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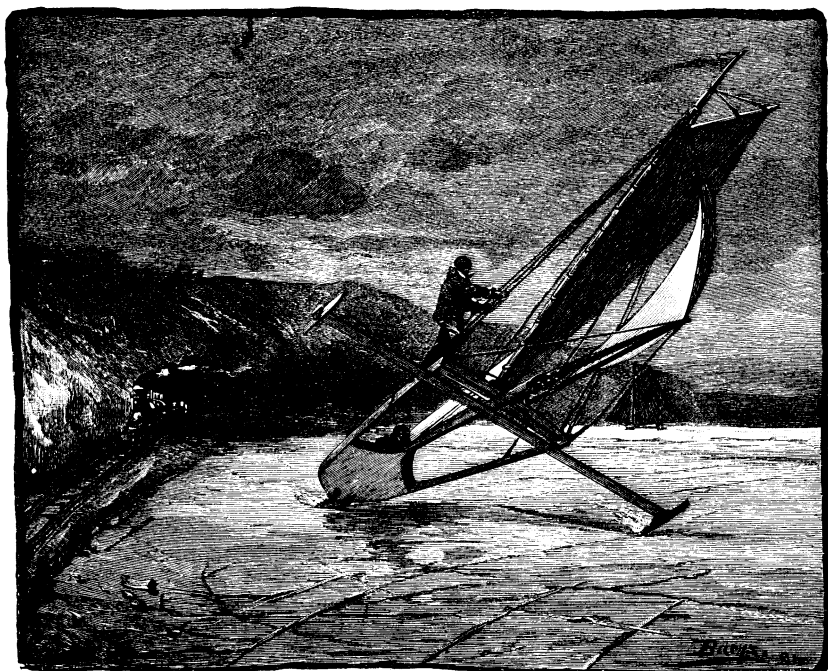
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ICE-YACHTING ON THE HUDSON.



STEAM AGAINST THE WIND.

AN ice-yacht flits about like a swallow, skimming over the river with the speed and grace of a bird. She is better than a bird, for she takes you along in her flight and gives you the triumph of the wing, as she sweeps, and swings, and trembles on through space. Mount this wayward flyer as she is launched upon the wind. Your course is down the Hudson from Poughkeepsie, and, as your sail begins at a moderate speed, you can observe the scene.

The old river is not now in its human, sympathetic mood, when it hums with talk and song, and its banks are bright with lawns and flowers. It is a long, narrow, level valley of ice, all gray between its dark brown headlands. The hills are sober in a fur of bare trees, and the fields are bald and white with snow. As you look eighteen miles down the narrow valley, it seems walled in by high headlands marking a long perspective, down to where the Highlands close about it with a wall of hoary mountains. The pure, keen air gives even the distant scenes the clearness of a miniature. Here at the start are the shores of Poughkeepsie, with smoking furnaces, deserted docks, and sloops bound in the ice. Two miles below, on the right, is Blue

Point—a high head of rock frowzy with bare trees. On the left are the cuts and tunnels of the railroad and the high cliffs, hung with gleaming icicles; and a train comes thundering into the wintry silence and veils the bluffs with steam and smoke. Farther on are the docks and houses at Milton nestled under the bank, and the Barnegat hills opposite covered with an olive-black forest of arbor-vitæ. On the right, the deep gorge of Marlborough veils its winter sculpture with golden willows, and the bold headlands of Hampton roll along the shore. Opposite these is the village of New Hamburg. The valley expands still farther on into the broad bay of Newburgh, lying at the base of the Highlands. It is a long, narrow stretch of cold and desolation. And yet, in gliding about, you get glimpses here and there of cheerful, active life. You may peep into fishermen's huts on the shore, where men are netting; or at a deserted mill tottering back under the rocks, while its perennial brook still sings and sparkles down the cliffs, now white with icicles and beds of frost-flowers. Your mind may linger about the farm-houses on the hills, where warmth and cheer fight off the winter cold and the biting breeze. It begins to blow more, and

you find yourself fitting about from village to village with a quick and pleasant motion. Teams crossing at the ferries shy at you and hasten their pace. Gangs of men are working at the ice-harvest; fishermen are hauling their nets up through the ice or skating hastily toward little signals that respond to a "bite"; foot-passengers are gingerly picking their way on the slippery surface; groups of men and boys dot the ice with their black figures and reflect the sunbeams from their skates, and more retiring couples swing along, hand in hand, in the little bays and coves. These bits of life and color are doubly welcome in the desert of winter, cold, clear, and stern. The stillness of death is broken only by the loud cracking of the ice—mutterings of the old river making a continual roar. You hear many sudden snaps, and the clear ring of thin sheets of ice falling in the "windrows"; then an angry crash from ice along the shore. The deepest tones are the loud, musical notes of a great crack that starts under your very feet and runs off to the bluffs.

All the large cracks run across the river. The lateral expansion finds room by crowding the ice upon the shores; but as the expansion up and down the river is prevented by bays and points, the ice buckles up in ridges across the river. Sometimes the bend goes downward and forms a hollow filled with water, until one side of the ice, dropping below the other, is caught by the tide, and broken off, and carried away.

