches 16 and 17.

In Fig. 16, *A* is the sail and *B B* is the wind, and *C* is the cone of dead air that rests upon the sail. Allow me to liken the sail and the wind and this cone of dead air to one's putting his hand into sand and moving it. It would be found that a cone of sand remains on the hand. Any one who has gone out on the boom of a sail "running" has found himself in a place of comparative calm, the smoke from his cigar remaining with him. If the sides of the cone are at a correct angle, the wind will be "split" and pass the sail without exerting its greatest effect on the sail, whereas if the sail have openings in it they allow the base of the cone to constantly pass through, bringing the apex nearer the base and increasing the angle of the cone. In a sail of 100 square feet area, I have found that 65 per cent of the area being covered by cloth and 35 per cent of the area being open, their speed was equal. What I have said of Figs. 16 and 17 must be thought of when looking at the following photographs.

PHOTOGRAPHS OF SAILS.

The accompanying photographs are a few of many experiments that have been tried—the general results may be stated as follows:

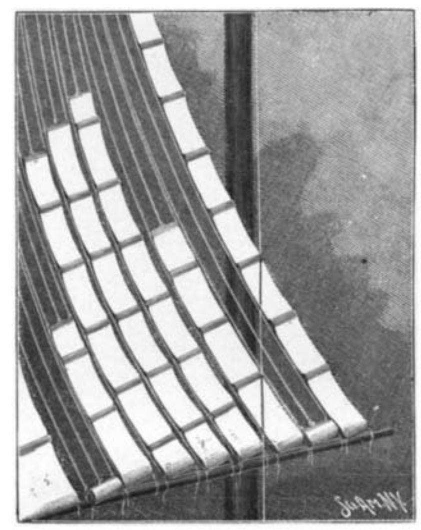


Fig. 5.

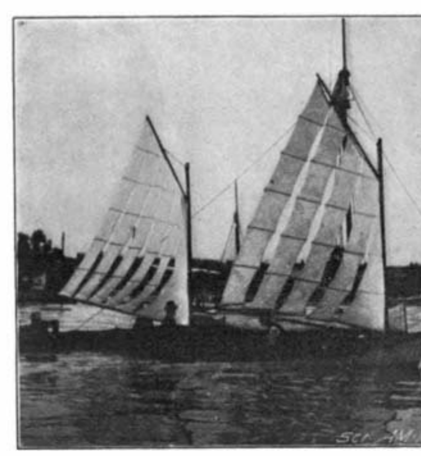


Fig. 6.

In running before the wind, all sails set at right angles to the wind are materially benefited by having holes in them through which the wind may escape and thereby lessen the height of the cone of dead air that rests on the sail. In beating, the sails are subject to a very much greater windage than they would be if there were no openings in them. Each section may be considered a little sail on the hoist of which the windage is felt. When a large sail is composed of a number of small sails, the "windage" of the large sail is very materially increased, as has been explained above, and this "windage" or direct contact of a substantially dead-ahead wind is so material that unless the advantage gained by getting rid of the "spilled" wind is very great the "windage" is materially felt, the result being that while any one of the forms that I have tried causes the boat to move at least one-half

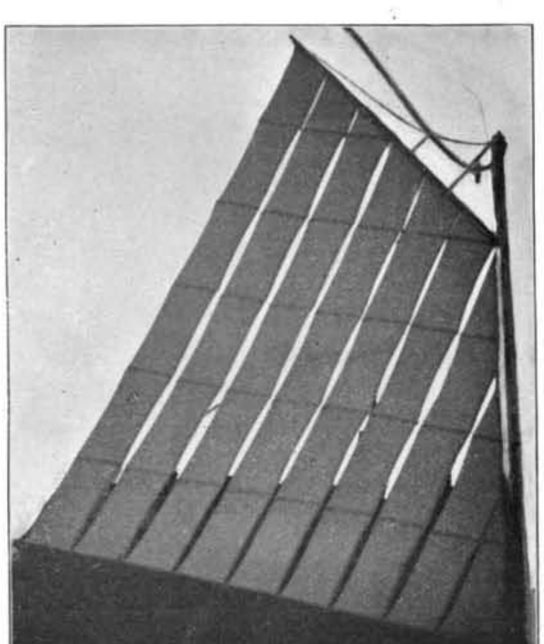


Fig. 1.

