THE TOPOPHONE.

Fogs are unquestionably the greatest menace to the mariner. When he can see a danger he has a chance to avoid it, but in a fog all he knows positively is the direction of his vessel as given him by the compass; as to the direction of warning sound signals, he has to depend on his unaided hearing. Now this is notoriously uncertain—the sense of hearing, so far as direction is concerned, is very defective even when assisted by the eyesight; witness the performance of a ventriloquist who does all the talking for several manikins on different parts of a stage. To the spectator it will seem as if the sounds proceed from the manikins, while, as a matter of fact, it is the performer who makes the sounds, and it is the spectator's imagination which gives the direction.

It is not improbable that it is also the imagination which frequently deceives the mariner. He knows, or thinks he knows, that a certain fog signal should be heard in a certain direction; he is listening for it, and when he hears it his preconceived opinion biases his judgment.

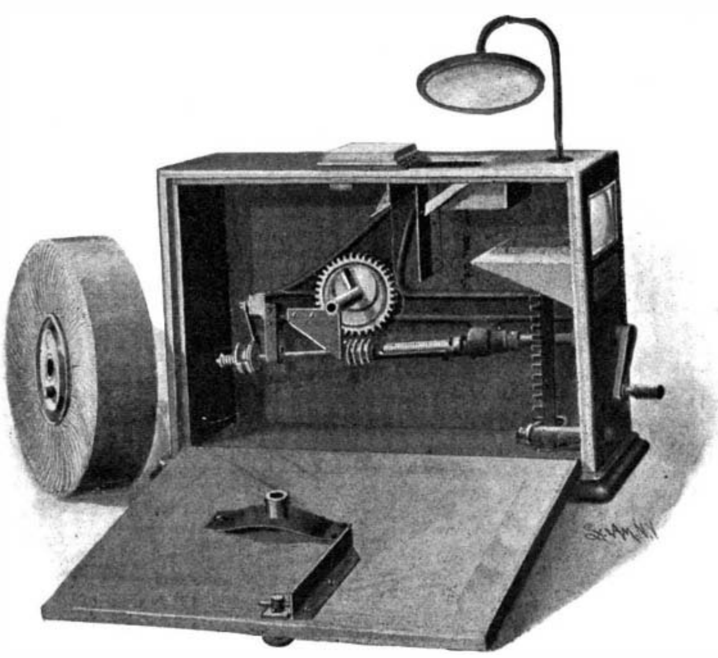
Various attempts have been made, especially of late years, to invent devices which will assist the mariner to locate his position in a fog. Fog signals themselves have been improved so as to give the sound a greater penetrating power, and wireless telegraphy and the late Prof. Elisha Gray's method of ringing bells under water have been pressed into service. The Hamilton-Foster fog-signal, which gives a distinctive blast according to the direction the fog-horn is pointed, may also be cited. All of these need special appliances, either on shore or on the vessel, or on both, to make them of any use, and all of them are so expensive as to debar their general introduction. Besides, with the exception of the Hamilton-Foster fog-signal, although a sound or a signal may be heard, its direction is not given. If the mariner knows the direction of any signal, in addition to the course of his vessel, he will be greatly assisted in keeping out of danger.

The United States government has established 393 fog-signals, 120 bell buoys, 73 whistling buoys, and 44 light-vessels with fog-signals on or near the shores of its navigable waters. Other nations have similarly guarded their coasts. Every vessel that floats is required by law to carry some kind of a fog signal. In addition, there are other sounds, such as echoes, breakers, etc., whose direction the mariner needs to know to prevent accident. The topophone has been devised to accomplish just this thing, and also to hear sounds at greater distances than is possible with the unassisted ear. With its use the mariner can determine the direction of any sound before it can be heard without the instrument. The topophone is simple in construction, light in weight, portable, can be used in any part of a vessel, and any one with normal hearing can soon become proficient in its use.