Such cracks often remain open all winter, for the water, boiling up from under the ice, is not easily frozen. In other cases, the bend goes upward and raises a ridge or bridge, sometimes several feet high; this does not interfere with travel until one-half drops down and makes a step or fault. The river is divided into long lanes and fields of smooth ice by windrows crossing in every direction. In some regions the windrows are so numerous as to prevent sailing; in others, large expanses offer good ice for long distances. When the first ice formed, it was so thin that it broke loose from the shores in large cakes or "fields"; these, in floating against one another, fractured the edges, turned them upward, and made ridges of broken ice, some of which are thin, clear sheets standing at every angle and flashing like mirrors. The yacht glides about in these fields and lanes, avoids the old mounds and windrows of snow-ice, and now and then dashes through a thin windrow, while the scales rattle and gleam like crashing glass.

All at once, you seem to be running straight into a hole of still, open water; in an instant you are skimming over the glassy surface of new ice. As you look down, you see muddy water floating under you in small, boiling currents like little clouds. The ice in places is quite full of bubbles; those near the surface are all white with delicate frost-work such as you have



FISHING THROUGH THE ICE.

seen on window-panes: those farther below, being protected from the cold, are as clear as cut-glass. Here and there is a catacomb filled with the skeletons of grass and ferns torn from the mountain brooks. The ice is all faintly veined and marbled, and tinted with reflections of the heavens. It seems like a picture of a dim twilight sky, with crystals for the stars. In other places it is a record of Nature in a warm and lenient hour, when she modeled in the ice little landscapes with gorge, rivulet, and bluff, and decked them with white flowers; but Old Winter caught the ripples playing with the wind and petrified them. There are great lumps of light, as it were, where blocks of ice lie in the sun; mosaics of frost-flowers, and Nature's geometry of crystals; and beautiful fractures, some of them composed of flat spiral strands like the threads of a screw, which gleam in the sunshine like a rope of rainbows. Thus the scene and the experience of ice-yachting are full of the weird and the magical. The gray desert of winter gleams with vivid colors; the silence of death is broken by roars as of sharp agony; you move airily over the surface of the deep; you lie still as the dead, and yet you glide about with the unearthly ease and freedom of a spirit. And your eagerness of expectation matches the keenness of the air and the brightness of the sunbeams on the winter scene.

You go on down the river now with a good wind on the beam. The playful breeze freshens in flaws, as if trying to escape you; but still you follow its wayward motions: you start when it starts, flit over the ice with its own speed, turn and glide with the lightness and the grace of its own whirling dance. The ice-yachts darting about look like white-winged swallows skimming over the ice: as they cross and recross your course, you hope that every captain knows his business and will avoid collisions. The ice-yachts have anticipated your wish, and flown away to various points of the horizon while your thought drew its slow length along. The ice seems to be running under you with great speed, and you sometimes feel that you might easily drop off the open, spider-like frame of the yacht. By such rapid motion, the bubbles, crystals, and lines of the ice are all woven into a silky web of prismatic hues. You distinguish only the cracks that run with the course; and, when they deviate from it, they seem to jump from side to side without connecting angles or curves. The mounds and the windrows seem to come

up at you suddenly, and dodge past. You begin to hold on to the hand-rail, and lie close down in the box. If you are steering, you feel that your hand is the hand of fate; and the keen excitement nerves you to extraordinary alertness. The breeze sings in the rigging; the runners hum on the ice with a crunching sound, and a slight ringing and crackling; and a little spurt of crushed ice flies up behind each runner and flashes like a spray of gems. The yacht seems more and more a thing of the air,—her motions are so fitful, wayward, and sudden. The speed with which you approach a distant scene makes it grow distinct while you wink with wonder. Things grow larger, as if under the illusions of magic; you feel the perspective almost as a sensation. You turn toward a brown patch of woods; it quickly assumes the form of headlands; these are pushed apart, and a gorge appears between them; while you stare, a stream starts down the rocks, behind the trees; a mill suddenly grows up; the rocks are now all coated with ice; statues of winter's sculpture are modeled before your eyes, and decked with flashing crystals, just as you turn away to some other point of the horizon. So you seem to be continually arriving at distant places.

A regatta is to be sailed over this course, and you arrive in time to see the start. The yachts all stand in a row, head to the wind. At the word, the first in the line swings stern around till her sails fill; she moves off at once, and the crew jump aboard,—one man standing or lying on the windward runner-plank and holding on to the shrouds, and the helmsman and another man lying in the box. Then the other yachts successively swing around; and, in a moment, the whole fleet is under way, gliding in zigzag courses among the windrows and mounds. They all diminish in apparent size with astonishing rapidity; they seem actually to contract in a moment to a mere white speck, skimming about the river miles away. You join the crowd of men and boys stamping and slapping to keep warm; you exchange a few words with a friend, and when you turn around again, behold the yachts sweeping down upon you! They grow as they come, flying at you with a wayward, erratic course, and you feel the wonder of embodied speed. The ten-mile race of the ice-yachts is lost and won in as many minutes. But for those who sailed it, these minutes were filled with more excitement than is found in many a long life-time.

Embark again and return up the river.