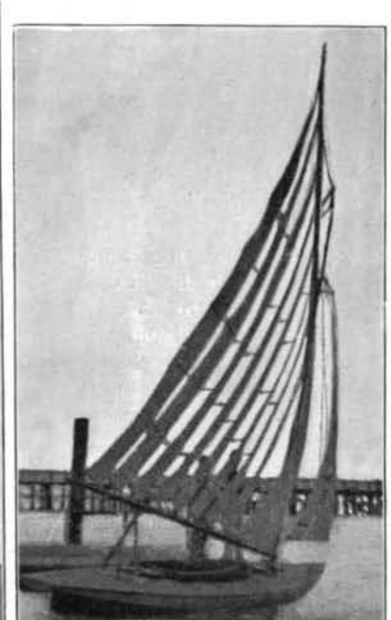


Fig. 2.

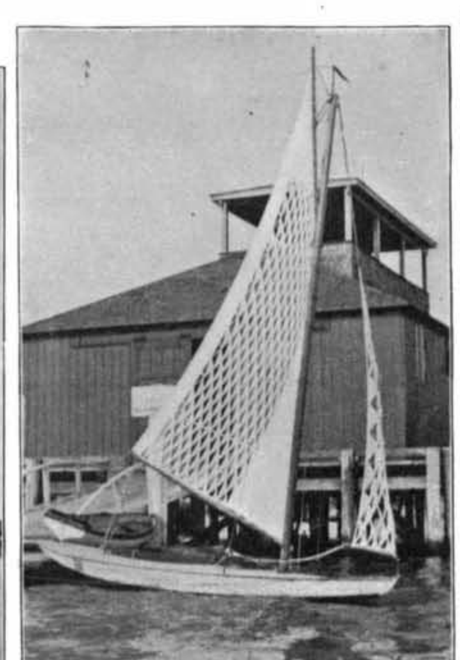


Fig. 3.

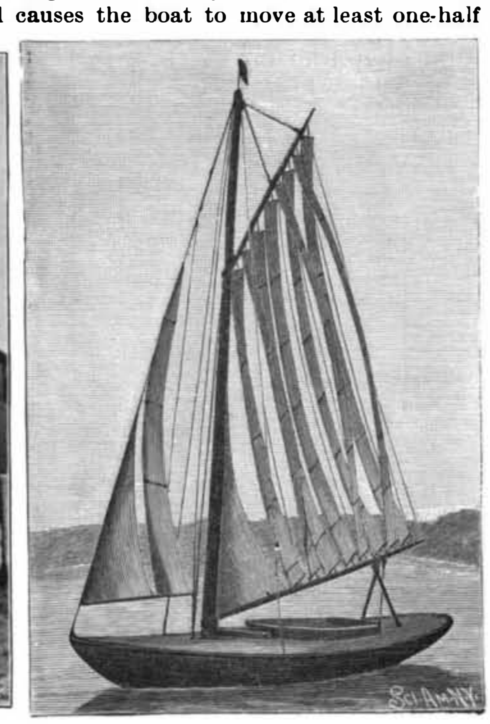


Fig. 4.

faster on a certain wind (that is on wind particularly adapted to the slant of the members and their "spill") on any but that certain wind it is a trifle slower than an ordinary sail.

Taking the whole field and sails as they are used, the old form of sail, that is, the sail having no openings in it, is best.

I present the accompanying photographs, as they may be of interest as photographs of odd forms of sails, and further in the belief that some of the phenomena shown in them may be of material benefit in setting sails and also in cutting them.

The accompanying photographs are not arranged in order, but being numbered, attention can be called to each one.

Fig. 1. This is a sail composed of strips running perpendicularly. Each strip is kept flat and stretched apart by strips of wood inserted in pockets, that is, "stretchers" are used, or "battens," the last or stern cloth is the sail having five battens in it. These strips were connected together by being tied at the points where the battens came, the front edge being held taut, the rear edge of the one in front of it strung out to leeward the distance which the uniting string allowed. By tying them close in or far out I could learn the thickness of the "spill." These experiments soon proved that the "spill" was about as thick as the current of direct air which struck on each strip. Fig. 2 is a view from the rear, which shows the opening between the strips through which the "spill" passed. (It is assumed that the wind deflected by one member passes off of that member to leeward, and on in front of the next member behind it.) Fig. 3 is a different form. In this, each member is in the form of a triangle, its apex forward.