It consists of two acoustic receivers or trumpets, pointing in opposite directions and supported on a vertical shaft—see Fig. 1. From the lower ends of the trumpets extend rubber tubes connected with the ears by specially constructed ear pieces. The observer holds the shaft so that the instrument is above his head; if a sound is heard in either ear—the right ear, for example—it shows at once that the sound must be somewhere on his right-hand side. If he then turns to the right until the sound is heard in his left ear, it shows that he has passed the direction of the sound. If he then oscillates the trumpets so that the sound is heard alternately in each ear, the sound will be in a direction inside the angle of oscillation; this angle generally is about one point of the compass. The whole operation is simple, and the above operations take but a few seconds.

As soon as the direction of the sound is ascertained, the observer can keep the topophone pointed in its direction, and, knowing the speed of the vessel and its course, the location of the sound can be quickly plotted accurately enough for all practical purposes. For example: Suppose the observer locates the direction of the fog signal at Beaver Tail, at first as due north—see Fig. 3 (*A*)—that the vessel's course is NE ¼ E, and that after the vessel has gone one and a half miles the direction of the signal is west, by a very simple calculation it will be known that when the vessel was at *A* it was about one mile, and when at *B* about one and one-eighth miles from the fog-signal. If the directions of the fog-signals at Beaver Tail and at Brenton Reef Light-Vessel are determined by the topophone, the location of the vessel can at once be plotted. The topophone is the invention of Lieutenant-Colonel D. P. Heap, engineer of the Third Light-House District, Tompkinsville, N. Y.

Prof. Mayer, of the Institute of Technology, Hoboken, N. J., invented an instrument to determine the direction of sound to which he also gave the name "topophone."



SIDE DOOR OF MUTOSCOPE LOWERED, BOOK OF PICTURES REMOVED TO SHOW TURNING GEAR

The following is the description of it, taken from the SCIENTIFIC AMERICAN SUPPLEMENT of July 4, 1885:

"Briefly described, the topophone consists of two resonators (or any other sound receivers) attached to a connecting bar or shoulder rest. The sound receivers are joined by flexible tubes, which unite for part of their length, and from which ear tubes proceed. One tube, it will be observed, carries a telescopic device by which its length can be varied.

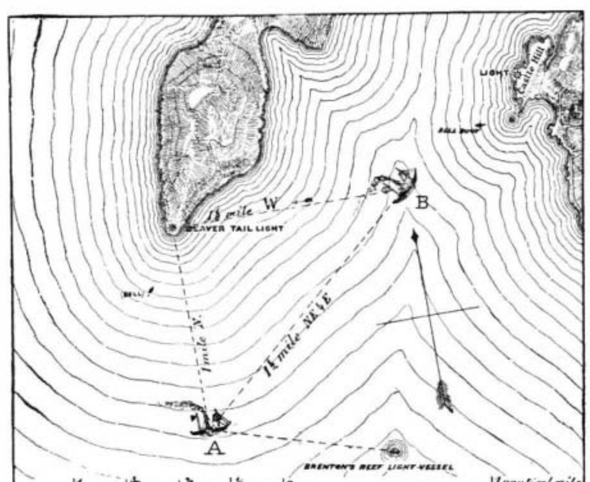


Fig. 3.—DIAGRAM SHOWING USE OF TOPOPHONE.

When the two resonators face the direction whence a sound comes, so as to receive simultaneously the same sonorous impulse, and are joined by tubes of equal length, the sound waves received from them will necessarily re-enforce each other, and the sound will be augmented. If, on the contrary, the resonators being in the same position as regards the source of sound, the resonator tubes differ in length by half the wave length of the sound, the impulse from the one neutralizes that from the other, and the sound is obliterated.

"Accordingly, in determining the direction of the source of any sound within this instrument, the observer, guided by the varying intensity of the sound transmitted by the resonators, turns until their openings touch the same sound waves simultaneously, which position he recognizes either by the great augmentation of the sound (when the tube lengths are equal) or by the cessation of sound, when the tubes vary so that the interference of the sound waves is perfect. In either case the determination of the direction of the source of the sound is almost instantaneous, and the two methods may be successively employed as checks upon each other's report."

Prof. Henry Morton, of the same Institute, experimenting with this instrument, says:

If the surface of a sound wave were always truly spherical, this instrument might locate its direction with a fair degree of accuracy, but this surface is frequently deformed, sometimes to the extent of being a curve of double curvature, and in such a case the instrument would be fatally misleading.