The wind, freshening all this time, now pours down over the banks of the Hudson in strong gusts. The sky is partly covered with clouds; the gray desert of winter has lost its gleams of color; snow-squalls enshroud the dark headlands, and the grim face of Nature frowns with stormy gloom. It is a time to draw up to the fire and talk of storms, while one is basking in luxury and warmth. But you are launched upon the wind; the light snow whirls upward in the lee of the mainsail, and she seems a spirit of the air in a cloud, sweeping onward like a whirlwind. The wind howls in the rigging, the ice crashes, the runners ring, and you hold on to the shrouds in a nervous frenzy of excitement. As she turns in her sudden motions, you feel as if your body were trying to fly on in some swift tangential course, even though your hands and feet remain. Space opens freshly before you every moment as a strange, devouring void, and you fly into it with a wild, erratic motion, seemingly beyond the rule of human will or natural law. You are not shut up in a ponderous train—a whole world of material, roaring, jolting matter. Here you fly alone through the keen air and the flashing sunshine, with the speed of a bird soaring in the sky. But your eyes are not those of an eagle, and they see things changed by the rapid passage. Objects seem melted down and drawn out into blurred, elongated forms; shapes and colors are lost, and things look blue. Now the wind lulls again; you listen to the roaring of the gust sweeping up the bluff and through the bare forest; then a louder roar comes on, as an express train thunders out of the tunnel. The windows are filled with eager faces, and waving handkerchiefs stream in the wind; the engine blows a shrill challenge, and you wave an acceptance. But the wind plays you false, and the train passes in triumph. Then all at once you get the breeze and move up; you skim along with ease compared to the thundering tread of the iron horse, and you gain on him. As you come abreast, the windows and platforms are crowded with excited people; you hold on your course and, with the next gust, pass them as though they were slowing up, while they cordially salute your victory with more waving and whistling. You soon lose sight and sound of them; the wind roars in the rigging; as the yacht sways in her course, her extreme speed makes her divergences appear like leaps from side to side—a mad, reeling motion.

As she "rears," or heels over, she seems to rise for an actual flight into the heavens; she slides a little sidewise with a wild, tremulous motion, and you wonder where she will alight. Now she rears again, and at that moment you have to wear away to avoid some rough ice. The descent and the swing combined seemed to have destroyed the force of gravity; your body seems to have lost all material existence, and you swing through space with a rush that makes you shiver. You have been in the shadow of the clouds, but now, in a single instant, you fly into a sunny world, gleaming sharply, faintly, with prismatic hues: you are dashing through a windrow, the ice flies and the air seems filled with a shower of diamonds. Even while they fall you have crossed the sunny world and entered another of storms. The whole face of nature is animated; the hills grow up while you stare, and come rushing at you with a new and awful grandeur—a feeling of omnipotence. But they pass by, and subside again, as if by a magic spell. Suddenly something has happened; your feet have flown out from the plank and your body swings out by the arms as if whirling on a trapeze; the yacht has run over a mound of ice and snow a foot or more high; as this tossed her into the air, the wind on the quarter swung her stern around and headed her across the wind, straight for a high mass of broken ice. And she keeps right on, through all these gyrations, with such speed that you have to cling with all your might to prevent her from flying from under you. The captain, however, keeps his head, and in a moment wears her away again, with another of those inconceivable swings and sweeps of a bird. Her sudden starts and turns make her a living thing of the air, full of wild, swift, and graceful motions, and a wayward willfulness that is startling. Now she dodges a mound with the clear determination of certainty; then, in the midst of barriers that would crush us all, she sways and reels and roars as if in the confusion of inevitable destruction. But the spell of magic is upon her, and guides even her wildest flights. The horizontal or the upward tendency of every atom destroys again and again your sense of weight; your body seems the subject of unseen, unknown powers; and a keen, shivering glee flashes through your soul. Such a flight over the earth is among heroic feats, and it kindles your nature with the fire of valor. But the flight is done, and you must stop the triumph of the wing; you descend from



WAITING FOR THE START.

the clouds of snow and the roaring storm on which you flew as an eagle on a whirlwind; you return to the common earth, to the long, narrow valley of ice, dull and gray between its headlands, now flaming out in the cold, clear, silent evening.

Ice-yachting seems to be the acme of recklessness. In its early days, when the men were less skillful, and the yachts, being ill-balanced, were less manageable, accidents sometimes occurred. But now that experience has improved the methods of handling and building, ice-yachting may be called a safe sport. Serious accidents are almost unknown, and yachtsmen do not hesitate to sail with their families under reasonable conditions of ice and weather. The ice-yacht is the fastest object moving on the earth; but if any one find her motions too slow, let him put on skates, and holding one end of a long rope made fast to the boom, take a tow behind her on smooth ice; when she is under full speed put her about sharply, and give him a swing before he lets go the rope, as if from a sling. He will compare himself to a bullet.

The handling of an ice-yacht differs from the sailing of other crafts in many particulars. Her sails are always trimmed flat aft; but if a wind on the beam is so strong