Fig. 4 is that photograph of those shown from which the greatest information may be derived. It is made of individual perpendicular strips which one raised and lowered by an individual halyard and downhaul. In this way I could set the first three and leave unfurled the next two, and set the next one-half way up, the next one three-quarters, and the next one-quarter, but in that way getting exact balance. The members being individual and all set, when I gave it a good full of wind, "laid down" in their proper order. As I gradually let out the boom, one member after another would spring to windward and belly out just as much to windward as the other members did to leeward. As I caught this snap shot, it will be seen that while members 1, 4, 5, 7, and 9 remain bellied out to leeward as they should be, that members, 3, 6 and 8 are similarly bellied out, but to windward. I account for this by the thickness of the current of deflected wind. No. 7 shows the same sail full of wind.

Fig. 5 is a view of the same sail shown as in Nos. 1 and 2, in which strips Nos. 2 and 8 are furled and Nos. 3 and 7 are half hoisted.

Fig. 6 represents two boats with substantially the same kind of sails, the difference being that the sail on the forward boat is composed of five members, whereas the rear sail is composed of six.

For a long time I have been convinced that the more individual members in a sail, the speedier it was. (I have asserted above that these sails are very much more speedy when sailed as they are adapted to be sailed, that is, on a certain wind and course only.) These two sails then are exactly of the same dimensions, placed on boats of the same model and sailed the same course, all things being alike but the sub-divisions of the sail, in one case into five members, in the other case into six. I always started the sail with five members ahead of the sail with six members, and invariably the sail with six members out-sailed that with five. (I have often wondered in view of the above experiments on the hull and sails, if the fastest boat under certain conditions would not be a boat of immense beam and shallow draught, that had a number of sails set on masts, that ran across the boat instead of fore and aft.)

I feel that the hull of boats is better understood and carried out than is the set and draw of the sails. I suggest that when, as has often been the case, two boats of seemingly the same model of hulls raced, the different results were more attributable to the sails than to the hulls.

Naval Estimates for the Year.

The estimates for the naval establishment for the fiscal year ending June 30, 1901, have just been approved by Secretary Long. The estimates amount to $73,045,183.15, an increase of $24,537,187.57. The increase includes $12,268,474.32 for public works at various navy yards and stations, the current appropriation for the same purpose being $5,840,786.50. For the new Naval Academy $2,021,000 will be required as compared with the current appropriation of $720,000. For the increase of the navy, including construction, machinery, armor and armament, $22,983,101 will be required, while the current appropriation is only $10,392,402. The Bureau of Construction and Repairs requires $3,000,000, additional. The Bureau of Steam Engineering $1,000,000, and for pay of the navy about $700,000. The Bureau of Ordnance on the other hand requires about $700,000 less.

XIPHOPAGES, OR HUMAN DOUBLES.

The first living double monster that we know much about was described by Isidore Geoffroy Saint-Hilaire, and consisted of the twin sisters Helene and Judith, who were born in Hungary in 1701 and died in 1723. The Siamese twins, Chang and Eng, attracted much attention in their time and were exhibited in Europe and America. They were born in 1717, were married and had children, and died at an advanced age. These two brothers were connected by means of a ligamentous band passing from the epigastrium of one to that of the other. Later on, the two sisters, Millie and Christine, who were born in Columbia County, South Carolina, in 1851, were exhibited in Europe. These twins were connected by the back. Recently, there have been presented to the Academy of Medicine of Rio Janeiro, Brazil, two sisters connected with each other in front and thus belonging to the category of what are now called Xiphopages.* By this term are designated two well-developed individuals with one umbilicus in common and connected from the lower extremity of the sternum to the navel. Such double monsters are curious. There are some that are provided with a thoracic cavity proper to each individual. These are genuine Xiphopages. In others, the independence of the thorax is limited to the upper part of the thoracic cavity. M. Marcel Baudoin, who has made a special study of such monsters, designates these latter by the name of Thoracopages.

Fig. 1.—THE SISTERS RODICA AND DOODICA.

Fig. 2.—THE SISTERS ROSALINA AND MARIA.

The true Xiphopages are rare in science. In fact, the number of those born living and that have been observed does not appear to exceed seven or eight, and several of these have not lived longer than a few days, or even a few hours.

In 1892 there were exhibited in Europe the two sisters, Rodica and Doodica (Fig. 1), who were born in the English Indies in 1889. They were three years and some months old when they were exhibited in Brussels.