In addition, it is necessary that all fog-signals should be tuned to one note to make this instrument effective, as it will not locate any sound not tuned in unison with it.

Fig. 1.—HEAP'S TOPOPHONE.

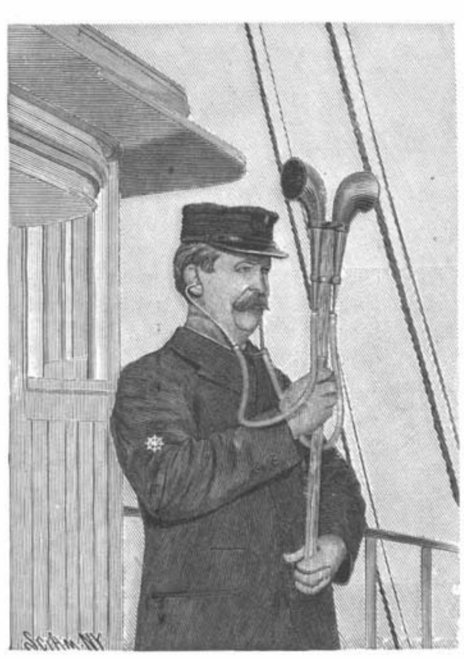


Fig. 2.—THE TOPOPHONE IN USE.

A Tunnel to the Isle of Wight.

The bringing of the Isle of Wight, off the coast of Hampshire, into closer communication with the mainland by the construction of a submarine tunnel has been proposed. The idea is by no means an original one, since it was first suggested over fifteen years ago. The scheme, at that time, was to construct a tunnel beneath the Solent, from Start Point, on the English coast, to Cowes, the yachting center on the Isle of Wight. It was, however, abandoned, principally owing to the many engineering difficulties that would have been encountered, the most serious of which was the provision of a suitable approach to the tunnel at Cowes, owing to the abrupt descent which the shore makes into the water.

The present idea, however, is to penetrate the bed of the Solent, near Hurst Castle, and to emerge upon the island at Totland Bay, near the Needles. The channel at this point is two miles in width, and the preliminary surveys have revealed the fact that the soil through which the tunnel will extend is favorable to the rapid completion of the work, so that no unusual engineering difficulties will be experienced. By this means the island, which is only accessible at the present time by steamboat lines, will be brought into close and rapid communication with the main trunk railroad in the south of England, and will thus be a valuable means of developing the island.

The enterprise is well supported financially, and the application for the necessary powers will be made during the coming Parliamentary session. It is estimated that the total cost of the project will amount to $3,750,000, and that it can be completed within two and a half years. It is proposed to construct a railway branching off trunk line of the London and South-Western Railroad at Brockenhurst, near Bournemouth, to a point on the coast of the Solent, somewhat north of Hurst Castle. This latter is really a range of buildings used principally as a Lloyd's signaling station for the mail steamers passing to and from Southampton, and is located at the end of a pebbly spit of land jutting out into the Channel somewhat similar to the Chesil Beach off Portland. The country is level at this part, so that no elaborate excavation will be necessary to construct the approach to the tunnel, the gradient of which will be gradual, since the bed of the Solent at this point has a gentle shelve. The first section of the tunnel will be constructed of circular iron plates, similar to the Central London Electric Railway, only of larger dimensions. This method has been suggested as offering the best resistance to possible scouring. When the tunnel has penetrated well beneath the sea bed it will be constructed of brick. On the island the tunnel will emerge up a gradual slope similar to that on the English shore. The total length of the tunnel and necessary approaches is to be seven miles, and the journey beneath the Solent will only occupy five minutes at the most. The line will be continued inland to Freshwater, where a junction will be effected with the insular railway system.

The construction of this tunnel will be instrumental in bringing the principal towns of the island within two and a quarter hours' railway traveling from London, whereas with the present facilities the journey occupies from three and a half to five hours. It will also enable the goods traffic to be carried on more expeditiously than it is under the existing circumstances.