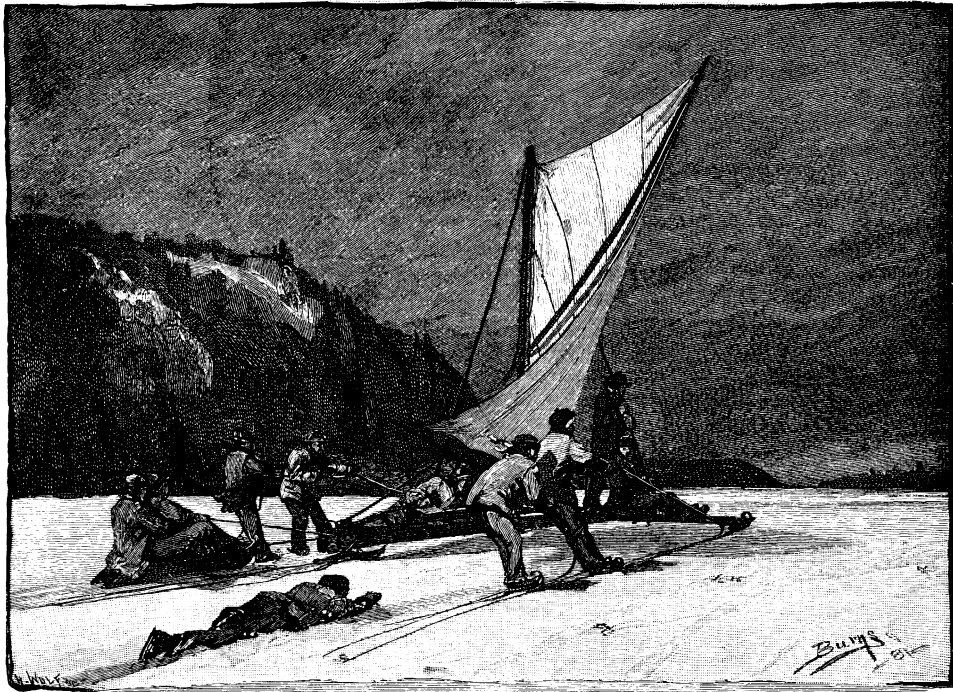
as to make her either slide or "rear up" too much, the boom is sometimes let off a foot. The steering of an ice-yacht is very surprising to a water sailor. The tiller generally moves as easily as a straw, unless the rudder catches in a crack or runs through snow or rough ice. Her extreme quickness and delicacy in obeying the helm is one of her chief attractions; but the helmsman must have a cool head, a quick eye, and a steady hand. Otherwise she may whisk about with such sudden and erratic motions as to throw all hands into eternity. Nevertheless, she may be turned about with extraordinary quickness if she is brought gradually to the shortest part of the curve,—somewhat as a whip-lash may turn very sharply without snapping. This gradual turning is very necessary in a stiff breeze; for if she be put about too suddenly her momentum causes her to slide sidewise, and to lose almost all her headway.

Pushing the yacht is the most prosaic experience. But it is often required in light, flawy wind and on a snowy surface where the friction is great, to prevent her from stopping and her runners from settling in the ice. Steering among obstructions and over rough ice or cracks requires much ex-

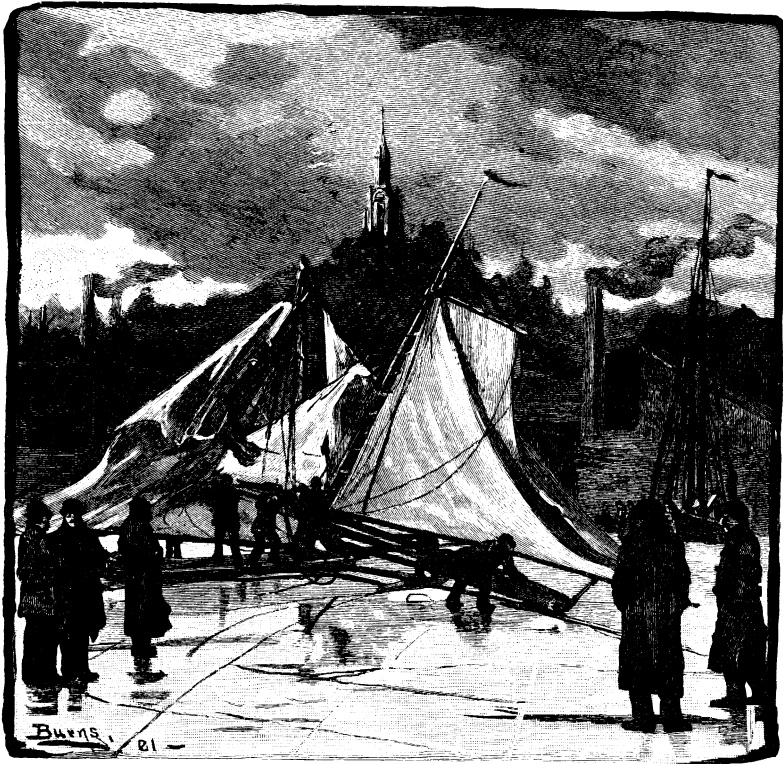
perience, coolness, and promptness. In going over a rough place, she is first headed so as to spill the wind and relieve her of strain; she is then headed as straight across a crack as possible, that the runners may not slip into it, and that they may both cross it at once. In going over broken ice where the cakes overlie one another, one or both runners must be run on the highest places to raise the plank above the obstructions. It is better to jump down from such high mounds or cakes than to attempt to run up their steepest side; for, if the points of the runners catch on the edge of a cake or in a snow-bank, the yacht will be brought up so suddenly that her rigging may all go by the board, or the whole craft may be wrecked. In approaching dangerous places, it is sometimes necessary to stop very quickly. The usual mode of stopping is to luff her up and run her into the "wind's eye" till all her headway is lost. There are two modes of stopping quickly. When sailing close to the wind, luff her till her headway is diminished somewhat, and then turn the rudder quickly square across. This acts then as a brake, scraping sidewise on the ice. The strain on the boat, of course, is very great, and necessity alone justifies this maneuver. When sailing free, stopping

suddenly is more difficult. Pay her off to jibe, and as the boom, in swinging over, gives her a jerk, at exactly the same instant turn the helm quickly square across, pointing, of course, to leeward. This jerk hauls her stern suddenly around and she turns about into the wind, while the rudder is kept square across to act as a brake. If the speed be not very high, the yacht may be stopped in the space of two lengths by this maneuver. An ice-yacht is temporarily anchored by turning her head to the wind, lighting up the jib-sheet, and turning the rudder straight across. The jib-sheet should always be cast off, to prevent her from getting away alone. On one occasion, when the fleet had come to anchor in a cove and the men were loitering about the yachts, one yacht ran away. The jib-sheet was not cast off, and a gust of wind had started her alone on a wild and dangerous course. She first stood off from shore, but suddenly put about. She came straight in, and in a moment struck another yacht and made two complete wrecks, but fortunately did no other harm.