In Fig. 2 are shown the two sisters, Rosalina and Maria, who have just been discovered in Brazil. These two girls are ten years of age and were born at Cachaeiro de Itapemerim. The parents were anxious to know whether or not they could be separated. That all depends upon the nature of the junction. Three Xiphopages have already been operated upon, two of them with success, and all were of the female sex.

With radiography, it will be easy to ascertain whether the two bodies are absolutely consolidated or whether they are independent. If the latter is the case, a surgical operation might be performed with a considerable chance of success.

For the above particulars and the illustrations, we are indebted to La Nature.

* From ξιφος, a sword, used in the anatomical sense of ensiform cartil ge, and πηγνυμι, "to fix."

The Fuel Value of Cereals.*

At the present time, when the consumption of stored fuels is so enormous, it seems to be interesting to obtain some data as to the annual production of fuel materials by ordinary growth. The fact that in some parts of the country coal is very expensive whereas corn and other cereals are very cheap, makes it interesting to know whether it might not be more economical to burn the corn than to export corn and import coal. That has been done in some states at certain times when corn was very plentiful; but comparatively little data exists on the subject. At the meeting in Toronto of the British Association for the Advancement of Science, Lord Kelvin read a very interesting paper on the annual product of fuels and gave some speculations with regard to the way in which the oxygen of the atmosphere has been supplied by the constant production of stored fuel, bringing out the approximate result that if the stored fuel were all burnt again we would be left with an atmosphere free from oxygen. Some of those points created quite a little interest at the time; and last year Dr. Mees gave a short account of Lord Kelvin's paper before the Science Club at Terre Haute which, in some way, got into the newspapers. The whole subject has in consequence been again brought prominently before the public through some of the information bureaus sending out abstract's of that paper, with photographs of Lord Kelvin and others, all over the country.

It occurred to us, while talking that matter over, that it might be profitable for some of our students to take up the matter and make some determinations of the actual fuel value of some of these cereals; it would be good practice and would furnish some information which might be valuable. Following out that idea one of our senior students took up the subject last spring and the results which he obtained are those which I have embodied in the table accompanying this paper. You will find a rather interesting result, for instance, in the case of corn (see yellow corn in the table), the fact that whether you take the stalk, the corn, or the cob, you get very nearly the same fuel value per gramme or per pound. We have it here in the gramme unit; heating value in Brith Thermal Units per pound is got by multiplying by 9/5. The percentage of water does not differ very much in the three cases. The dry corn would be a little, but comparatively little, higher than the others. You will find also the rather curious result that all these cereals come very nearly alike with the exception of the few that are known to contain considerable quantities of oil. Those run up high; but the ordinary cereals such as corn, oats, wheat, rye, barley, millet, rice, etc., are very nearly alike in their values; they run from about 3,800 to a little over 4,000; oats being the highest with 4,200, millet coming next, 4,137. Cottonseed, which we would expect to be high, is a little low in water (but that would not bring down the number very seriously) giving us 5,160, sunflower seed 4,900, and the castor bean the highest of all, 5,400.

I may say that the word was done in the chemical laboratory at the Rose Polytechnic Institute under the supervision of Prof. Noyes, with whose permission I have presented the results to this section.

Substance.	Heating value in therms per gramme.	Percentage of water.
Yellow corn	4,093	12·1
Yellow cornstalk	4,030	10·8
Yellow corncob	4.015	10·1
White corn	3,850	13 0
White corncob	4.065	....
Cornhusk	3,939	....
Mixed oats	4,203	11·0
Wheat	4,096	12·8
Rye	3,852	12·5
Barley	3,807	11·7
Millet	4,137	10·8
Rice	3,755	13·2
Navy beans	3,860	13·8
Wheat straw	4,043	....
Timothy hay	4,137	....
Cottonseed	5,152	7·7
Cotton	4,157	....
Sunflower seed	4,932	8·8
Castor bean	5,405	6·2

THE Egyptian Railway Administration has accepted the tender of a Belgium firm for the supply of twenty locomotives.

* A paper by Prof. Thomas Gray, of Rose Polytechnic Institute, Terre Haute, Ind. Read August 23, 1899, at the Ohio State University, Columbus, O., before the Section on Mechanical Science and Engineering of the American Association for the Advancement of Science. Reported especially for the SCIENTIFIC AMERICAN.