When the Channel Tunnel was projected with a view to connecting Dover on the English mainland with Calais on the French coast, the British War Office vigorously opposed the scheme, on the grounds of national defense. In this instance, however, it is anticipated that the military authorities will support the scheme, since it will enable them to transfer their troops from the military camp at Aldershot, which is also upon the main line of the London and South-Western Railroad, to the island, if the exigency arose, within three hours. Near the island entrance to the tunnel exist a number of modern forts, to guard the entrance to the Solent, and in case of war troops could be concentrated at this point with the utmost celerity. The military authorities have been seriously considering the advisability of strengthening the defenses of this island, which at present is in a very vulnerable condition, so that the construction of this railroad would probably facilitate the work of the military department. At any rate, it is not at all probable that they will offer any opposition to the enterprise.

THE INTERNATIONAL RACING-YACHT "INDEPENDENCE."

The very liberal policy which is being pursued by Mr. Thomas W. Lawson, the owner, and Mr. B. B. Crowninshield, the designer, of the 90-foot racing yacht, which is now under construction in Boston, for the defense of the "America" Cup, comes in pleasing contrast to the secrecy which of late years has surrounded the design and construction of challenging and defending yachts on their respective sides of the water. The illustrations of the "Independence" on the front page of this issue are made from photographs taken in the shed where the yacht is being built, and from the working drawings, blue prints of which were kindly furnished from the designer's office. The dimension of the boat are as follows: Length over all, 140 feet 10½ inches; length on water line, 90 feet; overhang forward, 27 feet 5½ inches; overhang aft, 23 feet 5 inches; beam, extreme, 23 feet 11½ inches; beam at water line, 23 feet 5 inches; draft, extreme, 20 feet; freeboard at stemhead, 6 feet 11 inches; freeboard at taffrail, 4 feet 8 inches; freeboard, least, 4 feet; deck beam at forward end of water line, 15 feet; deck beam at after end of water line, 18 feet 9 inches; beam at taffrail, 11 feet 8 inches; area of lateral plane, 772.6 feet; area of midship section, 117.9 feet; area of L. W. L. plane, 1,771.5 feet; wetted surface, with small rudder, 2,913.5 feet; with large rudder, 2,956 feet; displacement, 146.75 tons.

Assuming that the new defender which Herreshoff is building will be an improved "Columbia," as "Columbia" was an improved "Defender," it is interesting, with the plans of the Lawson boat before us, to compare the points of difference between "Independence" and "Columbia." In the first place, comparing the midship section, the "Independence" has a harder bilge, a flatter floor and the curve at the garboards is of much smaller radius; in these respects, indeed, she is not unlike the "Shamrock." As we leave the midship section, the difference between "Independence" and "Columbia" becomes very marked. In the "Columbia" the bilges begin to ease away rapidly toward the bow until at the forward end of the water line the cross section of the bow approximates a blunt V form, thus giving a sharp and easy entrance and water lines that do not lengthen much as the boat heels to a breeze. Aft of the midship section the run and quarters of the "Columbia" are remarkably fine and easy, and although in a breeze she lengthens her water line almost to the taffrail, the form is such that there is but little perceptible drag, or quartering wave, when the vessel is reaching in a strong breeze. The characteristics of "Independence" are her extremely long overhangs, giving her an overall length fully 10 feet greater than that of any previous cup defender. Coupled with this great length is the fact that she carries her hard bilges and flat floor well out beyond the normal 90-foot mark, both forward and aft, thus providing an extremely long, flat floor and a great gain in water-line length when the boat is heeled. With this form of hull it is possible to carry a maximum amount of sail with a minimum amount of ballast, and as a matter of fact "Independence" will carry only 75 tons of lead in her keel as against the 85 to 90 tons which are generally credited to the "Defender" and "Columbia."

Perhaps the best idea of the full bow and stern sections and natural sail-carrying power of the yacht is derived from a consideration of the load-water-line plane as shown on the accompanying plan, and the photographic views of the interior of the hull looking toward the bow and toward the stern from the mast-step. Here it will be seen how the flat floor extends practically the whole length of the yacht, the hard curves at the bilges being maintained well into the bow, and carried out to the 79th or last frame, as shown in the cross-section of the hull at this point. Although there will be a certain bluffness in the bows it must be admitted that once entrance has been made, the lines of the yacht will be such as not merely to provide great sail-carrying power, but a form which will lend itself to high speed. Even when driven to the limit, the "Independence" should leave a wonderfully smooth wake behind her. It will be noticed that two rudders are provided; the after rudder will be used in place of the forward one, if the sailing trials prove that its more powerful control is necessary.