An ice-yacht is got under way by trimming the jib-sheet and then swinging her stern around and pushing ahead till her sails fill. When she is temporarily laid up, all her run-



TAKING A TOW.



THE WRECK.

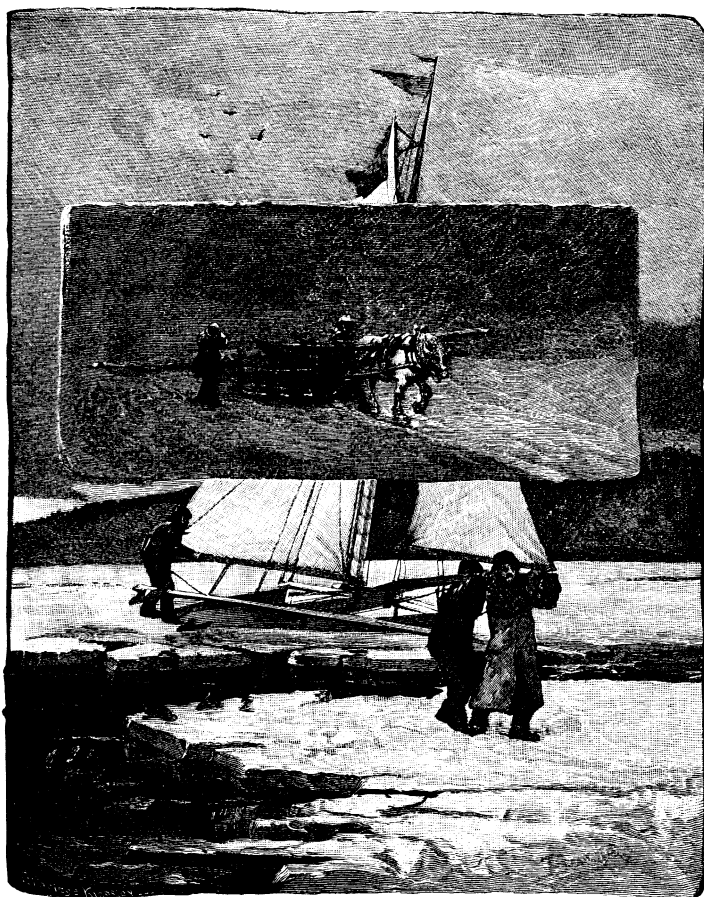
ners are placed on pieces of board, the tiller is removed from the rudder-post, and her sails are protected by canvas covers.

The crew stand on the windward runner and hold on to the shrouds. This is the only proper position for them; for there they not only give their weight as ballast on the windward side, but also relieve the leeward runner of extra weight added to the pressure given by the sail. And, moreover, it is the safer side, since the spars, if carried away, cannot fall on them, and if she capsizes, they are not under the sails. In a light wind, only the helmsman lies in the box; but when a stiff breeze makes her slide around, more weight is required on the rudder to make it take hold of the ice. The best management of an ice-yacht can scarcely be described; it varies with different courses and must be learned by intelligent practice. In general terms, of course, her actions are like those of other sail-boats; but, in some particulars, her special features necessitate a different handling. She sails closer to the wind than any other craft; a good ice-yacht stands up within four points,

and she goes about so quickly that she loses but little of her headway. In beating to leeward,—the ice-yachting expression for sailing with a free wind,—when she has her full speed, pay her off nearly on her true course for a little way; then should she begin to lose much of her headway, luff, or come up a little more to get up headway again. She is thus kept always at high speed, yet makes many short runs nearly on her true course. The higher the wind, the more she can run free. She always jibes on this course, and, if the wind favors, makes a long turn. To “bring her to” at a given point while running free, reach a point many lengths directly to windward of it; then head her directly with the wind till she slows up to the same speed as the wind, turn her suddenly into the wind till she is nearly stopped, and then turn the rudder across as a brake. A sharp lookout must be kept for cracks and rough places in the ice, for an ice-yacht cannot go safely at full speed over obstructions more than a very few inches high. When sailing over such places, she slows up and picks her way

among impassable mounds and windrows. But it sometimes occurs that a yacht flies over dangerous spots without either care or misfortune, and often in these fool-hardy or unavoidable feats she is brought up all standing against some obstacle, the rigging parts, the spars go by the board, and she looks in an instant like a hopeless wreck. The crew meanwhile continue the course alone, each according to his own personal

the crack, the water flies, but if the forward ends of the runners rise over the farther edge, she will plow through it all. A yacht and her crew may pass over a wide crack by backing her into it till the boom hangs over the farther edge of the ice; one or two men cross, by holding to the boom for safety, and lift the stern up on the ice. She is then backed still farther, till the runners also are raised on the farther edge of the