Considered from a structural standpoint, the new yacht shows how the principles of framed structures, as used by the engineer in bridge building, are being applied to yacht construction. The peculiar model of "Independence," with her great overhangs and shallow depth, renders the task of meeting and distributing the intense local strains which are set up in the structure of such an extreme racing yacht most difficult. For instance, it will be noticed that the mast is stepped fully 10 feet forward of the stem and at a point where the molded depth of the boat is not more than 4 feet and the draft 2 feet. Upon the thin bronze bottom of the boat, which at this point is less than ¼ of an inch in thickness, is to be carried the enormous vertical load of the mast with its towering structure of spars, canvas and rigging, a load which is intensified by many tons when the vessel is heeled to a breeze, and the vertical component of the pull of the shrouds is added to the normal dead-load of the mast. This vertical thrust is met by interposing between the heel of the mast and the plating of the hull a deep, cellular structure of steel plates, which measures 12 feet in width by 14 feet in length, and is 2½ feet deep at the center. This structure is riveted upon the frail floor of the boat, and serves to distribute the load of the mast throughout the surrounding framework of the hull. Associated with the mast foundation is a series of four, special, transverse, deck-beams, extending across the deck in the wake of the mast, which are in reality bowstring trusses, 17 inches in depth at the center, of great vertical stiffness. From the bottom of these trusses a number of ⅞-inch steel tie-rods are carried down through the steel ring which forms the step of the mast and secured by knots below the bottom face of the same, thereby transmitting a portion of the mast load directly to these deck beams. Moreover, it will be seen from the transverse section of the boat at the mast-step that the special deck beams above mentioned and the mast-step framing are connected by a system of trussing, composed of 2⅝-inch hollow steel struts and 3 by 3-inch angles. As the transverse strains which are set up at this point in a racing yacht when she is being pressed to the utmost in a strong breeze are enormous, not only is there the great downward thrust of the mast as above explained, but there is the upward pull of the shrouds on the side of the boat which in itself will run up to the total of a great many tons. The deep deck beams and the cellular structure of the mast step, with the triangular bracing of the angles and struts, together constitute a true bridge structure, admirably adapted to take care of the intensified local stresses at this point, and distribute them over a broad area of the delicate shell of the yacht.

Another interesting study is the provision made for giving the necessary longitudinal strength to the long, overhanging bow and stern of "Independence." It will be noticed that there is a deep, vertical keel-plate which varies from a depth of 9 inches at the bow to 18 inches at the point where the fin keel commences. At the center line of the deck there is also a horizontal steel plate of the average width of 18 inches associated with the vertical plate which is from 6 to 8 inches in depth. Between these two members, which might be called the top and bottom chords, there is worked in a system of tie-rod bracing and vertical, hollow, steel struts, the rods varying from ⅞ of an inch to one inch in diameter and the struts from 1½ inches to 2 inches in diameter. This construction provides what is practically a deep steel truss which extends from the stiffened framing at the mast out to the end of the overhanging bow. The necessity of trussing of this kind will be appreciated by those of us who remember what happened to the over lightly built bows of the 70-footers of last season, which, yielding to the enormous upward pull of the head stay and topmast stay, were drawn upward out of their proper line from 12 to 14 inches. The after overhang, it will be noticed, is similarly trussed, the tie-rod bracing, however, running only in one direction—being put in, doubtless, to assist in carrying the weight of the crew, when it is massed toward the taffrail to keep the bow of the boat up when she is running before the wind. The hull is further stiffened by four lines of stringers, two on each side, with 2-inch tubular struts, extending from the stringers to the deck beams.

There are 79 frames in the yacht, spaced about 2½ feet apart. The frames consist of nickel-steel angle bulbs. The plating of the hull is of bronze from the keel to the sheer strake, which latter is of steel. From amidships to a little forward of the mast the sheer strake is 9-32 of an inch in thickness, while from forward of the mast to the bow it is ¼ of an inch, and from amidships to the stern it is ¼ and 3-16 of an inch in thickness. From the garboard strake to the sheer strake the bronze plating is 7-32 of an inch and ¼ of an inch in thickness amidships and 3-16 of an inch thick forward and aft. From the garboard strake to the bottom of the keel the bronze plating is ¼ of an inch and 5-16 of an inch in thickness, while the bottom plate of the keel is a bronze casting ⅝ of an inch in thickness. In constructing the yacht the keel was first built up and riveted, and then pig lead, with shot to fill up the interstices, was stowed, until 62 tons of the same was in place. Molten lead was then run over the top, to form a crust, and keep it in place. After the yacht is afloat, about 13 tons of pig lead will be stowed above this until the vessel has reached the desired trim. The deck beams are angle bulbs of the same weight as the frames. The deck plating is of steel and aluminium, distributed as follows: Continuous steel side stringers run from stem to stern, and vary in diameter from 3-16 by 10 inches at the ends, to ¼ inch by 2 feet in width amidships. There is also the longitudinal centerline steel plate, already referred to, which varies from ¼ inch by 2 feet amidships to 3-16 of an inch by 1 foot in the ends. The deck is covered with 3-16 of an inch steel plating for a distance of 10 feet forward and aft of the mast. The rest of the deck is plated with aluminium. As the displacement of "Independence" is given as 146¾ tons and the total lead ballast will amount to about 75 tons, it is fair to presume that the total weight of the hull, spars, rigging, sails, stores and crew, when the boat is down to her 90-foot water line, will be about 72 tons.

There can be no question of the great originality and skill with which the construction of this interesting boat has been worked out. The peculiarity of her form, her great sail-carrying capacity, involve that she will be put to severer strains than any yacht of her size that has yet been launched; and we think that the designer is to be congratulated upon the success with which he has combined lightness and strength in producing a powerful form. Had the "Independence" been built upon what might be called the commonly-accepted lines of a 90-footer, and had there been less originality shown in the design, there would not be the great public interest attending her trials against the Herreshoff boat which is now certain to be manifested.

Electric Wind-Registering Apparatus.

A new apparatus for registering the direction of the wind is in use at the observatory of the Agronomical College, at Berlin, which permits of registering eight directions of air-currents by electrical means, using but two pendulums, each provided with a stylus. The apparatus carries at the top a vane of the usual type, carried upon a rod which passes below and has on its lower end a metal sector which may rub over four contacts placed at the corners of the platform carrying the pivot of the rod. The dimensions of the sector are calculated so that it may touch but a single contact or two adjacent contacts. The movable sector is connected to one of the poles of a battery. Each of the four contacts has a wire which passes to the coil of an electro-magnet and the four magnets are placed horizontally so that between each of the two pairs of coils oscillates a pendulum carrying the ink stylus. The other ends of the coils are connected with the other pole of the battery. With this arrangement each of the two pendulums will be attracted to the right or to the left according as one or the other contact is touched by the revolving sector; if the sector touches two contacts at once the two pendulums will be attracted either in the same or contrary directions. If the contacts 1, 2, 3, 4 correspond to the directions N., S., E., W., of the compass, suppose that the pendulum I. is deviated to the left by contact 1 and to the right by contact 4, while pendulum II. is deviated to the right by contact 2 and to the left by 3. Under these conditions a left deflection of the pendulum I. alone indicates N.; while the same deflection, combined with that of pendulum II. to the right, indicates N. E., etc. If the indications are to be given at regular intervals, the wire from the coils to the battery passes through a relay and clock mechanism by which the circuit is closed at periods of 5 or 10 minutes, etc. The current required to work the apparatus is very small.

The famous statue of Voltaire, by Houdon, is probably the most important art object displayed in the Théâtre Français. The fire in the theatre last year excited great alarm for the safety of this precious souvenir of the French stage. The architect of the new building has designed means by which, in case of emergencies, the statue can be moved out of danger. A series of wheels has been arranged under the pedestal so that the mass can be moved with as much ease as if it stood on a trolley.