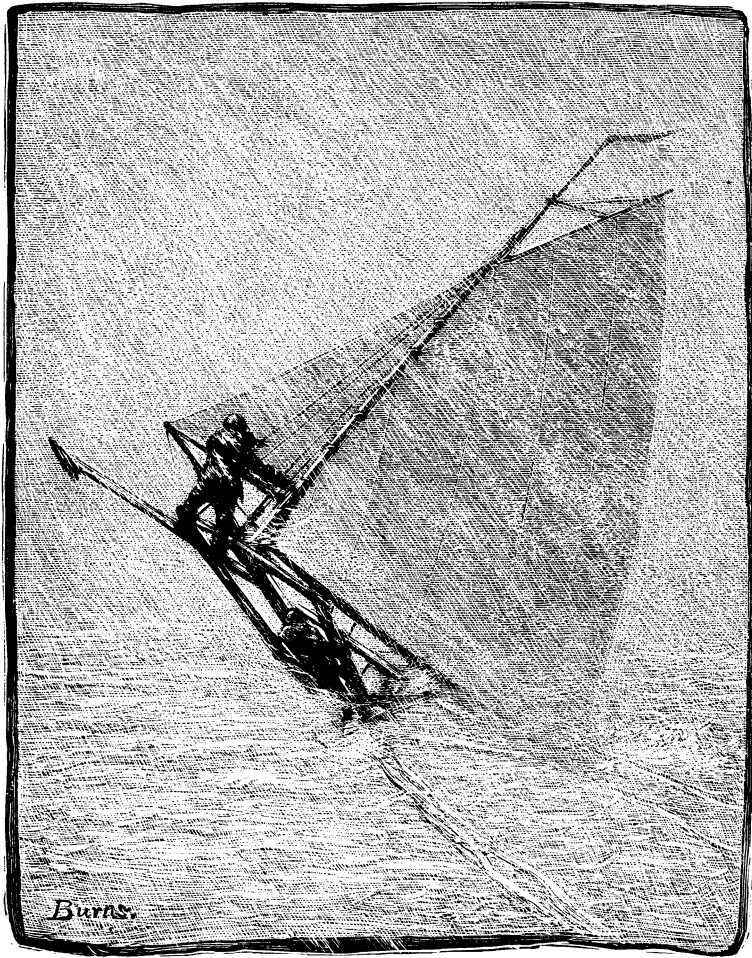
TOWING A WRECK.

JUMPING A CRACK.

capacity for sliding on ice. "Jumping" a crack is one of the liveliest maneuvers in ice-yachting. If the crack in the old ice be an actual, open crevice, she can jump but a few feet, even with the help of a brisk wind. For, if either runner catches on the farther edge of the crack, everything will come down. But if the crack be covered with even thin ice, or if the farther edge be lower than the edge she leaves, she may cross more safely. She dashes square across

ice; then the rest of the crew cross over on the bowsprit.

The rules of sailing adopted for regattas are the same as those of the New York Yacht Club, varied slightly to suit the requirements of ice-yachting, and extended to include a provision for pushing the boat under certain circumstances. In a puffy, flaw wind, of course a yacht may stop; and if she is allowed to remain stationary the runners settle into the ice so

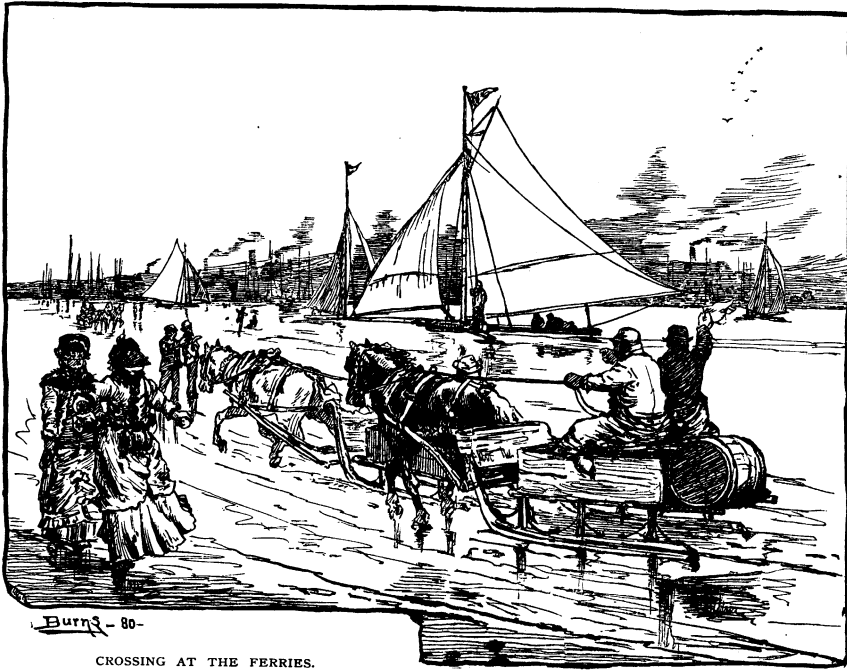


AN ICE-BOAT IN A SNOW SQUALL.

that she would not start again in a light wind. Hence it is necessary to allow a limited amount of pushing.

When an ice-yacht capsizes, which very rarely occurs, the movement is quite unlike her usual motions in being very gradual. As she "lifts" or "rears" and eases the sail, she slows up and heels over more and more, while the stern remains on the ice, and she quietly spills the crew out of the box, or lets them hang by the shrouds till they drop on to the ice. An ice-yacht often runs many rods on the leeward runner and the rudder, while the skillful captain keeps her poised in the wind. This "rearing" is an exciting maneuver. Sometimes the boom dragging on the ice steadies her a little. If she be beating up, she may at once be eased by luffing; if she be running free, she may

be eased by paying off, and the man who then stands for the first time on the windward plank when it is up in the air and descends as she wears away at that lightning speed, feels a new sensation,—a chill creeping over him, and his breath stopping; and, indeed, it seems as if one might be flying off to another world. This movement of wearing away before a strong wind tests the balance of an ice-yacht's sails and the helmsman's judgment and nerve. As she beats up to round a stake and turns it, she loses headway; then, when she wears away, the wind lifts her before she can get under way, and the question always is whether she shall be saved from capsizing by bearing off or by luffing. Then when the windward runner comes down on the ice, the rudder must be straightened just in the

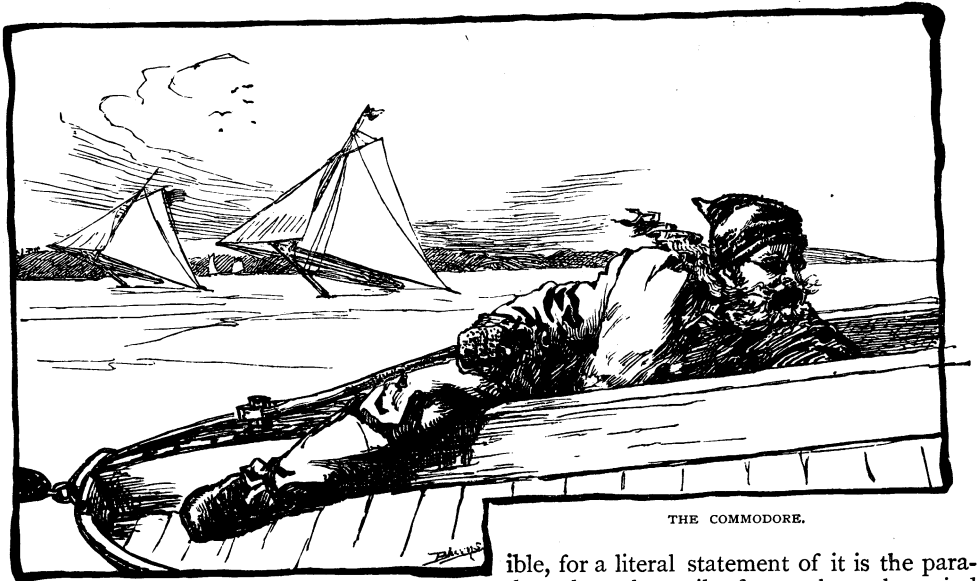


CROSSING AT THE FERRIES.

nick of time, to save her from spinning around. Even good helmsmen are sometimes flung out of the box by this maneuver. In wearing away, or in sailing free, a strong wind bears on the after half of the mainsail very strongly, and sometimes slues the stern around and heads her into the wind in the twinkling of an eye. When she runs through windrows, broken loose ice, or snow, the skates do not get solid bearings, and her motions are often very unexpected. Almost all ice-yachts carry a weather-helm, and no two have exactly the same balance. Breaking in is not a very serious matter. As the lee runner makes a long gash or crack in the ice, she slows up and capsizes before she runs the stern off the sound ice. The crew, if on the windward plank, are not slid into the water under the sails, but go aft, and get off at the stern with the captain. The sails are lowered, if practicable, and one of the halyards is unreeved from its thimble at the mast-step. The stern is swung around till the upper runner, when lowered, will rest on good ice. The halyard—fast at the mast-head—is passed over the upper runner, and then she is righted by hauling down this upper runner. If the ice be weak, it is well to place a board or a ladder on it, to prevent the runner from breaking in.

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When the lower runner has been raised above the ice, it is held up while she is run off on to good ice. She is righted after a capsize by the same use of the halyard; the stern is swung around till the wind is spilt from the sail; if she be a small boat, she may be swung around till the wind helps to lift her, but if she gets too much wind, she will come down so forcibly as to break the runner-plank. It is dangerous for yachts to follow one another closely on the same track, or run in high winds very near together, for a captain may not foresee the movements of another, or a yacht may slide a little and become unmanageable for a moment, and thus produce collisions. The only fatal accident recorded from ice-yachting on the Hudson occurred several years ago, when the handling of ice-yachts was less systematic. One yacht followed another pretty closely; the head one, instead of crossing a small crack in the ice, ran parallel with it, and caught her rudder in it so firmly that she almost stopped, while the second yacht came on too suddenly to avoid running her bowsprit against the man in the box of the head yacht. The by-stander on the ice is in more danger than the crew, unless he understand his rôle. When ice-yachts are darting about him, he should not lose his wits



THE COMMODORE.

and attempt to dodge the fleetest thing that moves on the earth; he should stand still, that the yachtsmen may know where he is, and may avoid mowing off his legs with the runner-plank. One man, however, who found that the captain did not see him, had the presence of mind and agility to jump up at the critical moment and let the plank pass under him.

Ice-yachting, of course, has the disadvantage of a very short and uncertain season. The past winter afforded an unusual amount of sport,—about thirty-six days; but usually we enjoy perfect conditions of wind and ice on not more than sixteen days per year. We have, however, many other days of passable sport, when the enthusiastic sail, as well as they can, in spite of a few inches of light snow, rough ice, or light winds. The weather is never too cold for the ice-yachtsman, for the excitement and the motion help circulation. His suit includes arctics, a fur skull-cap covering the ears, linen drawers over woolen ones, a calf-skin coat, or else cardigans, under a warm pea-jacket. The trowsers are tied about the ankle or tucked into the legs of woolen hose. When sailing in a driving storm, fine wire goggles are sometimes worn, or a wire covering for the mouth. But after securing even the best protection, you may some time have to study the best treatment of frosted parts.

The speed of an ice-yacht seems incred-

ible, for a literal statement of it is the paradox that she sails faster than the wind driving her. This interesting problem lately brought to print many letters from diverse sources. The people inquired about the facts and their explanation. Some professors of science explained why the speed of a yacht could not equal the velocity of the wind. Ice-yachtsmen replied by giving the recorded speed of their yachts as a mile a minute in a stiff breeze blowing at about twenty miles an hour. Then the professors reconsidered the problem, and sought for an explanation of the fact. Some of the contributors give long equations to demonstrate the relations between the rate of the wind, the amount of friction, and the speed of the yacht. One of the most elaborate studies—in Van Nostrand's "Engineering Monthly" of December, 1879, and January, 1880—shows that the yacht tacking before the wind goes a little more than twice as fast as the wind. This estimate seems, however, below the facts. But as the average reader prefers a more popular explanation than $x = y$, it is better to present here some of the most evident facts and principles connected with an ice-yacht's motion.

First. An ice-yacht meets with very little friction in moving on ice—less than that met in the very best mechanical appliances. The runners move on the ice with such ease that a yacht weighing eight hundred and sixty pounds can be kept moving with two strands of common cotton wrapping-cord. Moreover, in even the greatest velocity, the

little heat generated by the friction is absorbed at once by the ice. Hence, so far as the running friction is concerned, she might run, perhaps, a thousand miles an hour, without much increase in the force of the driving power. *Second.* She never loses any of the effective power of the wind, or the sail-push, by making leeway. For the runners hold her from any side-motion, and allow her to move only forward or backward—unless, of course, when the wind is so strong as to heel her over or make her slide. *Third.* She meets the most resistance in the air-friction; that is, when beating to windward, or sailing in such a direction that the sails and other surfaces receive the wind from ahead. *Fourth.* Her great speed changes the effective direction of the wind or the sail-push; for, if the wind blow twenty miles an hour from the north, and if the yacht sail twenty miles an hour to the west, the wind will strike her on the starboard bow, as if it came from the north-west. *Fifth.* Hence she cannot sail with the wind without running ahead of it during the lulls, and thus not only meeting air-friction from a wind apparently ahead, but also losing the force of the wind on her sails. In this direction, she cannot go much faster than the wind; it is her worst course. A wind on the beam is much better, for in this course, in going at right angles to the wind, she loses none of its force by her own speed; she cuts across it, but does not go with it. However, she meets some air-friction, which diminishes her velocity.

The practical results of these peculiarities are, that she never swings off the boom, but always trims her sails flat aft, and always beats to leeward, as well as to windward. It is easily foreseen that she will make the greatest speed on that course in which she meets with the least air-friction, receives the strongest push of the wind in a forward direction, and yet does not lose the wind too much by her own speed. This course is running free, with the wind on the quarter, or about one hundred and thirty-five degrees off her course. Suppose the boat heads north-east, while the wind blows from the west. Now, her speed diagonally across the wind causes her to receive the wind on the beam, as if it blew from the north-west. She practically has a wind on the beam; this offers but little air-friction against her forward motion. The running-friction is so slight that the boat keeps her way; the direction of the sail-push is sufficiently forward to be advantageous; and, lastly, her

diagonal course, partly with and partly across the wind, saves her from losing too much of the wind's force by her own speed. Suppose that a twenty-knot breeze blows from B to C, and that she heads toward D; while the wind, represented by the arrow A, blows in a given time to C, it carries the boat with it, in nearly the same time. But, as she heads diagonally across the wind, she is

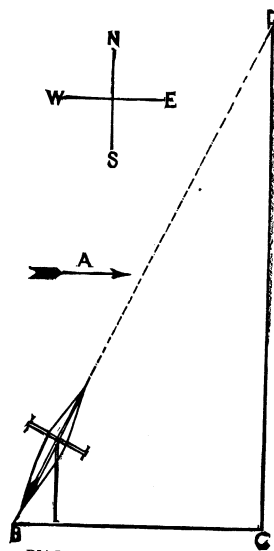


DIAGRAM ILLUSTRATING THE SPEED OF AN ICE-YACHT.

obliged to run the long distance from B to D, while the wind blows only from B to C. She therefore beats the wind. Her wonderful freedom from running-friction is the important element in the problem. Her speed is limited only by the loss or change of the wind through the effects of her own velocity. The greatest velocity of an ice-yacht is not recorded, because her finest runs occur either at unexpected moments, or when she sails over unmeasured distances. But the time over short and long courses has often been taken. The distance from New Hamburg to Poughkeepsie is over seven miles. The *Snow-Flake* ran this course in seven minutes. This is the quickest time on record; but many winters the trip has been made in from nine to ten minutes. This speed is attained with a stiff breeze on the beam or on the quarter, and when the ice is tolerably smooth and clear of impassable cracks. But an ice-yacht very seldom runs a straight course for even a mile. Various obstructions have to be avoided; the wind changes direction very often, and also comes and goes in fitful puffs over the hills. The consequence is that she makes a very crooked course at very uneven speed; she goes more than seven miles, and sails at her full speed during much less than seven minutes. Probably she flies at times from eighty to one hundred miles an hour. The speed of an ice-yacht, in working to windward, which is her poorest course, is from ten to fifteen miles an hour, against an eight to ten knot breeze.